TE TUPU NGĀTAHI
SUPPORTING GROWTH

North
Appendix K – Economic Assessment

May 2023

Version 1

WAKA KOTAHI NZ TRANSPORT AGENCY

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Disclaimer

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

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Introduction

Purpose

This report details the economic appraisal for the North Detailed Business Case (North DBC) integrated network at the Supporting Growth Alliance (Te Tupu Ngātahi) programme. The North DBC proposes upgrades to existing rural corridors, new urban corridors, and new strategic connections including a rapid transit corridor and dedicated cycleways to support the expected future growth in the North areas of Milldale, Silverdale, Whangaparaoa, Wainui, Silverdale West and Dairy Flat. The North indicative business case (IBC) recommended that both local and strategic level projects were required to support future growth in the North. The evaluation is based on the standard evaluation methods for transport infrastructure, which is typically dominated by travel time savings. Some of the schemes' main purpose is about providing the basic infrastructure to make things happen and although travel times may improve for those living in the area this is a secondary consideration.

The North DBC considers 23 projects and are split into strategic and local interventions. For the purposes of this economic assessment the analysis has grouped the projects as follows:

- Strategic corridor package (shown in **Figure 0-1**) includes:
  - Rapid transit corridor (RTC) and AMC along the RTC corridor
  - SH1 Improvements which includes active modes corridor (AMC) , Redvale, Wilks Road and Silverdale Interchange improvements
- Local projects package (shown in **Figure 0-2** below) includes:
  - Wainui / Pine Valley arterials
  - Silverdale West arterials
  - Dairy Flat arterials

An economic appraisal has been undertaken on each of the five components, as well as the combined North DBC package. This appraisal is undertaken in accordance with the Waka Kotahi NZ Transport Agency's Monetised Benefits and Cost Manual (MBCM) V1.5. All costs are reported in NZD unless otherwise stated.

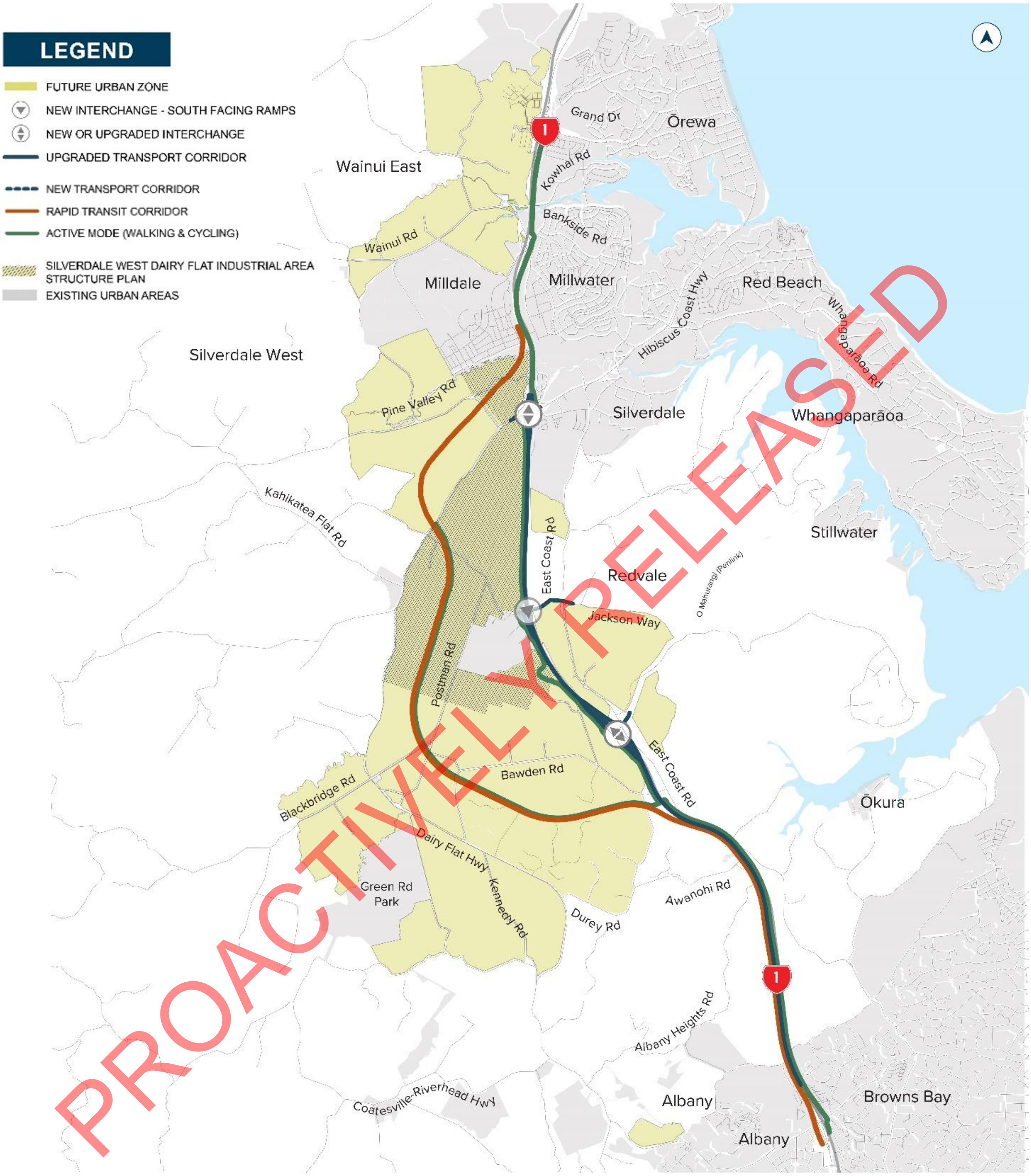

Figure 0-1: Strategic corridors in North DBC

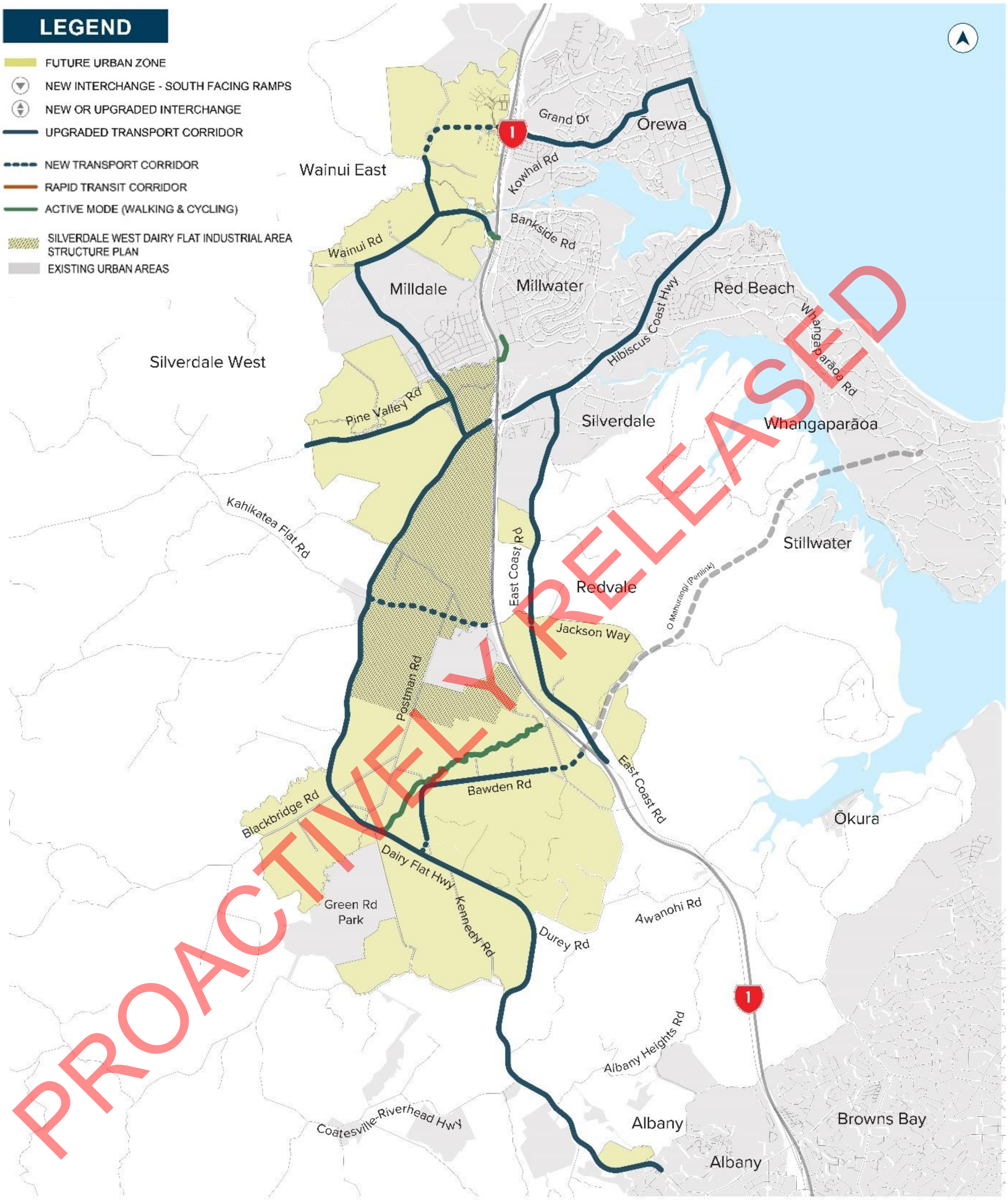

Figure 0-2: Local projects in North DBC

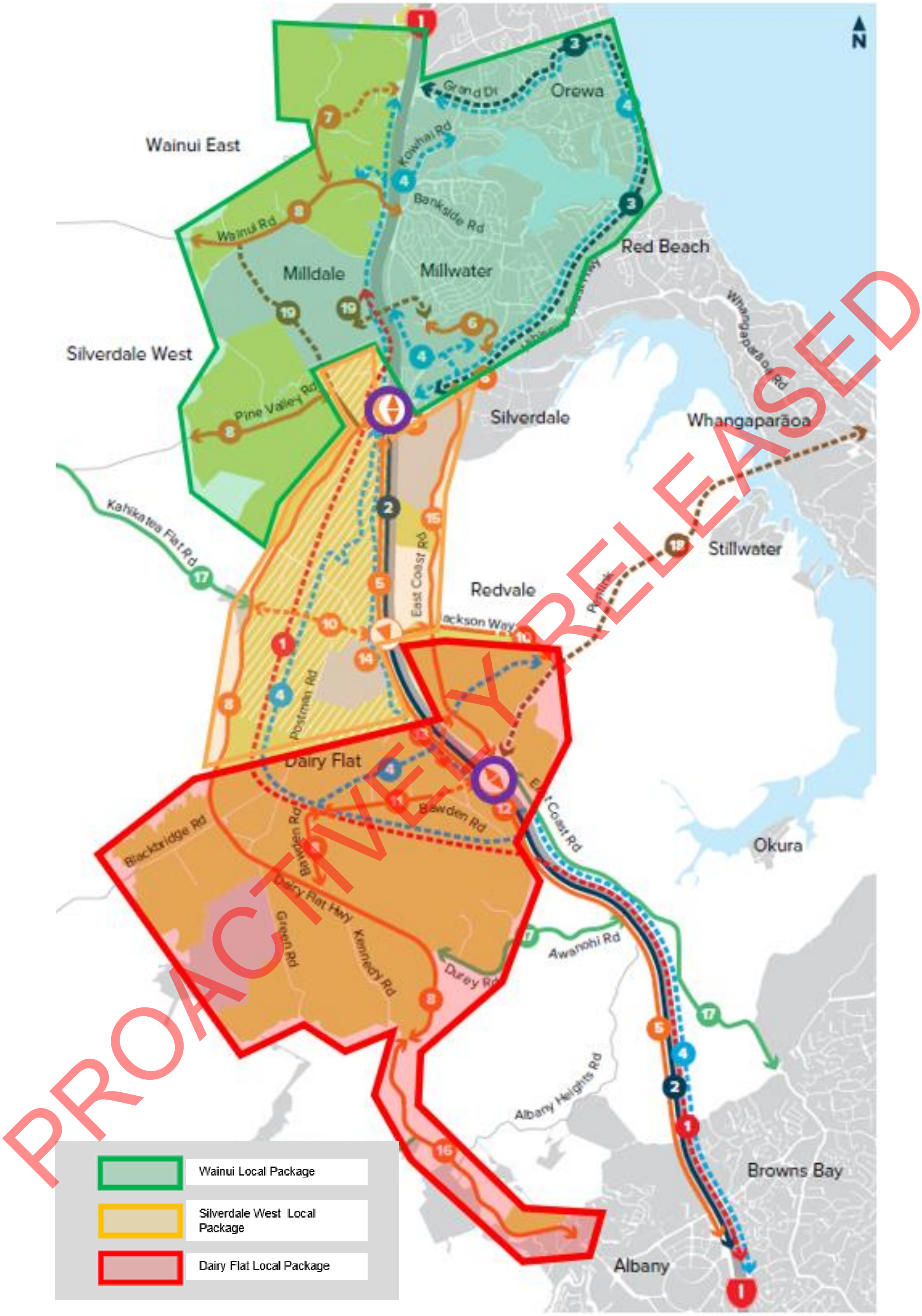

Figure 0-3: Local projects Area split by - Wainui, Silverdale West and Dairy Flat

Approach and Key Issues

The North DBC is for the purposes of route protection, rather than imminent implementation. The appraisal has therefore been targeted at this decision (to progress to route protection), rather than at a more detailed assessment that could be expected for an implementation decision. The appraisal has also been undertaken in the context of the following key issues:

- Estimates of the type, scale, sequencing and rate of growth have been made for the DBC. However, the resulting growth is highly uncertain and subject to other regulatory processes such as Structure Plans, Plan Changes, sub-division consents and economic demand.
- The Te Tupu Ngātahi Programme, via its owners and partners, will make decisions on the implementation of specific projects based on separate prioritisation and decision processes over the next 30+ years
- The Te Tupu Ngātahi business cases have focused on the transport elements and footprints to support the long-term, full build-out of the area. The actual land use development is likely to occur progressively in stages, which allows more detailed sequencing and staging decisions (e.g. some corridors could be improved with initial upgrades that are expanded in later years). This is particularly important given the, as yet unknown long-term effects of COVID-19 pandemic.
- The Te Tupu Ngātahi programme identified a network of improvements to support the growth with the desired outcomes for this area. However, the Te Tupu Ngātahi network is planned to compliment some planned upgrades in the area, including the Argent Lane Extension, Milldale / Highgate Bridge and O Mahurangi Penlink. Whilst those projects are independent of the Te Tupu Ngātahi programme elements, the appraisal of the Te Tupu Ngātahi programme elements is dependent on the assumptions made about the timing of those other elements. It is currently assumed those other elements will be implemented progressively between 2021 and 2031, but this is still subject to funding being confirmed.

Based on the purpose, scope and identified issues, the appraisal has adopted some key principles:

- A level of detail suitable to the route protection decision, rather than imminent implementation
- A focus on the appraisal of the full build-out project rather than analysis of fine-grained staging options
- Simplified modelling approach with limited analysis of project inter-dependencies, rather than extensive analysis of the various possible combination of project sequencing in the wider network
- Analysis of the project under a range of potential scenarios of project timing, discount rates etc, rather than a focus on a single BCR
- Each of the five component packages has been assessed against a ‘reference’ do minimum (DM) scenario (that includes an assumed sequencing of adjacent projects), rather than a ‘true’ DM that includes only committed projects. This is to avoid the potential for double counting of common benefits that would be assigned to whichever project is assumed to be implemented first.
- The overall combination of Te Tupu Ngātahi programme elements (all five component packages) termed as “Combined Package” in this report, has been considered against an overall ‘reference’ DM package. This provides a framework to enable consideration of the combined benefits of the Te Tupu Ngātahi programme elements, as there are anticipated to be benefits arising from the combination of network elements that may not be captured in the evaluation of each individual element.

Modelling Tools and Assumptions

Modelling Tools

The transport user costs and benefits have been estimated based on a suite of transport models, owned by the Auckland Forecasting Centre (AFC). The models include:

- **The regional, multimodal, macro strategic model (MSM)**. This creates estimates of car, truck, and public transport (PT) movements at a regional level based on land use, network, and policy inputs. This model is the primary tool to estimate future regional PT usage and provides the basis for the more detailed forecasts for the road network described below. Generally, these models are run using regional assumptions as per recent Auckland Transport Alignment Project (ATAP) planning, but with scenario-specific inputs in the Te Tupu Ngātahi growth areas. Models for years 2028, 2038, 2048 and 2048+ have been run and their outputs were used for obtaining traffic matrices for traffic models, PT benefits, crash savings, and wider economic benefits (WEBs).
- **Emme traffic model**. This uses the traffic demands from MSM on a more detailed representation of the road network and have more refined zone system. The traffic model in Emme is developed from the MSM network by adding more details to the network from traffic perspective. For the economic analysis, the outputs from the traffic model are extracted from the same scenarios i.e., reference option and DM scenarios for the modelled years 2028, 2038, 2048, and 2048+.
- **A strategic active modes model (SAMM)**. This tool gives strategic-level estimates of walking and cycling demands that respond to land use, the quality of the walking and cycling network, and the relative change in costs for competing car and PT modes. It derives land use and network data directly from MSM whilst using a more refined zone system. MSM zones are disaggregated to a smaller zone system for use in SAMM, i.e., MSM covers the Auckland region via some 600 zones, while SAMM covers the same area via some 1,100 zones. The refined zone system was deemed necessary to obtain more precise trip costs, particularly for shorter and intra-zonal trips. The model has a strong interface with MSM to provide key inputs but can be operated independently to assess specific changes to the active modes network.

MSM is used to derive PT user benefits and provides traffic demand estimates for the traffic model. The traffic model is used to estimate benefits to general traffic, while SAMM was used to estimate benefits to walking and cycling, as shown in **Figure 0-4**. Each mode (PT, general traffic, walking and cycling) are appraised separately, albeit with the changes in mode share reflected in the demands for each mode.

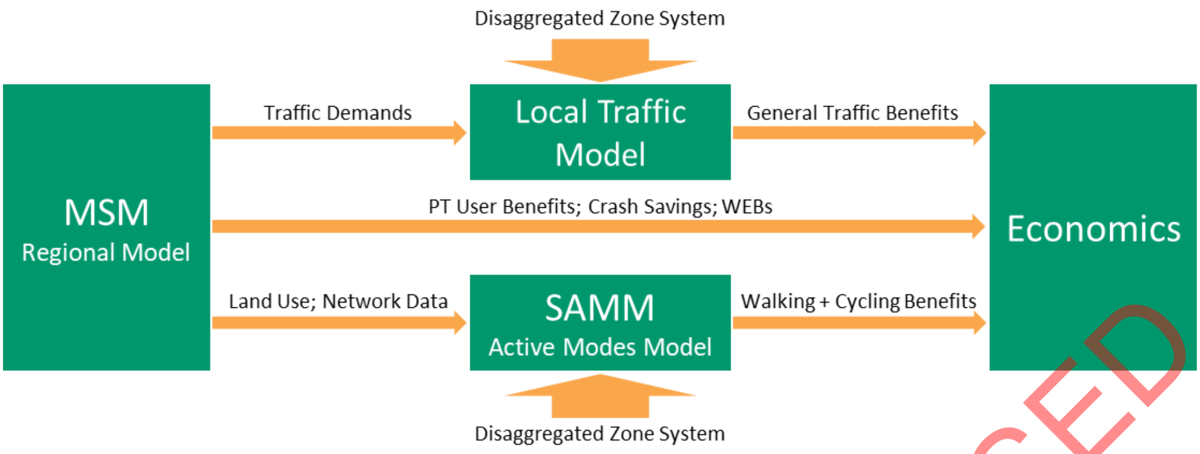

Figure 0-4: Suite of Transport Models

Although MSM was suitably validated against observed 2016 conditions, analysis against 2013 census data indicated that not all 2016 commuter trip distribution patterns were well replicated. However, because the land use in the growth areas will significantly transform travel patterns in this area, those 2013 patterns will be of limited relevance to those future conditions. This means that while the changes in the predicted travel patterns and benefits which form the key element of this economic appraisal appear plausible, the total travel movements will continue to have some uncertainty. Additionally, longer term changes in travel behaviour due to COVID-19 could eventuate such as higher frequency of working from home. As these remain highly uncertain, no changes have been made to the model inputs or parameters to reflect COVID-19 changes in travel pattern. Considering this however, sensitivity tests have been undertaken (see **Section 0**), including with 25% less benefits, which to a large extent would cover this issue.

Modelling Key Principles and Assumptions

Land Use Information

The modelling has been based on the regional growth assumptions reflected in land use 'scenario i11.6' forecasts released by AFC in mid-2020.

The scenario i11.6 forecasts are based on Statistics NZ medium population growth estimates for Auckland. In those forecasts the staging of greenfield growth is based on the direction indicated in Auckland Council's Future Urban Land Supply Strategy (FULSS). The standard Scenario i11.6 forecasts extend to the year 2048, however, an additional scenario was developed for Te Tupu Ngātahi referred to as 2048+. This is based on the standard 2048 forecasts but reflects full build-out in the greenfield growth areas which would occur beyond 2048. The timing for full development build-out is uncertain, however for the purposes of this appraisal the 2048+ model results were allocated to the year 2053, estimated from the typical rate of growth predicted for the area. The allocation of the 2048+ benefits to year 2058 have been sensitivity tested and discussed in Section 4.2

In some parts of the Northern growth area, a large proportion of the land use growth (both residential and employment) is forecast to occur in the period to 2048+ (i.e. beyond 2048). Figures 1-5 and 1-6 below illustrate the forecast employment and household growth respectively. The transport modelling has been completed for both 2048 and 2048+ forecasts years, but in terms of the economic evaluation, the timing of growth and hence supporting infrastructure, necessarily means the evaluation period will extend well beyond the modelled scenarios.

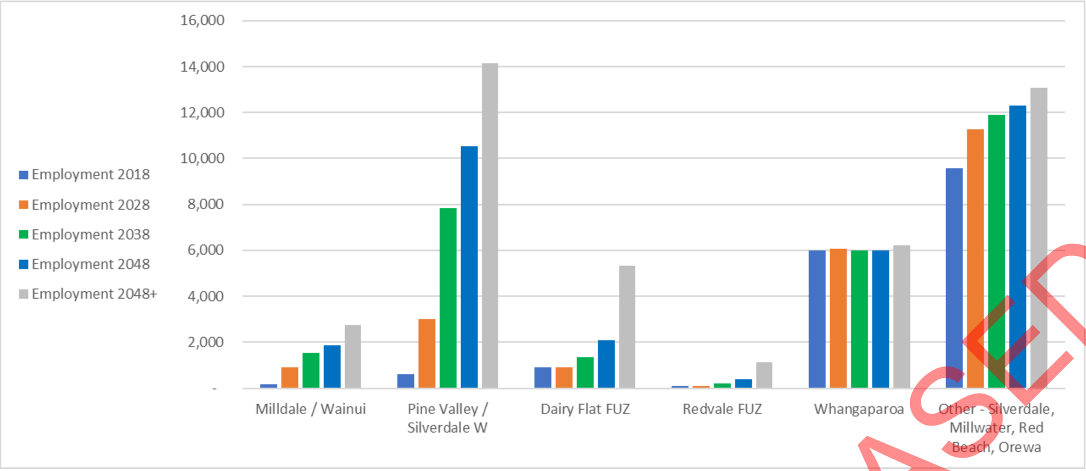

Figure 0-5: AC growth scenario i11.6 by area - Employment

Figure 0-6: AC growth scenario i11.6 by area - Household

Option and Do Minimum Model Development Process

Due to the inter-dependencies with other projects in this area, DM and option scenarios were created for each modelled year, based on a reference scenario. The reference scenario included an assumed sequencing of the full IBC network. For example, the 2028 reference model only included a subset of the DBC networks, while the 2048+ reference model included the full DBC network.

If the project being appraised (e.g. the RTC / AMC), was included in the reference model for the forecast year, then this was used as the option scenario. A matching DM was then created for that year that excluded the project being assessed. If the reference model did not include the candidate project, then this was adopted as the DM. An option scenario was then created by adding the candidate project. As the local arterial corridors have been assessed as three area packages, this approach was adopted across each of the local packages.

For example, in the 2048+/2048 models, the reference model was adopted as the option scenario for the BCR assessment of RTC. The DM for RTC was created by removing it from the 2048+/2048 models. For the overall assessment of all North DBC schemes, the DM was developed by removing SH1, RTC and other corridor upgrades in the Wainui, Pine Valley, Silverdale West and Dairy Flat area. This method can generate lower benefits for individual elements in later years compared to project being evaluated in isolation (as it assumes all other projects are in place). This interdependence is discussed later in **Section 0**.

<u>North DBC Components Assumptions</u>

There are uncertainties around the project implementation year. Hence, some broad assumptions are made on the construction start date based on the expected implementation period. The construction periods were assumed based on advice from the Te Tupu Ngātahi North DBC design team, as below. The staging of the Projects as planned is shown in

Figure 0-7 where,

- Stage 1 projects are modelled in year 2028
- Stage 2 projects are mdoelled in year 2038
- Stage 3 projects are modelled in year 2048
- Stage 4 projects are modelled in year 2048+

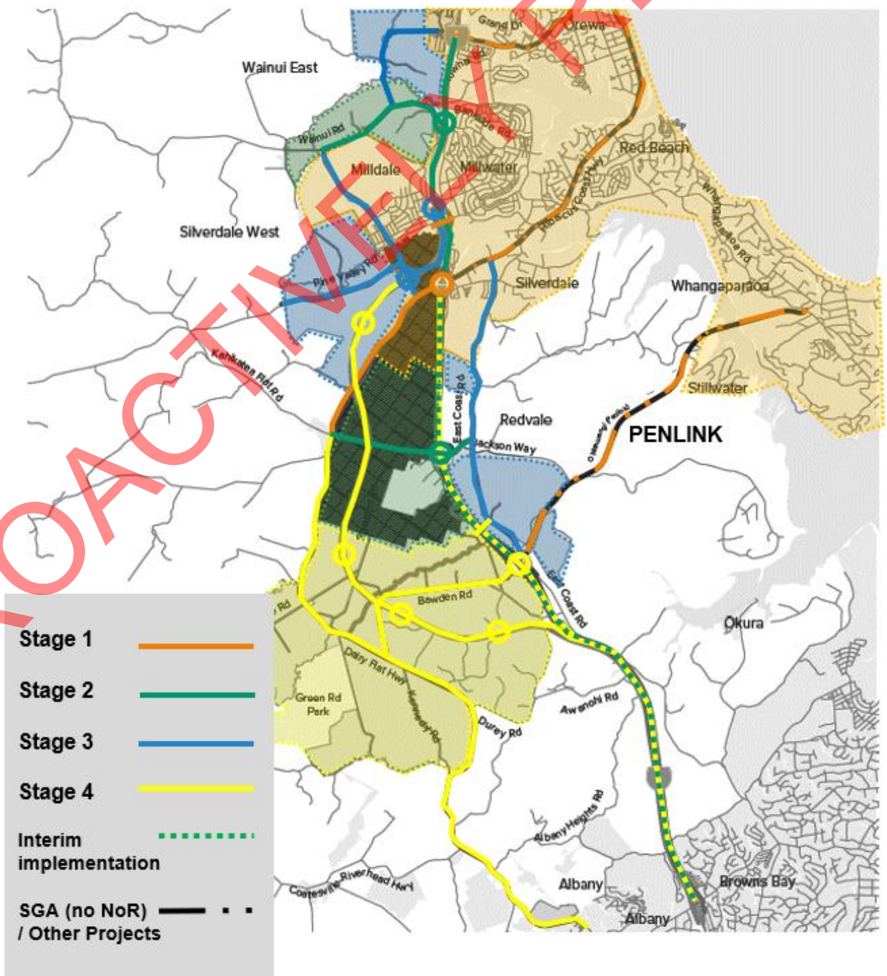

Figure 0-7: North DBC Staging

- **RTC / AMC strategic corridor package** – The project is assumed to be implemented in year 2047 and benefits to be realized in 2052.
- **SH1 strategic corridor package** – The project is constructed in stages where the interchange upgrades and SH1 bus lanes (Oteha valley to Redvale) occurs in 2031-2036. The bus lanes are extended to Silverdale in the next decade and are later replaced by general traffic lanes as a part of SH1 widening. Hence, it is assumed that the project construction starts 2036.
- **Wainui/ Pine Valley arterials local package** – The project is assumed to be implemented between 2026 and 2044. Hence, it is assumed that the construction start date be mid-year of the period and will begin by 2035.
- **Silverdale West arterials local package** – The project is assumed to be implemented between 2036 and 2044. Hence, it is assumed that construction year is 2040
- **Dairy Flat arterials local package** – Majority of the Dairy Flat local package upgrade is likely to occur in 2049

The time zero is the date that all future cost and benefit streams are discounted to. Time zero for all proposed activities is standardised to 1 July of the financial year in which the analysis is submitted. Time zero is independent of the construction date of a proposed activity and therefore all options being assessed must use the same time zero. The 'time zero' and the project construction period for the North DBC projects are given in in **Table 0-4**.

Modelling of the Public Transport Benefits

The PT benefits are directly derived from MSM for all the modelled years for the strategic projects. For the local package projects, the MSM PT volume was used to calculate benefits.

The strategic corridor packages are expected to contribute to PT benefits and usage as follows:

1. The proposed RTC between Albany and Milldale will serve the North growth areas and is expected to contribute PT user benefits by the more frequent and faster services (reducing travel times), increasing capacity (via reduced crowding), and improved reliability (more system reliance). The more attractive services are also expected to attract users from cars with resulting decongestion benefits for remaining vehicles on the network.

2. Access to the RTC will be supported and enhanced by the complementary and adjacent AMC in Dairy Flat and Silverdale, which is expected to provide health benefits and improved station access.

3. Improved access to SH1 between Albany and Silverdale is expected to contribute to PT benefits by providing a new interchange at Wilks Road and upgraded interchange at Redvale, and widening SH1 to provide bus shoulder lanes in the short-medium term.

The local packages are also expected to contribute PT benefits as follows:

1. PT benefits are expected from reduced travel times by providing new and/or improved bus priority facilities on Dairy Flat Highway, Bawden Road, Hibiscus Coast Highway, Grand Drive, the new Argent Lane and new Pine Valley Road.

2. Moreover, the reference option was modelled to have an improved headway, relative to the do minimum, for local bus services with the rationale that PT travel time savings from the proposed bus priority facilities will enable a higher frequency of bus services, leading to higher patronage. This assumes that AT will increase the frequency of these services, allowing them to make better use of the assets involved. Although this headway difference is expected to result in greater benefits, it will also result in higher PT operating costs to AT in the reference option.

Modelling of Walking and Cycling Benefits

SAMM was run only for the full build-out 2048+ scenario, with benefits allocated to earlier years based on assumed growth profiles. SAMM was run with the full North DBC active mode network (reference option) and without the proposed active mode facilities (do minimum). This provided the combined package active mode benefits. To isolate the benefits of strategic projects AMC benefits two models were developed excluding the RTC AMC and SH1 AMC from the North DBC Network to obtain the corresponding AMC benefits. For the local packages, the contributions of each project package are assumed based on their estimated contribution to the overall network, after allowing the benefits for RTC and SH1 AMC components.

The provision of active mode facilities (i.e. the proposed SH1 and RTC AMCs along with local walking and cycling projects) is expected to contribute to walking and cycling benefits as follows:

1. Providing a complete, connected and legible active mode network improving accessibility to key employment and social destinations within North Auckland.

2. Providing safe, dedicated and separated active mode facilities (compared to the limited existing cycleways and onroad unbuffered cycle lanes), reducing the risk of exposure for those choosing to walk or cycle in North Auckland.

3. Providing facilities to accommodate for the anticipated uptake of active modes and increased walking and cycling demand.

Modelling of Traffic Benefits

The traffic benefits are calculated from the traffic model which has more detailed modelling in the region between Ōrewa and Albany than in MSM. The proposed changes as part of the North DBC are expected to be primarily relatively local, hence the detailed network for the traffic is considered only in the North region as mentioned above.

The North DBC is expected to bring about considerable amount of traffic benefits in the region due to the following:

1. The RTC is expected to reduce congestion along the motorway, by providing alternative travel corridor by PT services from Mildale to the City Centre. While the SH1 widening and interchange improvements will reduce the travel time from the Silverdale, Redvale and Dairy Flat areas.
2. The SH1 widening also creates a safe and resilient network by allowing extra road space for the travel to/from city Centre, reducing traffic on the internal or rural road corridors
3. There is improved accessibility for the people living in the Dairy Flat FUZ areas due to the new connections in the local areas (e.g. Bawden road connection to the motorway)

4. The Wainui/Pinevalley, Silverdale and Dairy flat arterials alleviate the traffic conditions by providing more direct connections between the regions (e.g. Grand drive connection between Mildale and Grand drive and Industrial Arterial between Kahikatea Flat Rd to East coast Road)

Modelled Scenarios

For the purpose of economic assessment, scenarios were modelled in MSM and the traffic model. **Table 0-1** summarises the modelled year and the scenarios modelled in MSM and the traffic model. Program-wide North DBC which includes all the project components (RTC,SH1, Wainui, Silverdale West and Dairy flat) was developed for all the modelled years (2028, 2038, 2048 and 2048+) to understand the annual benefits contribution of each package and this have been discussed in detail afterwards . For the reference scenario the projects were modelled in the relevant years based on staging as shown in the

Figure 0-7.

Table 0-1 summarises the modelled year and the scenarios for individual packages as described below:

For the **RTC / AMC** assessment, the Te Tupu Ngātahi North reference is the option and the DM was developed by removing the RTC / AMC proposals. The RTC / AMC models are developed in MSM for years 2048+ and 2048 and the traffic model only for year 2048+.

For the **SH1** assessment, the Te Tupu Ngātahi North reference is the option and the DM was developed by removing the proposed SH1 upgrades. The SH1 models are developed in MSM for years 2048+ and 2048 and the traffic model only for year 2048+.

The local project packages were modelled only in the traffic model using fixed demand matrices from the relevant MSM scenario, which is either the North DBC Reference Scenario or North DBC Do minimum Scenario, which was decided based on the staging of the Projects. The local project BCR also includes the walking and cycling benefits obtained from SAMM (once the benefits associated with the strategic AMCs have been identified):

- For the **Wainui / Pine Valley** assessment, the 2028 and 2038 option scenarios were developed by upgrading the Wainui / Pine Valley corridors (e.g. Hibiscus Coast Highway, Grand Drive, Wainui Road, Argent Lane, and new connections) to the reference configurations, which was compared against the DM model. For the 2048+ assessment, the DM scenario was developed by downgrading the Wainui / Pine Valley corridors to the DM configurations, which was compared against the reference model.
- For the **Silverdale West** assessment, the 2028 and 2038 option scenarios were developed by upgrading the Silverdale West corridors (e.g. Dairy Flat Highway, East Coast Road, and new connections from Kahikatea Flat to Postman Rd) to the reference configurations, which was compared against the DM model. For the 2048+ assessment, the DM scenario was developed by downgrading the Silverdale West corridors to the DM configurations, which was compared against the reference model.
- For the **Dairy Flat** assessment, the DM scenario was developed by downgrading the Dairy Flat (e.g. East Coast Road, Dairy Flat Highway, Bawden Road, and Dairy Stream Road Crossing) to the DM configurations, which was compared against the reference model.

Table 0-1: Scenario List

BCR Scenario	Option Scenario	Do minimum Scenario	Modelling Suite used and Modelled Years
RTC / AMC	Reference Scenario with Full North Projects included	Without RTC	MSM – 2048+/2048 Traffic model – 2048+
SH1	Reference Scenario with Full North Projects included	Without SH1 upgrades	MSM – 2048+/2048 Traffic model – 2048+
Wainui / Pine Valley	2028 & 2038: Adding Wainui / Pine Valley upgrades to the Do Minimum Scenario 2048+: Reference Scenario without Dairy Flat upgrades	2028 & 2038: Do Minimum Scenario without North Projects 2048+: Reference Scenario without Dairy Flat upgrades minus Wainui / Pine Valley upgrades	Traffic model – 2048+/2038/2028
Silverdale West	2028 & 2038: Do Minimum Scenario with Silverdale West upgrades 2048+: Reference Scenario without Dairy Flat upgrades	2028 & 2038: Do Minimum Scenario without North Projects 2048+: Reference Scenario without Dairy Flat upgrades minus minus Silverdale West upgrades	Traffic model - 2048+/2038
Dairy Flat	Reference Scenario with Full North Projects included	Without Dairy Flat upgrades	Traffic model - 2048

A **Combined Package BCR** was also estimated by summation of individual project costs and benefits to account for the different start times of each of the packages as described in the **Table 0-2**. For the purpose of overall benefits check, the benefits for the North DBC programme-wide models have been assessed by comparing the reference case with an absolute DM scenario (which excludes SH1, RTC/AMC and all the local package upgrades).

It was found that the summation of the individual project traffic benefits was lower than the total package benefits in year 2048+. This could be the result of the strong interaction between the projects, which brings about higher traffic travel time and congestion savings as a combined effect, rather than individual implementation, as was identified in the North West DBC.

Similar to the North West DBC, the benefits of each individual project could be understated due to them being compared against partially or fully developed networks, rather than against a true DM network. In the North West DBC, to understand the contribution of strategic projects and the local projects in the overall savings, a further model was developed to estimate the combined benefits of strategic projects and it was found that the combined benefits of the strategic projects (RTC and ASH) in 2048+ was about twice the aggregate of individual projects in place. Hence, the difference between the sum of the individual project benefits and combined benefits was majorly distributed to the strategic projects with small uplift to the local packages proportionally. For the North DBC, the sum of individual projects is 73% of the combined package unlike to 50% in North-West. Hence, a similar methodology was adopted, where the difference of the sum of the individual projects and combined package is distrubted between the strategic projects proportionally, with no uplift made to the local projects.

Three scenarios were modelled in SAMM for year 2048+. The reference option was developed by adding the AMC to the MSM reference network, relevant cycle facility upgrades and zone connector refinements. **Table 0-3** lists the active mode models developed in SAMM for year 2048+. The benefits of the total combined package were assessed from scenarios 1 and 2 while the contribution of the AMC along RTC and SH1 was estimated using scenario 3 and 4 respectively.

Table 0-3: SAMM Scenario List

No.	SAMM Assessed Scenarios	Comparison
1	North Reference Active Mode Scenario	Option
2	North Do minimum Active Mode Scenario	Do Min
3	No RTC AMC	Do Min
4	No SH1 AMC	Do Min

Evaluation Framework

The economic evaluation is consistent with the Waka Kotahi NZ Transport Agency's MBCM, 2021.

Economic evaluation approach

The overall economic evaluation is based on the following assumptions:

- Base values of time (VoT), vehicle operating costs (VOC), etc. are derived from the values set out in the MBCM (Version 1.5), updated to current values with a base date of 1 July 2021 using update factors in **Table 0-5**.
- Assessment of base and congested travel time benefits from the traffic models due to the reasons detailed in **Section 0**
- Assessment of base running VOC from the traffic models
- Time zero, construction start date and duration specified for each sub-project as in **Table 0-4**
- Analysis period is 40 years, but sensitivity tested at 60 years
- Discount rate 4% applied to all annual benefits and costs, but sensitivity tested for 3% and 6%
- Traffic reliability benefits assumed as 8% of the base travel time benefit, as a standard approach.
- Following analysis for local project packages, public transport reliability benefits was estimated as 70% of PT user benefits in the commuter peaks and 40% in other periods.
- Carbon dioxide (CO_2) benefits are calculated from the vehicle emissions prediction model (VEPM) version 6.3, with (upper bound) rates as per the MBCM and specified in **Table 0-5**
- Travel Time user cost is a mixture of Urban Arterial and Rural Strategic composite costs. The North DBC project traffic benefits are largely associated with Urban projects. As such, it is expected to have 90% urban arterial share and rest 10% as rural strategic. This aligns with the assumed share estimated for Te Tupu Ngātahi South DBCs and North West DBC. For

robustness, a test with 100% urban arterial share was undertaken and the BCR remained unaffected.

- Walking and cycling benefits were estimated based on trip demand and travel cost matrices from SAMM, using the same method as used for PT benefits in the MSM, and using same approach as South DBCs.
- As a sensitivity test, WEBs were calculated, in accordance with the MBCM, then applied to the project using an adopted percentage uplift on the conventional benefits. The analysis is done for three principal types of WEBs (agglomeration impact, imperfect competition impact, and labour supply impact).
- Beyond the 2048+ modelled year (assumed to be allocated to year 2053) benefit growth is assumed to remain constant with no further benefits growth.

The key assumptions and parameters are discussed in further detail below.

Table 0-4: Time Zero, Construction Start Date and Period Assumption

Project Components	Time Zero	Construction Start Year from Time Zero	Construction period (in years)
RTC / AMC BCR	1 July 2023	25	5
SH1 BCR	1 July 2023	14	3
Wainui / Pine Valley BCR	1 July 2023	13	2
Silverdale West BCR	1 July 2023	18	2
Dairy Flat BCR	1 July 2023	27	2

Table 0-5: Update factors for benefits

Item	Base date	Update factor
Travel time costs	July 2002	1.59
Vehicle operation costs	July 2015	1.15
Crash cost savings	July 2015	1.10
Passenger transport user benefits	July 2008	1.28
Walking and cycling benefits	July 2018	1.06

Table 0-6: Update factors for cost[1]

Calendar year in which estimate prepared	Factor to adjust to July 2021
2017	1.11

[1] Update factor only applied to station and track maintenance costs based on estimates from 2017

Expansion of Benefits from Transport Models

Annualisation factors for private transport are shown in the following tables. The below factors are based on analysis of current traffic patterns.

Table 0-7: Traffic annualisation factors (2-hr MSM and traffic models)

Period	Modelled period used	Equivalent hours per day	Days per year
Weekday AM	AM	1	245
Weekday PM	PM	1	245
Weekday Interpeak	IP	3.6	245
Weekday evening/night	IP	1.9	245
Weekend / holiday	IP	6.5	120

A different set of factors was used for PT indicators, as its usage profile is different from the private cars.

Table 0-8: Annualisation factors for public transport (2-hr models)

Modelled Period	Annual factor
AM	245
Interpeak	1524
PM	245

The SAMM model provides daily estimates of travel, so an expansion factor of 365 was assumed.

Analysis Period

The economic analysis was carried out for a 40-year analysis period as a base estimate, but sensitivity tested for 60 years

Benefits Analysis and Discussion

The benefits analysed for the North DBC economic assessment are discussed below and the outcome is enumerated in **Section 5**.

Traffic Travel Time and Congestion Savings

The travel time costs have been calculated based on the matrix-based traffic model outputs. The travel time components included:

- Base travel time; and
- Congested travel time (defined as 'CRV' in the MBCM).

The base travel time applies to the total travel times, whereas the CRV has been applied to the mean delay time from the transport model outputs. In theory, CRV should be applied to where the CRV value has been applied to sections of road deemed congested, such as:

- Urban roads in the model use the methodology for urban roads, whereby CRV only applies to links with a volume/capacity (V/C) ratio greater than 70%; and
- All bottleneck delay, such as at intersections.

However, due to the nature of the matrix-based outputs, the CRV has been applied to all the mean delay time calculated by the transport models, due to the inability to distinguish individual V/C on each section of road for each origin-destination pair. This is deemed to be acceptable given minimal delays at V/C lower than 70%.

Traffic Reliability Benefits

The travel time reliability can generally be improved by upgrading the road network, improving the connectivity and improving the public transport services. Traffic reliability was assumed to be 8% of the travel time benefits, as standard approach and consistent with South and North West Te Tupu Ngātahi business cases. However, we acknowledge that with increased levels of congestion this may underestimate the full reliability benefits.

Vehicle Operating Costs

VOCs for private travel were estimated based on applying running costs to the traffic model outputs. PT operating costs were included as a system cost item (rather than user cost).

Active Mode Benefits

The active mode benefits were calculated from SAMM based on the change in demands and generalised costs (the same method used for PT benefits from MSM). The road sections where cycling facilities are upgraded are designated as buffered or protected cycle lane in the Option as shown in the cycle facility map in **Figure 0-1** below and are measured against the DM where cycle facilities and footpaths are excluded (except the ones present in the base year) as in **Figure 0-2** and **Figure 0-3**.

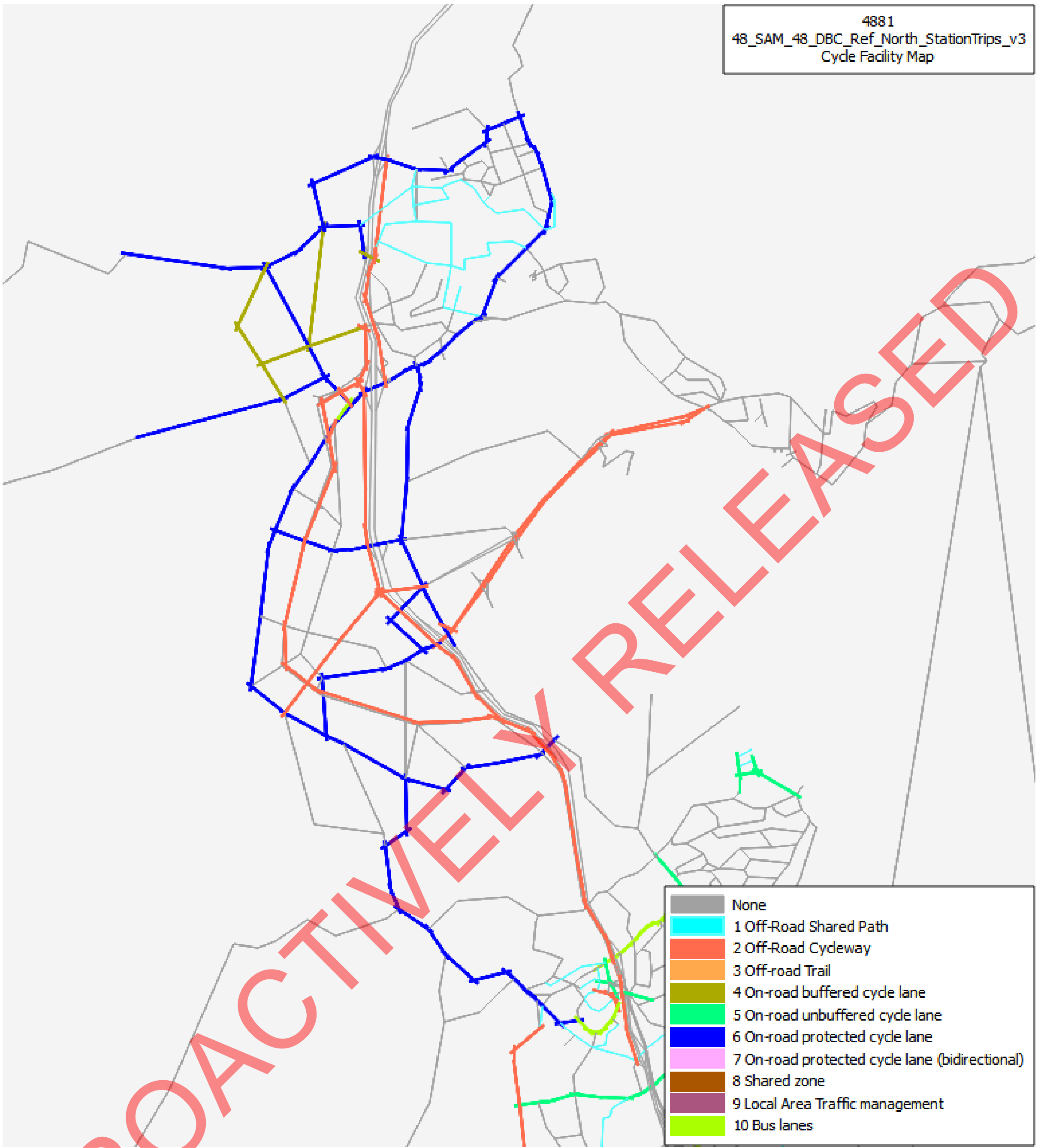

Figure 0-1: Cycle facilities for Reference Active Mode Scenario in 2048+

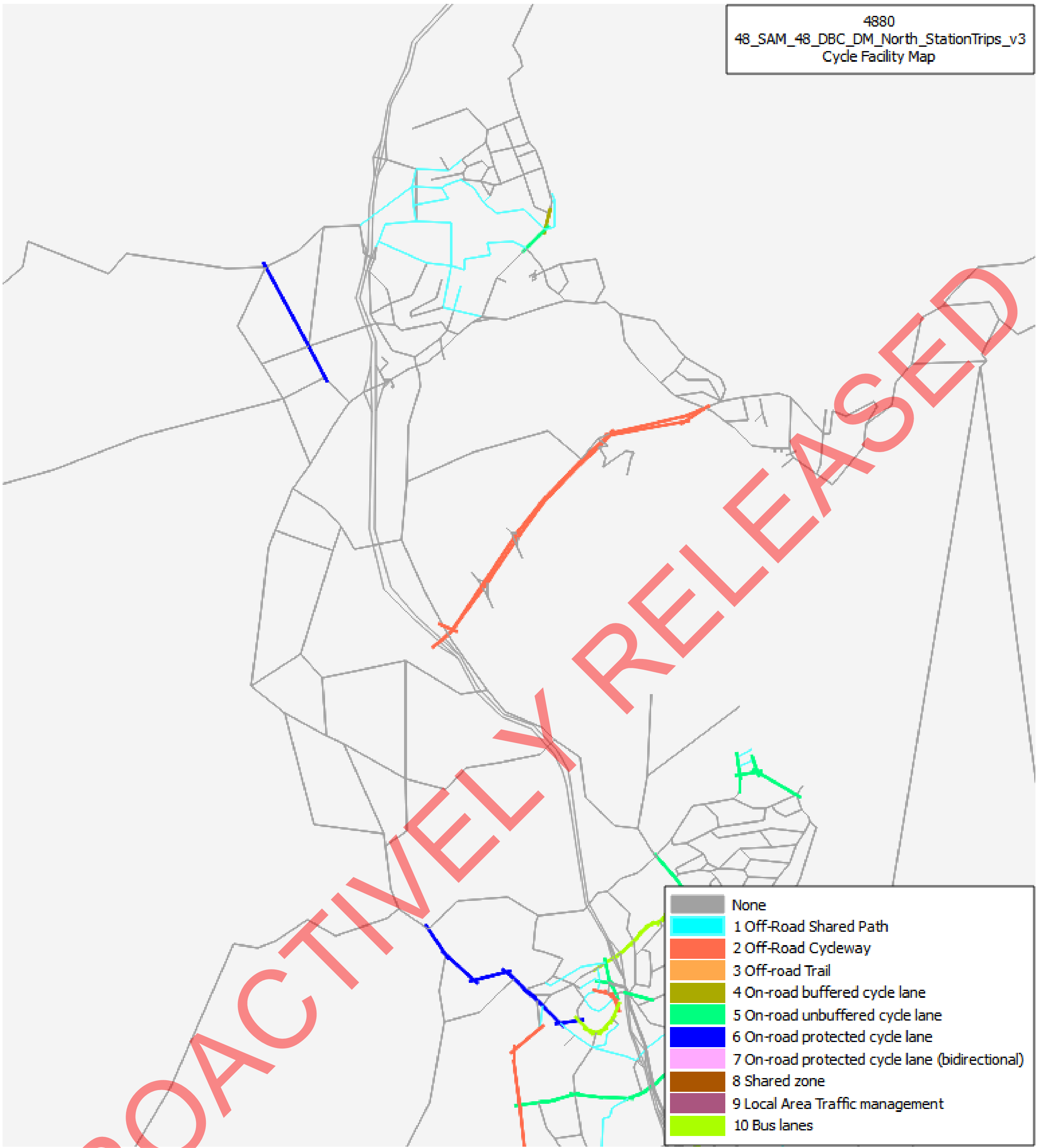

Figure 0-2: Cycle facilities Do Minimum Scenario (without AMCs and local active mode facilities) in 2048+

The walk benefits are measured by removing the footpath on some of the rural roads in the DM where the footpath does not exist in the base year as shown in red in **Figure 0-3**.

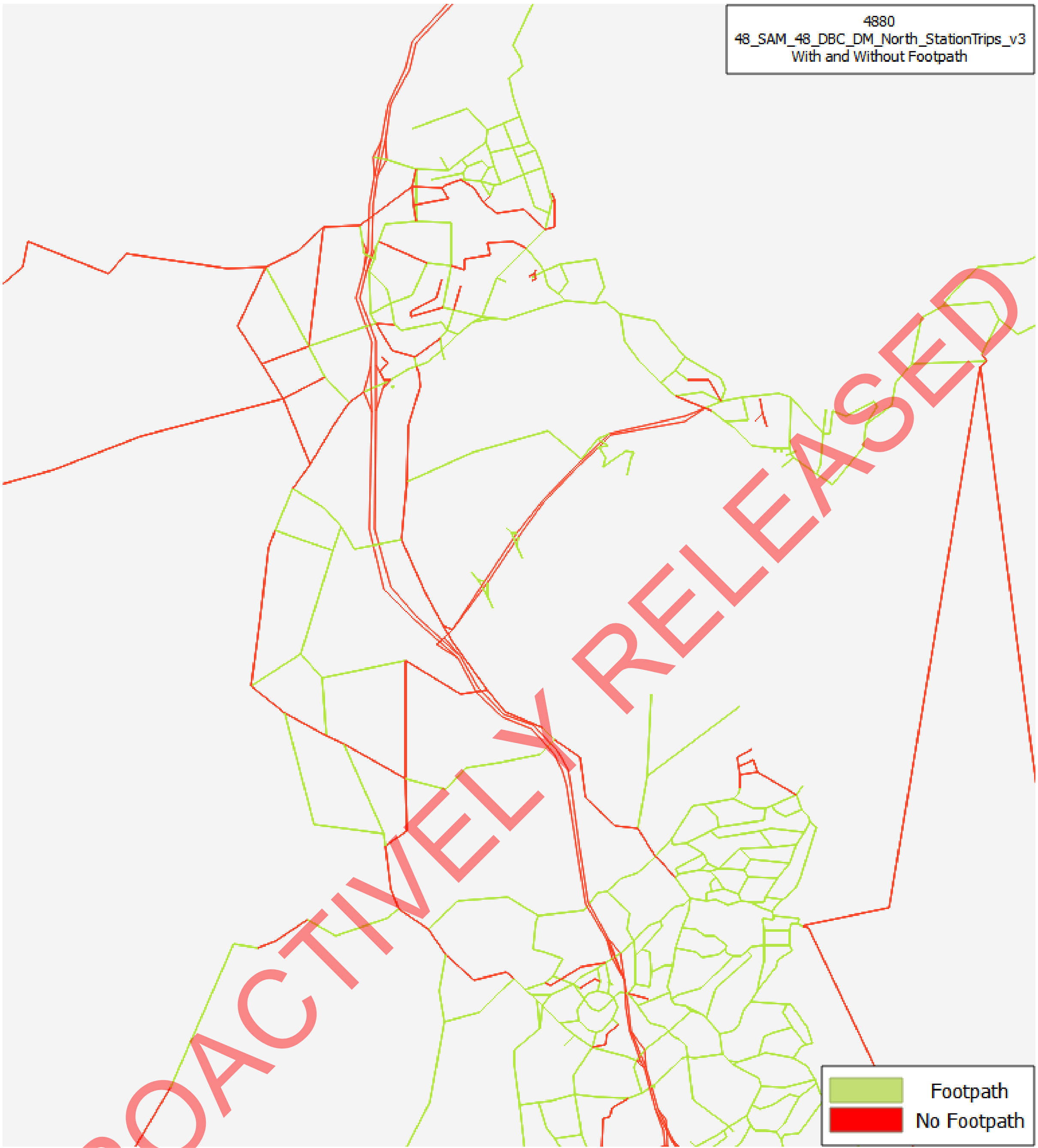

Figure 0-3: Footpath locations in Do Minimum Scenario in 2048+

There are various components to the active mode benefits as shown below:

Travel time Benefits

The user travel cost benefits were assessed using the demand and perceived cost matrices in SAMM. They are split into two purposes: home based work (HBW) and other (including home based education (HBE), home based other (HBO), and non-home based). The value of time used for the HBW purpose is $7.80 per hour and for non-work travel purpose is $6.90 per hour, which are then multiplied with the update factor of 1.59 (year 2021).

Due to the provision of the regional active mode corridor with high quality facility there is better connectivity between regions with efficient travel corridor. Also, the corridor being exclusively for active modes leads to travel time savings for the cyclists. It is expected to obtain reasonable travel time savings for the active mode users for the local package areas (Wainui) due to provision of upgraded cycle facility and availability of footpaths facilitating better connectivity. The North programme-wide active mode travel time benefits are shown in **Table 0-1.** Differences in the quality of the routes are reflected in the attributes incorporated in SAMM which are similar to those included in the MBCM.

Table 0-1: Active Mode Travel Time Benefit – Year 2048+

Mode	Base	Option	Benefits (generalised minutes)		VoT, $/hr		Update Factor	Annual Factor	Annual TT Benefit ($M)		
			HBW	Other	HBW	Other			HBW	Other	TOTAL
Cycle	DM	Preferred	3,809	4,627	7.80	6.90	1.59	365	0.29	0.31	0.60
Walk	DM	Preferred	1,380	174,173	7.80	4.49	1.59	365	0.10	7.56	7.66

Note: The value of time for the Walk Other trips has been reduced by 35% of the EEM recommended to account for the TDM effect in MSM (conversion of a proportion of mechanised short trip (<3km) to active mode trips in MSM) turned off for HBO trips. This have been agreed during the Drury local peer review process as the reviewer considered Walk Other purpose benefits to be potentially over-stated relative to HBW purpose. Additionally, for evaluation purposes the walk trips beyond 6 km and cycle trips beyond 30 km were removed to avoid particularly long trips.

Health Benefits, Safety and Decongestion Benefits

Road traffic reduction and health benefits were estimated from the change in the amount of walk and cycle km as obtained from SAMM. The walk and cycle km were calculated in SAMM by multiplying the walk and cycle trips with the walk and cycle distance travelled, respectively. The change in predicted walk and cycle km is multiplied with the cyclist ($2.20 per cyclist per km) and pedestrian ($4.40 per pedestrian per km) composite benefit factors, as obtained from the MBCM. These are updated to year 2021 by applying the update factor of 1.06.

The decongestion benefits obtained due to cycling are calculated by multiplying the change in cycle km by the road reduction factor and the number of car users who experience mode shift. It is calculated as the ratio of car diversion rate (65%) and car occupancy (1.2 persons). The road traffic reduction factor of $1.54 per vehicle per km was obtained from the MBCM, but because SAMM only provides daily demand this was reduced by 50% to make allowance for lower decongestion outside the peak periods. The decongestion benefits were updated to year 2021 by applying the update factor of 1.28. The safety benefits for cyclists are obtained by multiplying the cycle km with the safety factor of $0.05 as obtained from MBCM SP11[2] and updated to year 2021 by applying the update factor of 1.10.

[2] The safety factor has no reference in recent MBCM but is present in SP11 calculation worksheet.

Table 0-2: Active Mode Health, Safety and Decongestion Benefit – Year 2048+

Mode	Base	Option	Km Increase	Health factor	Benefits ($M)		
					Health	Safety	Decongestion
Cycle	DM	Preferred	2,886	2.2	2.46	0.06	0.56
Walk	DM	Preferred	5,738	4.4	9.77	-	-

The active modes benefits were assessed from SAMM for year 2048+, with benefits of earlier years being assessed as a proportion of the 2048+ benefits, based on the population data of zones (using land use scenario i11.6) affected by the active modes network. The assumed proportions for the interim years are as follows:

- 2028 = 10%
- 2038 = 20%
- 2048 = 35%
- 2048+ = 100%

Crash Cost Savings

Crash reduction benefits were estimated using average crash costs per VKT for different road categories, as used in the IBC. This captures both changes in the total VKT (e.g. from mode shift) and from shifting traffic between different road categories. The crash rates used were calculated based on the total recorded crashes in the Auckland Region between 2013 and 2017 and the VKT by road type and speed from the 2016 MSM regional model and are outlined in **Table 0-3**.

Table 0-3: Crash Costs per Type of Road

Road Type	Speed	Veh Km (millions/year)	Crash Cost (million NZ$/year)	Cents/Veh km
Motorway	All speeds	4,687	126	2.69
Arterial	<80	4,659	526	11.28
	>=80	68.97	10	14.56
Local	All speeds	1,698	140	8.22
Rural	<80	486	22	4.43
	>=80	1,390	243	17.46
All categories		12,991	1,066	8.20

This method assumes that the new roads proposed would perform only as well as the 'average' arterial roads in Auckland. This would not capture the higher standard of road proposed, which could be expected to have a better crash performance due to fully separated walking and cycling facilities, wider berms and medians, reduced vehicle access and hence turning conflicts etc. To reflect this, the standard road crash rates were reduced for travel on the new roads.

The expected reductions for individual treatments for elements included in the project (e.g. separated cycle facilities, flush medians, etc) were identified. Those reductions varied between 4% and 55%, depending on the treatment and type of crashes addressed. As a result, an overall 20% reduction was adopted as representative of the higher standard roads proposed through adoption of current safe-system and Vision-Zero policies and standards.

The network-wide crash cost savings are obtained by multiplying the veh-km savings from the traffic models with the crash rate and then updated to year 2021 by applying the update factor of 1.10. It is expected to have some crash cost saving due to reduced VKT with mode shifts from private vehicles to PT in the reference option. However, due to the intensive upgrade of the roading projects, there is increase in induced demand all over the network, reducing the benefits obtained from mode-shift.

Public Transport Users Benefits

The PT user benefits are estimated by multiplying the VoT (as obtained from the MBCM) of each trip purpose to the passenger hours obtained from MSM. The VoT used for HBW purpose is $7.80 per hour, for work travel purpose is $23.85 per hour, and for other non work travel purpose is $6.90 per hour; these were then updated to year 2021 by applying the update factor of 1.59.

Compared to the Do Min, the Option scenario has higher PT services in terms of frequency and capacity. The new stations provide better PT accessibility and increased PT services along the Dairy Flat growth areas improves the Public transport demand substantially.

The SH1 gives minor negative public transport benefits since, some public transport trips are converted to car trips due to the improved car accessibility in 2048+.

The MSM was not considered sensitive for the the local packages PT benefits. Hence, a simplified approach was adopted which assumes that the difference of PT benefits between combined package and sum of the individual strategic projects will be allocated to the local packages in proportion to the patronage in those areas.

It is acknowledged that the PT journey times will have an impact on the benefits. But this approach is used only to understand the contribution of each package towards the total public transport benefits.

The percentage contribution in 2048+ is deemed reasonable based on the public transport interventions undertaken for each region. They are as below:

- Wainui – 9%
- Silverdale West- 3 %
- Dairy Flat – 19%

The allocation of PT benefits is obtained highest for the Dairy Flat region in 2048+, this is deemed appropriate since there is increased operation of feeder buses operated to service the RTC stations (3 out of 5 stations are modelled within the Dairy Flat region). Next being Wainui is deemed reasonable, as with the Grand Drive connection there is increased accessibility for PT passengers in this region.

Public Transport Reliability Benefits

The provision of RTC and increased PT services is expected to improve overall network PT reliability by reducing congestion to PT and allowing PT services to operate promptly, increasing mobility for people who cannot or do not want to drive and reducing reliance on private vehicle travel. For simplicity it is assumed that The PT reliability will be 70% of PT user benefits for the commuter peak and 40% for interpeak for all projects. Though, as per North-West DBC it is expected that the RTC will have higher reliability than assumed and lower for SH1 but given the scale of PT benefits this is not expected to change the BCR largely. The PT reliability sensitivity test is carried out to cover this.

Public Transport Health Benefits

In addition to the health benefits obtained using SAMM as described in **Section 0**, a certain amount of health benefits was also obtained from the PT walk trips (trips that walk to the stops or stations to access PT services) predicted from MSM.

The construction of the RTC provides increased rapid transit capacity and the stations improve the rapid transit accessibility, which leads to increase in station/stop access walk trips in the options. The health benefits obtained due to PT walk trips from MSM for year 2048+ are shown in the table below.

Table 0-4: PT Stop/Station Walk trips Health Benefits from MSM – Year 2048+

Scenario	Health factor	Update Factor	Km Increase	Annual Health Benefits ($M)
Preferred	4.4	1.06	23,403	$39.8
RTC	9.9	1.06	23,549	$40.1
SH1	9.9	1.06	-3,603	-$6.1

The disbenefit identified for SH1 is due to it resulting in a mode shift from PT to cars leading to decreased walking.

The difference of PT health benefits between the modelled package benefits and the summation of RTC and SH1 was distributed between the local package in proportion to the PT benefits split.

Carbon dioxide Emissions

The carbon dioxide (CO_2) emissions are calculated from traffic models using the VEPM 6.3 emission rates. The difference in Option and DM models gives the emission impact due to the project.

There is decrease in CO_2 due to the implementation of RTC, as it leads to decreased private vehicle usage. SH1 generates higher car usage and in turn adds to the CO_2 emission, but this effect is relatively small. Overall, the North DBC Package reduces the annual level of emissions as seen in

Table 0-5. The economic benefit of the emissions is calculated by multiplying the social cost per CO_2 tonne emitted as per the upper bound rates provided in the MBCM[3].

Table 0-5: Annual Emission benefits (NZ$ million) for the modelled years – North DBC Programme-wide

Year	Social Cost of CO_2 ($/tonne)	Annual CO_2 Emission savings (in tonnes)	Annual Emission cost saving ($M)
2028	143	1,162	0.17
2038	178	1,538	0.27
2048	222	4,638	1.03
2048+	246	14,462	3.55

Other emissions like volatile organic compounds, NO_x and particulates were assessed and it was found that the emission savings were comparatively insignificant. It is noted that with latest MBCM (version 1.6), these emission savings are likely to increase substantially.

Wider Economic Benefits (WEBs)

Given the scale of the proposed improvements and its impact in the future urban mobility in the area, it was deemed likely that that there would be significant WEBs. The WEBs were initially assessed using the MBCM procedures from the 2048+ MSM models. After consideration of the results, a method was adopted that involved a fixed uplift in the conventional transport benefits.

The analysis is done for three principal types of WEBs:

- Agglomeration impact;
- Imperfect competition impact;
- Labour supply impact and more productive jobs impact.

The total WEBs evaluated for the North DBC are shown in **Table 0-6**.

[3] The social cost of CO_2 used for 2048+ is the upper bound value for year 2053, extrapolated from the values provided in the MBCM.

Table 0-6: WEBs by Type Determined from MSM Models 2048+

Item	Benefits ($M)
Agglomeration impact	118.6
Imperfect competition impact	29.9
Labour market impact	2.1
Total WEBs	150.6
WEBs percentage	24%

As shown above, the WEBs were estimated as 24%, as a conservative approach the present economic appraisal adopted 15% uplift over the conventional benefits (for each year) in the sensitivity tests for including WEBs.

Project Costs

Capital Cost

For the BCR calculations the expected cost (P50) is used . The following Table 0-1 summarises the cost estimate for each individual project.

Table 0-1: Expected Capital cost (P50) and Property Cost of North DBC (undiscounted costs, NZ$ million)

[redacted] s 9(2)(j)

The P95 given in the Table 0-2 is used for cost sensitivity test as reported in **Section** Error! Reference source not found.

[redacted] s 9(2)(j)

Operation and Maintenance Costs

Operating and maintenance costs associated with each project were assessed as follows:

[redacted] s 9(2)(i)

s 9(2)(i)

[redacted]

s 9(2)(i)

[redacted]

Benefits-Cost ratio (BCR)

National BCR Outputs

Based on the methodology described above, the net present values of benefits were evaluated and summarised in **Table 0-1**. The core results for the North DBC package components generated from a set of 'core' assumptions.

Table 0-1: Summary of Core Benefits of Individual projects in North DBC ($ million PV)

Items	NPV Benefits ($m)					
	RTC	SH1	Wainui Arterials	Silverdale West Arterials	Dairy Flat Arterials	Combined North DBC
Traffic - Travel Time Benefits	447	889	35	243	3	1618
Traffic - Congestion Benefits	179	195	5	18	-29	368
Traffic - Trip Reliability	36	71	3	19	0	129
Traffic - Vehicle Operating Costs	-20	49	12	39	-59	21
Active Modes	9	17	89	8	20	143
Crash savings	5	10	0	3	0	18
PT - Travel Time Benefits	474	3	81	32	132	723
PT - Reliability	249	5	39	16	64	373
PT - Health benefits	242	-23	24	11	22	276
CO2	14	-2	1	3	-3	12
PV total net benefits excluding WEBs	1635	1213	290	393	150	3681
PV of total net costs	919	1251	516	198	480	3365
National BCR Excluding WEBs	**1.8**	**1.0**	**0.6**	**2.0**	**0.3**	**1.1**
WEBs %	15%	15%	15%	15%	15%	15%
WEBs Benefits	245	182	43	59	23	552
PV Benefits Including WEBs	1880	1395	333	452	173	4233
National BCR Including WEBs[4]	2.0	1.1	0.6	2.3	0.4	1.3

[4] The National BCR including WEBs is considered as sensitivity test as per MBCM

Key Observations

- The PT user benefits comprise the major portion of benefits for RTC which appears reasonable for this scale and type of Project. There are also significant benefits for car users from the reduced congestion.
- The SH1 improvements with the widening and interchange upgrades is expected to improve travel time benefits significantly, when compared to the use of the existing SH1 corridor.
- For the Wainui package main proportion of benefits comes from walking and cycling and public transport usage. This is considered reasonable, considering that the Wainui upgrades were mainly focussed on active mode improvements, and providing improved PT services along the area.
- The Silverdale West package shows higher level travel time savings and its mainly driven by the new connection between Kahikatea Flat and East Coast Road termed as Industrial Arterial.
- The Dairy Flat Package exhibits a high level of public transport user benefits and these are driven by intensified feeder bus system in the area to service the RTC stations
- The North DBC Benefits composition from each package is shown in the **Figure 0-1** which indicates that RTC comprises major portion of North DBC Benefits followed by SH1, Silverdale West, Wainui and Dairy Flat
- The North DBC Package has 58% traffic benefits, 37% PT benefits and 4% Active mode benefits which shows that the project is reasonably a balanced package

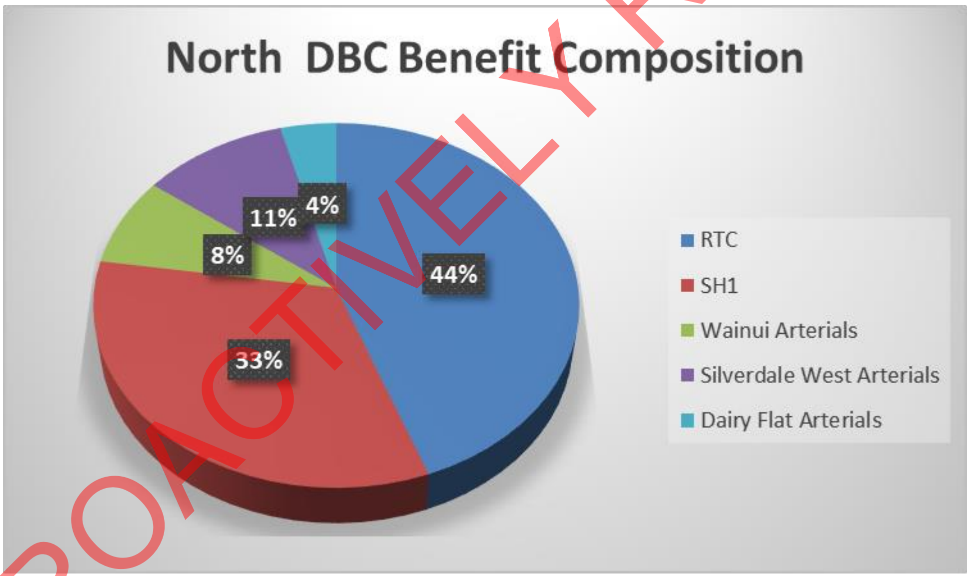

Figure 0-1: North DBC Benefits Composition

Sensitivity Tests

The key purpose of the sensitivity tests is to understand the relative impact of key assumptions on the BCR. The sensitivity tests were carried out as per the MBCM.

The sensitivity tests are split into analysis framework and parameter sensitivity tests. The analysis framework includes discount rate and analysis period, whilst parameter sensitivity includes WEBs, PT, active mode and traffic benefits variability. Additional sensitivity tests were performed, as agreed with the peer reviewer.

Analysis Framework Sensitivity Tests

The analysis framework includes discount rate and analysis year:

Discount Rate and Analysis Period

The discount rate recommended in the MBCM is 4% with sensitivity tests for 3% and 6%. A range of discount rates was tested, being 3%, 4%, 6%. The analysis period used for testing is 40 years and 60 years. The longer analysis period is relevant for this kind of long-lived strategic infrastructure project.

The **Table 0-2** shows the BCR range (excluding WEBs) for the above analysis parameters

Table 0-2: BCR Variation with Different Discount Rate and Analysis Period (excluding WEBs)

		BCR					
Discount rate	Analysis Period	RTC	SH1	Wainui	Silverdale West	Dairy Flat	North DBC
3%	40 year	2.0	1.2	0.7	2.4	0.4	1.3
4%		1.8	1.0	0.6	2.0	0.3	1.1
6%		1.4	0.6	0.4	1.4	0.2	0.8
3%	60 year	2.2	1.7	0.9	3.1	0.4	1.6
4%		1.9	1.3	0.7	2.4	0.4	1.3
6%		1.5	0.8	0.4	1.6	0.3	0.9

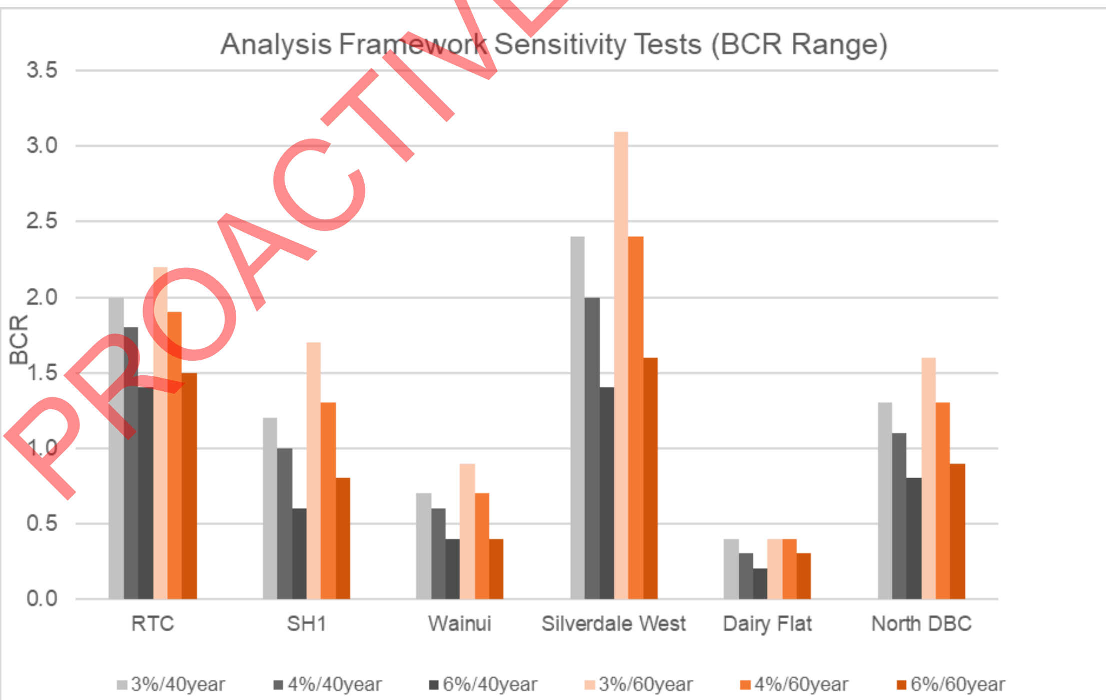

Figure 0-2: Analysis Framework - BCR range for the North DBC Project

The above analysis shows that:

- Using the recommendation in the MBCM (4%/40 years), the BCR for RTC, SH1 and Silverdale West are 1.8, 1.0 and 2.0 respectively, and for Wainui and Dairy Flat are 0.6 and 0.3 respectively, giving a combined BCR of 1.1 for the North DBC package.
- As per the MBCM, it is justified for this kind of long-lived strategic infrastructure to be analysed for 60 years which further uplifts the BCR for RTC and SH1 to 1.9 and 1.3 respectively, raising the overall North DBC package BCR to 1.3.
- The MBCM also suggests that a lower rate of 3% can be used for activities with long-term future benefits that cannot be adequately captured with the standard discount rate and this would further raise the RTC and SH1 BCR to 2.2 and 1.7 respectively (over an analysis period of 60 years).

Parameter Sensitivity Tests

These sensitivity tests are performed by altering one parameter at a time while maintaining rest of the core assumptions, including the 4% discount rate and 40-year analysis period. The following parameter sensitivity tests were carried out:

- Including WEBs: +24%
- PT benefits variability: ±25%
- PT reliability benefits: ±30% for commuter peak and ±10% for IP
- Active mode benefits variability:
  - ±25%
  - 50% reduction the value of time for the Walk Other trips, as agreed with the peer reviewer
  - Slower growth of active mode benefits in line with construction
- Traffic benefits variability: ±25%
- Costs at P95 values

WEBs Sensitivity Test

As discussed in **Section 0**, a sensitivity test was performed by including WEBs benefits as 24% uplift over the conventional benefits. The results are shown in **Table 0-3**. It is observed that the adopted 24% WEBs raises the BCR from 1.8 to 2.2 for RTC and 1.0 to 1.2 for SH1, and 1.1 to 1.4 for the North DBC package.

Table 0-3: BCR Variation including WEBs

WEBs%	BCR					
	RTC	SH1	Wainui	Silverdale West	Dairy Flat	North DBC
0% (core)	1.8	1.0	0.6	2.0	0.3	1.1
15%	2.0	1.1	0.6	2.3	0.4	1.3
24%	2.2	1.2	0.7	2.5	0.4	1.4

PT Benefits Sensitivity Test

Table 0-4 shows the BCR variation from testing with ±25% of the PT travel time, reliability, and health benefits. Given that RTC primarily involves PT projects, RTC is the most impacted by the PT benefits tests, with a BCR ranging between 1.5 and 2.0. The other BCRs and the combined package are fairly insensitive to changes in PT benefits.

Table 0-4: BCR variation with PT benefits change

PT Benefit test	BCR					
	RTC	SH1	Wainui	Silverdale West	Dairy Flat	North DBC
-25%	1.5	1.0	0.5	1.9	0.2	1.0
0% (core)	1.8	1.0	0.6	2.0	0.3	1.1
+25%	2.0	1.0	0.6	2.1	0.4	1.2

PT Reliability Percentage

In discussion with the peer reviewer, to reflect possible uncertainties with the approach to assessing PT reliability it has been agreed to sensitivity test the PT reliability percentage and determine its effect on the BCR. **Table 0-5** shows that deviating the PT reliability percentage from the core assumptions of 70% and 40% in the peak and interpeak periods, respectively, have little effect on the BCRs. Given that RTC primarily involves PT projects, it is the most impacted by the PT reliability percentage (although minimal), with a BCR ranging between 1.7 and 1.9. Overall, the BCRs for the projects seem fairly insensitive to changes in the PT reliability percentage.

Table 0-5: BCR variation with PT reliability percentage

PT Reliability % (AM/PM & IP)	BCR					
	RTC	SH1	Wainui	Silverdale West	Dairy Flat	North DBC
40% & 30%	1.7	1.0	0.5	2.0	0.3	1.1
70% & 40% (core)	1.8	1.0	0.6	2.0	0.3	1.1
100% & 50%	1.9	1.0	0.6	2.0	0.4	1.1

Active Mode Benefits Sensitivity test

During the Drury Local peer review, extensive modelling methodology checks were carried out to understand better the walk benefits predicted by the model, especially for the ‘Other’ trip purpose. These were found to align with expected daily travel by each mode and purpose. However, the greenfield nature of the location and the extensive future population growth make it more difficult to independently check the scale of benefits. It was therefore agreed to test with ±25% active mode benefits. The same tests have been carried out for the North DBC Economics.

Moreover, the peer reviewer commented that even with the adjustment to the 'Walk Other' value of time there seems to be an imbalance between the benefits for HBW and Other walk trips, hence a sensitivity test was undertaken to only consider 50% of the 'Walk Other' travel time benefits.

The peer reviewer also commented on the methodology for assuming the proportions of active mode benefits in the interim years which may imply benefits being generated before the schemes are constructed and suggests that the core active modes benefits may be overestimated. Therefore, an additional sensitivity test was undertaken with a slower build-up of benefits in line with construction as follows:

- 2028 = 1%
- 2038 = 5%
- 2048 = 10%
- 2048+ = 100%

As shown in **Table 0-6**, the variation in active mode benefits cause no significant variance to the overall BCRs.

Table 0-6: BCR variation with Active Mode benefits change

Active Mode Benefit test	BCR					
	RTC	SH1	Wainui	Silverdale West	Dairy Flat	North DBC
-25%	1.8	1.0	0.5	2.0	0.3	1.1
0% (core)	1.8	1.0	0.6	2.0	0.3	1.1
25%	1.8	1.0	0.6	2.0	0.3	1.1
50% 'Walk Other' value of time	1.8	1.0	0.5	2.0	0.3	1.1
Slower growth	1.8	1.0	0.5	2.0	0.3	1.1

Traffic benefits Sensitivity test

On discussion with peer reviewer, it was decided to test the traffic benefits variability for robustness since, the traffic benefits exhibited high level of inter dependency between the projects. The travel time, congestion, vehicle operating cost and trip reliability was tested for ±25%. The results in **Table 0-7** show that the BCRs, particularly for RTC, SH1 and Silverdale West, are relatively sensitive to changes in traffic benefits, which is expected given that they form the bulk of the benefits in the present appraisal.

Table 0-7: BCR variation with Traffic benefits change

Traffic benefit %	BCR					
	RTC	SH1	Wainui	Silverdale West	Dairy Flat	North DBC
-25%	1.6	0.7	0.5	1.6	0.4	0.9
0% (core)	1.8	1.0	0.6	2.0	0.3	1.1
25%	2.0	1.2	0.6	2.4	0.3	1.3

Cost sensitivity test

The cost variability was tested for robustness by applying the P95 capital cost estimates. The results are shown in **Table 0-8**.

Table 0-8: BCR variation with Capital cost change

Cost Scenario	BCR					
	RTC	SH1	Wainui	Silverdale West	Dairy Flat	North DBC
P50	1.8	1.0	0.6	2.0	0.3	1.1
P95	1.6	0.8	0.5	1.7	0.3	0.9

Land Use sensitivity

There is particular uncertainty around the extent and timing of the land-use development in the North growth area particularly with the allocation of the 2048+ benefits. The core BCR has been calculated with the assumption of 2048+ landuse allocated to 2053 for the purpose of economics assessment. However, this has been sensitivity tested by considering the 2048+ as 2058. This was done to reflect the alterative assumption to when the 2048+ benefits will commence considering the long-term benefits from this project this is a valid sensitivity that needs to be addressed. The overall BCR is 1.1 (excluding WEBs) , which does not significantly change from this test, which has a BCR of 1.0. The Error! Reference source not found. for the 40-year benefits profile shows staggering the benefits to year 2058.

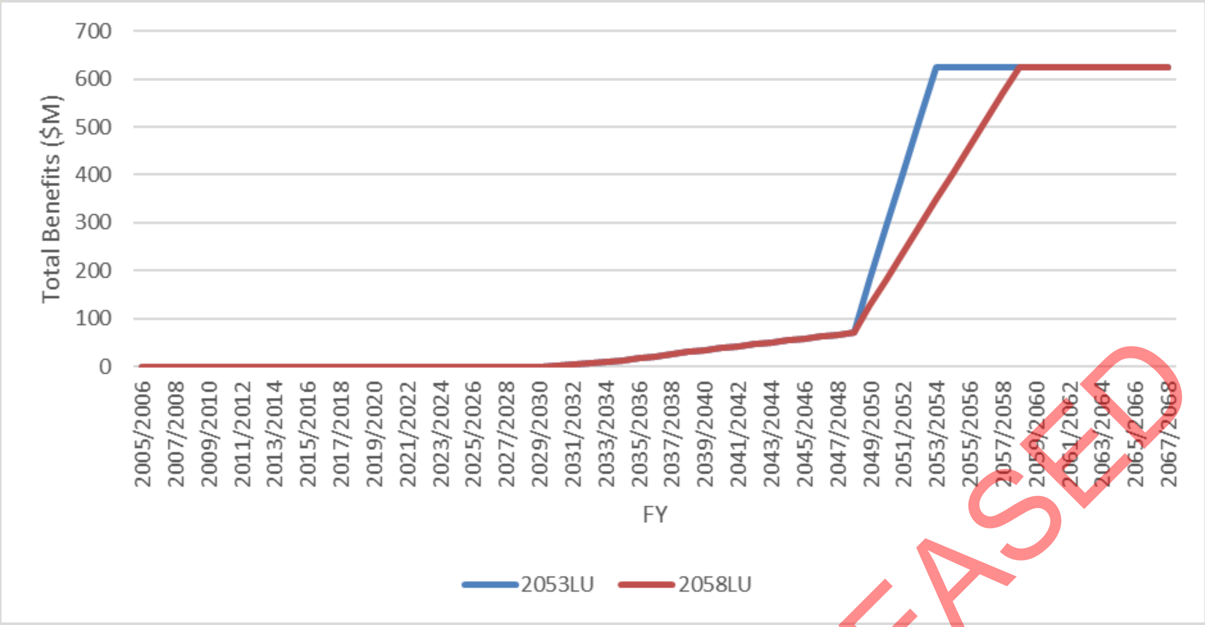

Figure 0-3: Total benefits profile for 2048+ benefits allocation to 2053 and 2058

Table 0-9: Land Use Sensitivity tests

	BCR					
Land Use Scenario	**RTC**	**SH1**	**Wainui**	**Silverdale West**	**Dairy Flat**	**North DBC**
Base	1.8	1.0	0.6	2.0	0.3	1.1
2048+ Benefits Allocated to 2058	1.6	0.9	0.5	1.8	0.3	1.0

COVID-19 Scenario

The land use growth might slow down due to COVID-19 or any other unknown reasons in long term and hence the project start date might need to be delayed to meet the changed transport needs. It was assumed that if such a situation arises, it will not have any significant impact on the economic returns from the project as the costs and benefits timestreams will be shifted with the project start. However, to large extent, the COVID-19 scenario is covered by the reduced traffic benefits sensitivity in **Table 0-7** and **Table 0-9**.

Summary

The core results for the economic evaluation of the components of the North DBC package are set out in the table below:

Table 0-1: BCRs per Project – with and without WEBs

Projects	PV total benefits, $M PV	PV total net costs, $M PV	BCR excluding WEBs	WEBs	BCR including WEBs
RTC	1635	919	1.8	245	2.0
SH1	1213	1251	1.0	182	1.1
Wainui Arterials	290	516	0.6	43	0.6
Silverdale West Arterials	393	198	2.0	59	2.3
Dairy Flat Arterials	150	480	0.3	23	0.4
Combined North DBC	**3681**	**3365**	**1.1**	**552**	**1.3**

Key conclusions were noted as follows:

- The BCRs for the strategic components of the package, the RTC and SH1 which provide the overarching and city shaping framework for the overall development in the area are 1.8 and 1.1 without WEBs and would increase to 2 and 1.1 if WEBs are included.
- The BCRs for the components of the package more closely associated with the land use development expected Wainui, Silverdale and Dairy Flat arterials , are in the range of 0.3 to 2.0. For these components of the package, it is the basic accessibility provided to the new development sites rather than improvements in travel times which is the main driver, and a transport economic evaluation would therefore really only cover a limited part of impacts which these components are intended to provide.
- Combining the two components, the strategic schemes and the elements more closely associated with the land use developments. the full package achieves a BCR of 1.1 excluding WEBs
- Sensitivity testing of many of the assumptions or parameters used in the analysis indicates that the BCRs obtained are relatively insensitive to changes in these and the results can therefore be considered to be robust. The results of these sensitivity tests are summarised below

Table 0-2: Summary of BCR Range for the North DBC Projects

	RTC	SH1	Wainui Arterials	Silverdale West Arterials	Dairy Flat Arterials	Combined North DBC
Analysis Framework	1.4-2.2	0.6-1.7	0.4-0.9	1.4-3.1	0.2-0.4	0.8-1.6
Parameter Sensitivity	1.5-2.2	0.7-1.2	0.5-0.7	1.6-2.5	0.2-0.4	0.9-1.4

The combined BCR or the BCR for the North DBC Package is generally 1 or above for all the parameter sensitivity tests except for 25% reduction in traffic benefits and P95 cost where it drops to 0.9. Though, it is acknowledged that this BCR is possibly on low side as for, this economic assessment the current MBCM , V1.6 rates have not been tested, due to the timing of the reporting. It is noted that the improved crash cost and the travel time rates is expected to give a higher benefit resulting in a higher BCR than obtained from the MBCM V1.5 rates.

Also the appraisal has not considered 3rd party funding (such as developer contributions), nor the intangible benefits. Both of these opportunities could increase the likely BCRs. The progressive development of this area over the next 30+ years suggests there would likely to significant opportunities for such strategies and also for developing the transport network in line with the growing demands if these are different to the base assumptions used in this appraisal.

1 Appendix 1 - Model Extents

The sector system considered for the benefit analysis is shown below, it comprises of all the regions in Auckland as in MSM model

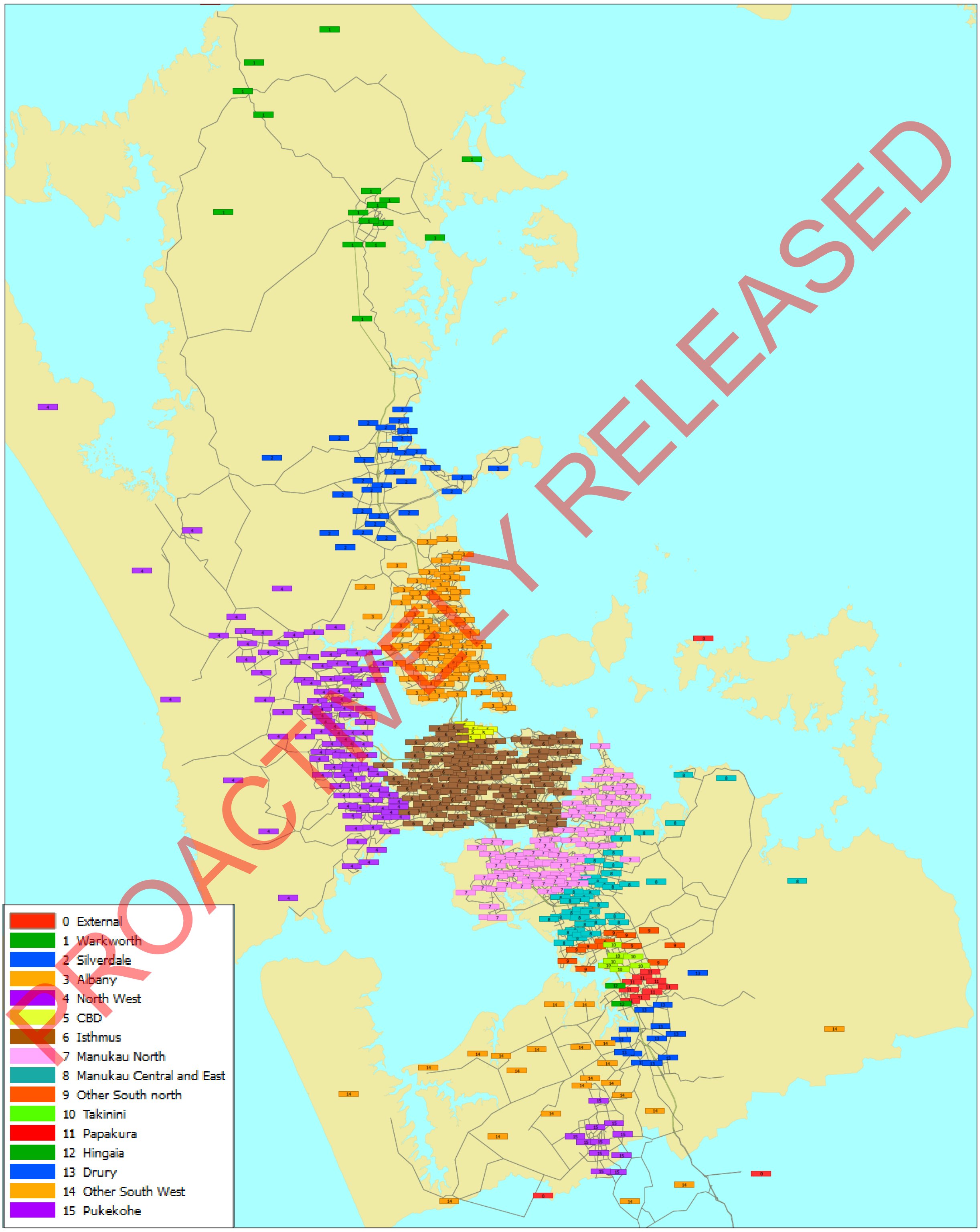

Figure 0-1: Economics Sector Map

The Traffic model comprises of region from Silverdale to Albany. The cordon volume from MSM is transferred into Traffic models and all the zones south Of Albany covering the CBD, Isthmus, South and East and North West are treated as external zones. The below figure shows the Traffic network boundary

Figure 0-2: Traffic Model North DBC Network