IN THE HIGH COURT OF NEW ZEALAND
AUCKLAND REGISTRY

I TE KŌTI MATUA O AOTEAROA
TĀMAKI MAKAURAU ROHE

CIV-2021-404-1618

UNDER THE	Judicial Review Procedure Act 2016
IN THE MATTER	in the matter of an application for judicial review
BETWEEN	**ALL ABOARD AOTEAROA INCORPORATED**
	Applicant
AND	**AUCKLAND TRANSPORT**
	First Respondent
AND	**THE REGIONAL TRANSPORT COMMITTEE FOR AUCKLAND**
	Second Respondent
AND	**AUCKLAND COUNCIL**
	Third Respondent

AFFIDAVIT OF HAMISH PHILLIP BUNN ON BEHALF OF THE FIRST AND SECOND RESPONDENTS

Affirmed 25 February 2022

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I **Hamish Phillip Bunn**, manager of Auckland, solemnly and sincerely affirm:

BACKGROUND, EXPERIENCE AND ROLE

1. I am the Group Manager: Policy, Planning and Investment at Auckland Transport (**AT**). I have been in this position since December 2017.

2. In this role I am responsible for:

(a) development of key strategy and planning documents for the Auckland transport network, across all modes including walking and cycling. This ranges from network level plans and strategies to very localised plans;[1]

(b) commissioning research on Auckland transport trends and issues, such as the "Analysis of the 2018 Census Results: Travel to work and travel to education in Auckland";

(c) policy and bylaw development, such as production of the Auckland Carshare Policy and current development of the Activities in the Road Corridor bylaw;

(d) leadership of AT's input into higher level or multi-agency transport strategy and planning exercises, such as development of the Auckland Plan and the Auckland Transport Alignment Project;

(e) investment planning, including:

(i) development of the Regional Land Transport Plan (**RLTP**);

(ii) leading advice on new investment proposals – such as input to the Mayor of Auckland's recent Environment Targeted Rate proposal;

1 Examples of the strategy and planning documents developed by my Group include the "Future Connect" Integrated Network Plan; the Regional Public Transport Plan; the Auckland Parking Strategy; the Auckland Freight Plan the Auckland Roads and Streets Framework; the Auckland Walking Programme Business Case; the Auckland Accessibility Plan; and key planning input to the Auckland Cycling and Micromobility Programme Business Case.

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(iii) oversight of AT's Portfolio Management Framework;

(f) development of AT's Statement of Intent and monitoring and reporting on performance against Statement of Intent targets, along with wider network performance indicators.

3. I began my career in strategy and capital programming as an analyst with the Ministry of Defence in 1999, before moving to Auckland Council to work in funding and strategy in 2004. After a short period in consultancies, I moved to the Ministry of Transport's (**MoT**) Auckland Office in 2008 as a principal advisor on Auckland transport issues.

4. While at the MoT I was heavily involved in most of the key transport strategy issues or initiatives from 2008 to 2016, often leading the analytical work, including:

(a) input into the transport elements of Auckland governance reform and the response to the Royal Commission (as part of a whole of government team);

(b) MoT input into the 2010 Regional Land Transport Strategy;

(c) development of the 2010 funding package for new electric trains;

(d) advice to Ministers on the performance of the Auckland transport network;

(e) Government Review of the City Rail Link in 2011;

(f) MoT input into the first Auckland Plan;

(g) the 2012 City Centre Future Access Study and City Rail Link decisions;

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(h) commissioning Auckland related research, such as the comprehensive analysis of the Journey to Work results for the 2013 census;

(i) the Prime Minister's June 2013 Auckland transport announcements;

(j) development of the Government's 2014 Auckland Transport Package, including development of the associated financing solution between the Crown and then NZ Transport Agency (**NZTA**);

(k) consideration of Auckland Council's Alternative Transport Funding Proposals (essentially a motorway network pricing scheme);

(l) development of the 2016 Auckland Transport Alignment Project (**ATAP**), which was an initiative my manager and I had worked towards, in collaboration with colleagues particularly from Auckland Council, for several years beforehand.

5. In late 2016 I moved to AT as the Integrated Transport Plan Manager, before being promoted to Group Manager Policy, Planning and Sustainability. The role was slightly restructured to shift the Sustainability portfolio to a separate tier three manager in late 2019.

6. Relevant to the issues in this case, between 2016 and now I:

(a) was involved in AT input into the finalisation of the 2016 ATAP process;

(b) led AT input into the 2017 ATAP update;

(c) led AT input into the 2018 ATAP process and associated programme development, which heavily informed the 2018 RLTP;

(d) undertook analysis and modelling of Auckland's emission trends, including development of the document "Auckland's Road Transport Emissions…a new dialogue May 2019";

(e) led or oversaw development of the documents listed in paragraph 2 (footnote 1) above.

7. As a result of this work history, I have significant experience and practical understanding of the following (in an Auckland context):

(a) transport strategy, including the links to wider urban economics and high level relationships with land use;

(b) transport funding and machinery of government from both a central and local government perspective, including the history since the early 2000s;

(c) capital programme development;

(d) trends in the performance of Auckland's transport network;

(e) integrated transport network planning, for all modes;

(f) Aucklanders' travel behaviour, particularly for commuting;

(g) road pricing issues and their relationship with wider transport strategy;

(h) land transport emissions.

8. I am authorised to make this affidavit on behalf of the first and second respondents.

PURPOSE OF EVIDENCE

9. This evidence is in two parts.

10. In the first part, I will describe AT's process in preparing and approving the 2021 RLTP. This will include:

(a) an introduction to the RLTP, its purpose and effect;

(b) an introduction to the ATAP, which was a significant input into the RLTP, and its relationship to the RLTP;

(c) the development of the ATAP Terms of Reference, including consistency with the Government Policy Statement on Land Transport (**GPS**);

(d) the process of developing the ATAP programme, including the evaluation and prioritisation process which involved identification of 'baseline' and 'discretionary' projects and programmes, and the overall final package;

(e) the emissions modelling carried out for the purposes of Auckland Council's Auckland Climate Plan: Te Tāruke-ā-Tāwhiri and as an input into ATAP and the RLTP;

(f) AT's involvement, including AT Board member involvement, in the ATAP process;

(g) finalisation of the ATAP package;

(h) AT's development of the RLTP based on ATAP;

(i) preparation of a draft RLTP, public consultation, consideration of submissions and changes to the RLTP in response;

(j) the decision by AT's Regional Transport Committee (**RTC**) to recommend approval of the final RLTP by AT's Board. This includes specific discussion of the information before the RTC as to compliance with the statutory prerequisites for its decision;

(k) approval of the final RLTP by AT's Board;

(l) a brief comment on the MoT's Green Paper Hīkina te Kohupara – Kai mauri ora ai te iwi, in the context of RLTP consistency with the GPS.

11. In the second part of this affidavit I will respond to some specific matters and allegations of a factual nature raised in the pleadings and evidence filed on behalf of the applicant.

12. To the extent that in responding to the allegations made by the applicant I necessarily need to address matters of expert opinion, I confirm that I have read and complied with the Code of Conduct for Expert Witnesses, acknowledging however that I am employed by AT and give this evidence in that capacity.

13. Accompanying this affidavit is a volume of exhibits (HB1) that I produce. I refer to exhibits below by reference to the page number in that volume, for example HB1-015 is page 15 of the volume.

PART ONE - PREPARATION OF THE RLTP

14. I have read in draft (and agree with) the affidavit of Jenny Chetwynd, AT's Executive General Manager Planning and Investment, which provides a higher level overview of the process of preparing and adopting the 2021 RLTP. In this affidavit I will discuss that process in greater detail, with particular reference to the climate change aspects of the RLTP, as they are relevant to these proceedings. I was very closely involved in the entire RLTP process and authored many of the key reports and documents.

Introduction to the RLTP

15. Before explaining this process, it may be useful to provide some overview remarks about the RLTP, what it is, and what it is not.

16. The RLTP sets out the Auckland region's proposed multi-agency programme of investment in transport projects, programmes and

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services to achieve shared government and Auckland Council policy outcomes. Besides being a public statement of transport objectives, policies and priorities, its main practical purpose is to collect and prioritise funding 'bids' from multiple agencies at a regional level so they can be considered by Waka Kotahi-NZTA for inclusion in the National Land Transport Programme (**NLTP**). This is particularly important in regions other than Auckland, where there are multiple territorial authorities along with the regional council and Waka Kotahi-NZTA.

17. The RLTP has limited substantive effect. Inclusion of an activity in the RLTP is not a decision by the responsible agency to carry out that activity. Although dealing with projects and their funding, the inclusion of a project within a RLTP prioritised list does not guarantee funding. That depends on the NLTP and Waka Kotahi-NZTA business case decisions, along with matching funding. That said, in Auckland (and unlike other regions) there is a greater level of confidence that RLTP projects will receive funding, because close alignment with Government policy has been confirmed through ATAP, as discussed below.

18. The RLTP is not a regulatory document. It cannot, for example, change the price of parking, introduce new road charges or create higher penalties for speeding. These kinds of changes are the realm of other strategies, as well as legislation or regulation.

19. In my experience, there can also be a perception that an RLTP has greater significance and influence on land transport outcomes than is actually the case. Its scope is in fact quite limited: it is primarily, a capital programme[2] (more accurately a *proposed* capital programme i.e. subject to inclusion in the NLTP and subsequent Waka Kotahi-NZTA funding decisions), together with some specific policy proposals (in the case of the 2021 document).

20. Auckland's RLTP does not cover all of the actions AT is undertaking to achieve transport policy objectives. For example, significant change is underway to parking policy via the revised Auckland Parking Strategy which aims to reduce emissions and encourage greater mode shift via

2 Operational expenditure on maintenance and services is also covered at a high level.

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reprioritisation of parking space and increased cost of parking, but this is outside the scope of the RLTP.

Background to ATAP

21. I turn now to the preparation of the RLTP. Like the 2018 RLTP before it, the starting point for development of the 2021 RLTP was the ATAP process, in this case the 2021 ATAP.[3]

22. ATAP is a non-statutory process involving central government and local government in Auckland. It was initiated in 2015 as a way of addressing the impasse that had arisen between the then National Government and Auckland Council (**Council**) over transport strategy and funding in Auckland. The intent of ATAP was for Ministers and the Council to agree:

(a) shared objectives for transport in Auckland consistent with the GPS and the Auckland Plan;

(b) the level of transport funding to be made available in Auckland;

(c) an overall transport strategy, including an investment programme, that would best meet agreed objectives within the available funding.

23. The essence of the original 2015 'deal' was that Auckland's transport strategy documents and capital programme would better reflect Government objectives and, in return, Government would provide additional funding to support the agreed programme.

24. Even though the ATAP investment strategy and programme was not a statutory document, the expectation of the parties was that it would have a close relationship with the statutory documents: it would inform, and be consistent with, the GPS; and, once agreed, it would be reflected in the RLTP and the NLTP. This was to ensure that all parts of the transport decision-making machinery in Auckland were working towards aligned

3 This ATAP process started in 2020 and was sometimes referred to as the 2020 ATAP Update (or "Refresh"). However, I will refer to it as the 2021 ATAP because that is when it was finally agreed.

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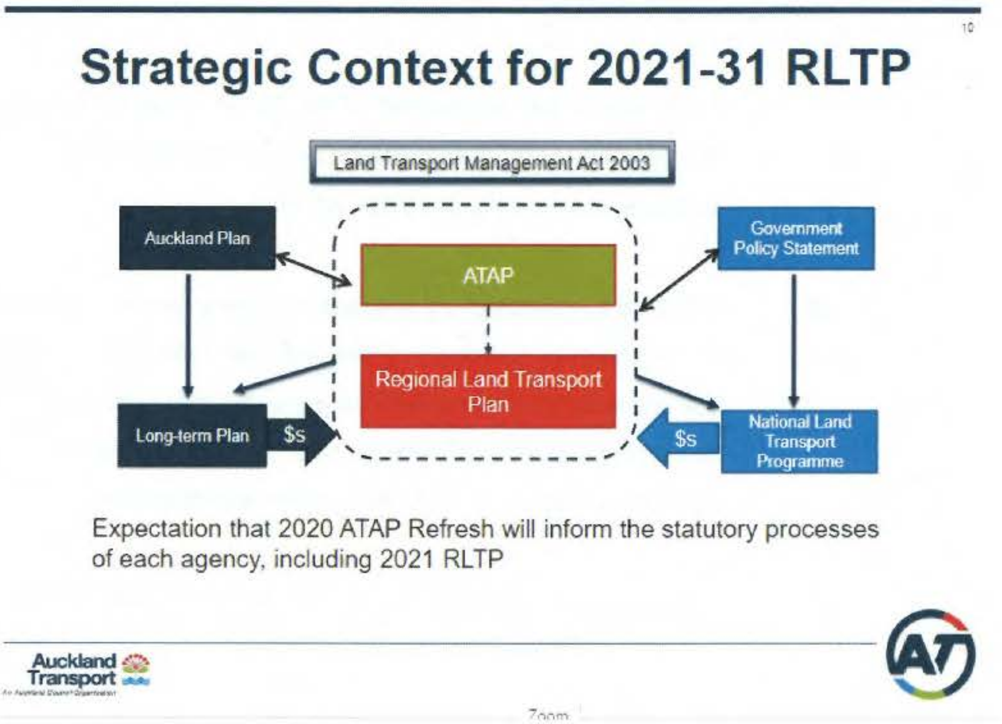
objectives. The slide below, which was provided to the AT Board on 8 July 2020 captures the concept.



25. This expectation of alignment can be seen in the 2016 Recommended Strategic Approach[4] report, which recommended "the Government, Auckland Council, Auckland Transport and the NZ Transport Agency incorporate the strategic approach into their statutory strategic documents".[5] A copy of this report is at HB1-001. The 2018 ATAP report included similar text, noting that "Immediate next steps are to align statutory documents, including the Regional Land Transport Plan and the National Land Transport Programme, with the direction of this report". As discussed below, the need to provide direction for the upcoming round of statutory planning processes was also stated as one of the reasons to undertake the 2020 ATAP.

26. ATAP has been a successful initiative to improve transport outcomes for the benefit of Aucklanders. Before ATAP, much of AT's proposed land transport programme was seen as inconsistent with then Government policy and therefore was often not receiving funding via the national land

4 This report was prepared by the ATAP Working Group for consideration by the Parties
5 Page 45 of the Recommended Strategic Approach

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transport fund (**NLTF**). The Government was also reluctant to entertain Auckland's proposals for alternative mechanisms to fund the AT programme. As noted, the result was largely deadlock.[6] The aim of ATAP was to achieve a level of consensus between central and local government as to acceptable and deserving transport projects in Auckland, as an input into the statutory processes. Agreement at the start of the process also maximised the prospects of the projects finding their way into the NLTP and being approved for funding out of the NLTF.

27. In practice, it took a little time for the benefits of the ATAP process to be realised. Although the first ATAP 'Agreed Strategic Approach' was agreed in 2016 and updated in 2017, initially the process did not deliver expected results, as some key funding issues remained unresolved. It was not until the 2018 ATAP, and the Government agreement to a Regional Fuel Tax (**RFT**) to address Council funding issues, that the process really matured with an agreed and largely funded programme. The RFT provided $1.5 billion of funding over ten years, which, when combined with Waka Kotahi-NZTA co-funding and development contributions, underpinned around $4 billion of AT's $10 billion capital programme.

Governance of ATAP and role of AT in ATAP

28. ATAP is an agreement between central government (through the Ministers of Transport and Finance) and local government (through the Council). It is overseen by a Governance Group of Chief Executives from key agencies, including AT, Waka Kotahi-NZTA, Auckland Council, KiwiRail and the MoT, and supported by a Working Group of officials from each of the five agencies, led by the MoT. I was a member of the Working Group for the 2021 ATAP (as well as parts of the 2016 ATAP, and all of the 2018 and 2018 ATAP processes).

29. Although AT is not itself one of the parties to ATAP, it is closely involved in the ATAP process and decision-making. As mentioned, it was understood and expected that the ATAP programme, once agreed, would inform the statutory documents, including the RLTP, for which AT

6 The Government was able to proceed with its 'Roads of National Significance' motorway investment programme, but this was controlled by NZTA.

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had responsibility. AT is also the operator of the Auckland transport network. Clearly, therefore, AT had to be "on board".

30. AT involvement and influence occurred primarily through the representation of AT officers on the Governance Group and Working Group. In turn, officers kept the AT Board and its committee, the Design and Development Committee (**DDC**), informed of ATAP progress and developments throughout the process, and Board members gave guidance which was fed back by officers into the ATAP Working Group and Governance Group meetings.

31. As described below,[7] two areas where the AT Board's influence on the 2021 ATAP programme was particularly apparent were in ensuring that there was appropriate investment in the renewals programme, and the inclusion of a range of smaller scale projects to achieve outcomes at a community level.

Development of ATAP/RLTP objectives

32. This process began, pre-ATAP, with the development of objectives that would guide the RLTP, along with ATAP. This process was called 'Future Connect'. Future Connect was to be an Integrated Network Plan that set out objectives for the development of Auckland's transport network, consistent with Government and Council direction, and identified problems and opportunities to guide prioritisation of the programmes in the 2021 RLTP. Future Connect would also include a 'Strategic Case', which would summarise the objectives, problems and opportunities for development of Auckland's transport network at a high level, again as an input into the ATAP/RLTP processes.

33. Future Connect, and ATAP more broadly, was therefore developed taking into account the need for alignment with the statutory requirements for an RLTP, including consistency with the GPS. The participation of the Minister of Transport, and the MoT, also gave assurance in that latter regard.

7 Paragraphs 65 and 66, and 142.

34. As a result of an Investment Logic Mapping[8] process attended by representatives from AT, Auckland Council, Waka Kotahi-NZTA and the MoT, the following set of objectives was prepared:

(a) Enabling and supporting Auckland's growth and the quality compact urban approach;

(b) Accelerating better travel choices for Aucklanders;

(c) Better connecting people, places, goods and services;

(d) Improving resilience and sustainability of the transport system;

(e) Making Auckland's transport system safe by eliminating harm to people.

35. These objectives were deliberately based on the 2018 ATAP and RLTP objectives, which in turn reflected the Auckland Plan and earlier GPS documents. However, the Future Connect objectives included a stronger emphasis on sustainability of the transport system.

36. At this time (February 2020), the current GPS was the 2018 GPS. Key objectives in this GPS were under the headings Access [to opportunity], Safety, Value for Money and the Environment, with the 'Access' objective having a strong public transport and active modes flavour. The Future Connect objectives were considered to align with the GPS, albeit reflecting specific Auckland circumstances. There was, however, a difference of views over the wording of the growth related objective, which was ultimately resolved in the ATAP Terms of Reference.

ATAP Terms of Reference

37. Formal ATAP development began with agreement of the 2020 Terms of Reference (**ToR**) in May 2020. A copy of the ToR is at HB1-049. The ToR set out the purpose of the work, along with key objectives, broad methodology and workstreams.

8 Investment logic mapping is a series of structured workshops that bring together key stakeholders to ensure that there is early agreement on problems, outcomes and benefits before any investment decisions are made or a specific solution is identified. It is part of the Waka Kotahi-NZTA business case process.

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38. The purpose of the 2020 ATAP update, as set out in the ToR, was to "refresh the 2018 package in light of a number of emerging considerations". These included:

(a) the significant impacts of COVID-19 on Auckland Council and central government revenue streams, taking into account any economic stimulus packages announced by government within the timeframes of the ATAP 2020 update;

(b) the recent New Zealand Upgrade Programme (**NZUP**) of transport investment in Auckland;[9]

(c) climate change and mode shift as increasingly significant policy considerations for both Auckland Council and central government;

(d) the need to provide direction for the upcoming round of statutory planning processes including the RLTP, Council's Long-term Plan (**LTP**), the GPS, and the NLTP. ATAP was therefore prepared so as to align with the requirements of such documents;

(e) emerging spatial priorities.

39. The ATAP agreed objectives evolved out of the Future Connect work, albeit with a broadening of the growth objective and a strengthening of the environmental objective. The final objectives were expressed as follows:

> The prioritisation process is defined by the shared central government and Auckland Council objectives for transport in Auckland, which are:
>
> - enabling and supporting Auckland's growth through a focus on intensification in brownfield areas and with some managed expansion into emerging greenfield areas
> - accelerating better travel choices for Auckland
> - better connecting people, places, goods and services

9 The NZUP is discussed in the affidavit of Jenny Chetwynd.

- improving the resilience and sustainability of the transport system, and significantly reducing the greenhouse gas emissions it generates
- making Auckland's transport system safe by eliminating harm to people
- ensuring value for money across Auckland's transport system through well targeted investment choices.

In addition to the objectives above, the focus of the update will be on climate change, mode shift, emerging brownfield and greenfield priorities, and post COVID-19 recovery. The update will also take into account broader priorities outlined in relevant statutory documents such as the Auckland Plan and the draft GPS.

40. The ToR also set out key areas of focus for the ATAP work and methodology, as follows:

> The initial focus of the update is to identify the available funding envelope. The process of prioritising projects and programmes for possible inclusion in the indicative package can only commence once available funding levels are determined. There are a number of key considerations that will impact upon this calculation:
>
> (i) the impacts of COVID-19 on existing revenue streams and the implications of any economic stimulus packages announced by the government within the timeframes of the update;
>
> (ii) the implications of the NZUP;
>
> (iii) will the $1.6 billion of decade one ATAP funding freed up by the announcement be available for reallocation in Auckland?
>
> (iv) what consequential investments will be required as a result of the announcement?
>
> (v) pending decisions on significant investments such as Drury and City Centre to Mangere;
>
> (vi) cost escalation of existing projects;
>
> (vii) the portion of the existing programme that is already committed (and therefore not available for reallocation).

41. The ToR reflected the key issues for the parties at the time of signing. Although there was some emphasis on climate change as an issue to address over the ten-year period, more immediate issues were around funding and consistency with existing or recently established programmes. In particular:

(a) The Government had announced its NZUP, which included a substantial funding allocation to Auckland projects, especially around the Drury area. The Government therefore wished to

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see the ATAP process support overall investment in the Drury area. In particular, MoT officials were initially very keen to see the inclusion of local investments, from AT's programme, to complement the larger scale NZUP projects, such as at Drury. This was especially the case for the roughly $700m funding that had been 'freed up' in the AT programme by the Government decision to transfer the Mill Road and Penlink projects from AT's programme into the NZUP;

(b) From AT's side, the key immediate issue was the impact of the Council's emergency budget in response to the first COVID-19 lockdown, and the forecast reduction in capital funding over the next two to three years of the programme. A key consideration was preserving the core of the AT programme initiated as a result of the 2018 RLTP and to ensure that the momentum that came with the additional funding in the 2018 RLTP was not lost. The bulk of the 2018 programme was regarded as being aligned to the 2021 ATAP objectives, particularly as the largest roading elements had been moved into NZUP. The expected reduction in capital funding, combined with an increase in forecast costs for a number of key projects, meant that from an AT perspective the $700m freed up from Mill Road was largely required to deliver the remainder of the 2018 RLTP programme.

42. Although relatively small in the context of the total programme, this difference between MoT's emphasis on investment to complement NZUP and Drury, and AT's emphasis on preserving the core of the 2018 RLTP programme, set the scene for the first part of the ATAP work. In particular, this influenced views as to what was to be treated as 'committed and essential' and should therefore form part of the 2021 ATAP/RLTP programme.

Consistency with the 2021 GPS

43. The Draft 2021 GPS was published in March 2020, just as work to scope the 2021 ATAP process was beginning. In terms of policy objectives, the draft 2021 GPS was an evolution of the 2018 GPS, and on that basis the TOR was regarded as still consistent with the ATAP objectives.

44. The main changes in the Draft 2021 GPS were:

(a) a sharper focus on better travel options, which was consistent with ATAP's 'better travel choices' objective; and

(b) a much stronger focus on environmental outcomes, particularly greenhouse gas reductions;

(c) the addition of a new objective - improving freight connections

45. The first two of these changes were already priority areas for Auckland Council, which had adopted the target of reducing Auckland's emissions by 50% by 2031.[10] These priorities were also emphasised in the ATAP ToR, which highlighted "climate change and mode shift as increasingly significant policy considerations for both Council and Central government". Meanwhile, the new freight objective in the draft GPS was seen as consistent with the ATAP's "better connecting people places, goods and services" objective.

46. The interrelationship of the draft 2021 GPS and ATAP, and consistency between them, was reinforced by:

(a) the ToR's acknowledgement that the ATAP work was needed "to provide direction for the upcoming round of statutory planning processes, including" the RLTP and GPS. Thus ATAP was itself an input into the GPS:

(b) the Draft 2021 GPS referred to ATAP, saying that: "the Government expected forthcoming NLTPs to meet investment expectations, including a $16.3 billion commitment to ATAP"; and, "the activity classes in the GPS had been set to deliver the results the government wishes to see from ATAP". In my opinion, this was a positive signal that the Government was aligning its transport policy and funding with the ATAP programme – as envisaged by earlier ATAP agreements.

10 This target was reaffirmed by the Council's Environment and Climate Change Committee on 12 March 2020

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47. ATAP's consistency with the GPS was also reinforced by the fact that the ATAP ToR was developed with key input from MoT officials, agreed by the MoT's Chief Executive, and signed by the Minister of Transport and the Minister of Finance. From AT's perspective, and given the purpose of ATAP, Ministers and Chief Executives would not have agreed to a regional level process if the objectives were inconsistent with their national policy objectives, particularly as the ToR and the GPS were being developed at the same time.

48. AT officials – and from my observation, the rest of the ATAP Working Group – therefore proceeded on the basis that the ATAP objectives in the ToR were consistent with the GPS and its objectives. Hence, prioritising projects to deliver ATAP objectives was considered to be working towards achievement of the GPS objectives (within constraints such as funding). Even so, as discussed below, there was later a separate cross-check of the RLTP's consistency with the GPS, as part of adopting the RLTP.

49. Advice confirming alignment between ATAP and GPS objectives was given to the AT Board on 20 July 2020. A copy is at HB1-055. The final 2021 GPS, published in September 2020, was materially unchanged from the draft and therefore did not warrant any change to the ATAP/RLTP objectives or process. Essentially, with the ATAP objectives agreed, the focus shifted to developing the best possible investment programme to support those objectives within the available funding.

Development of ATAP/RLTP investment programme

50. The methodology for developing the ATAP/RLTP investment package involved a number of workstreams, as summarised below. In practice, towards the end of the process these began to merge together.

(a) **Funding:** Identifying available funding, and then looking at options to modify existing funding practices to support the preferred programme;

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(b) **Climate change:** To determine how a climate change lens could be applied to addressing ATAP projects;

(c) **Urban Development:** Prioritising potential growth areas to achieve alignment between government and the Council, and identifying inputs to project prioritisation;

(d) **Operating Expenditure:** Identifying operating cost requirements and priorities, particularly to understand how much operating expenditure is needed to gain the full benefits from proposed capital expenditure;

(e) **Operationalising ATAP:** To identify and review any operational rules that may impede the implementation of ATAP and seek agreement on ways to resolve these;

(f) **Prioritisation and evaluation:** The core workstream, bringing together inputs from the other workstreams. In practice, this had a number of subcomponents as follows:

   (i) *Identification of the 'baseline projects and programmes'*. This workstream sought to identify and agree the existing projects and programmes that should be included in the 2021 ATAP/RLTP without further reprioritisation;

   (ii) *Project prioritisation*. This workstream undertook prioritisation of new projects/programmes along with existing projects and programmes (from the 2018 RLTP) that had not been included in the baseline;

   (iii) *Package development*. This workstream drew on the baseline and prioritised projects to identify different optional packages of projects emphasising different policy priorities – for example, growth, climate change or better mode choice packages. The original intent was to put these packages before the ATAP parties to illustrate, and seek decisions on, the trade-offs

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between different packages. However, in practice, there was so little available 'discretionary' funding that changes in emphasis made little difference to outcomes and although the packages were reported to a subcommittee of the AT Board, they were not directly reported to the parties;

(iv) *Development of the final ATAP programme*. This was the development of the final programme, drawing together outputs from all the previous work to date;

(v) *Revision of the final programme*. The final programme was revised following feedback from Cabinet – which wanted to see stronger emphasis on the Auckland Housing Programme – and the AT Board.

51. The Prioritisation and Evaluation workstream had the greatest impact on the final ATAP (and subsequently RLTP) package. I will therefore focus on the work carried out under this workstream.

Evaluation and prioritisation: Identification of 'baseline' projects and programmes

52. A key initial task for the Prioritisation and Evaluation workstream was to identify and agree which projects and programmes[11] should form part of the 'baseline'. The baseline comprised those projects/programmes, and their associated funding requirements, that had to be completed in all scenarios. Examples included projects which were either formally committed, through some form of contract or other agreement, or which must be undertaken for some other reason – such as ongoing operational requirements.

53. Identification of the baseline enabled the potential programme and the available funding to be divided into two parts:

(a) Non-discretionary – i.e. the baseline projects and programmes (together with their associated funding requirement), which for

11 A project is a single named item within the ATAP/RLTP programme, such as the Tamaki Drive/Ngapipi Road Safety Improvements, whereas a programme is typically a collection of smaller projects, such as the On-going Cycling Programme

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practical purposes were mandatory, and therefore there was no realistic option but to include them in the programme;

(b) Discretionary – projects and programmes where there was still a realistic choice about whether to proceed or not or, in the case of programmes, a choice about the size and cost of the programme.

54. In terms of funding, the 'discretionary funding' is what is available for allocation from the budget after the non-discretionary element has been removed. The cost of discretionary projects and programmes will always exceed available discretionary funding, so prioritisation is required.

55. In the 2021 ATAP process, definition of the baseline also reflected the existing commitment to the 2018 ATAP/RLTP programme, which had been partially funded through the new Regional Fuel Tax. The Regional Fuel Tax had been adopted, following a public consultation process, on the basis that funding of a specific set of projects and programmes listed in the relevant Order in Council would be supported. The ongoing relevance and importance of the 2018 RLTP was provided for in the ATAP ToR, which said that "The ATAP 2020 Update will use the agreed decade one (2018-2028) package of projects as a base given the existing commitment to its delivery".

56. The ATAP baseline work involved representatives from MoT, AT, Waka Kotahi-NZTA, Auckland Council and KiwiRail considering projects against a set of criteria, to determine whether they qualified as part of the baseline. Initially the baseline was limited to those projects that had a formal contract or agreement to undertake their relevant project phase – such as design or construction; and those projects with a formal political commitment to allocate specific funding – principally NZUP.

57. However, after some discussion, the criteria were widened to include programmes and projects that were regarded as 'essential' to achieving the ATAP policy objectives. For example, AT had a number of programmes, such as the safety programme, that were not 'committed' in the formal sense, but were nevertheless so important that it would not adequately achieve ATAP outcomes without them.

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58. Increased costs for existing essential projects were also considered to be part of the baseline. However, for programmes the specific allocation of funding was provisional and dependent on the overall package outcome.

59. Each project or programme proposed for inclusion in the baseline was tested by the ATAP Working Group, based on evidence of project commitment, business case evidence or subject matter expert advice. The larger programme elements were also considered by the ATAP Governance Group. Given the MoT's desire to identify funding that could be reallocated to support the NZUP programme, and particularly Drury, this was a robust process, and there were some differences of opinion between agencies. Although intended to be relatively quick, the baseline was not resolved until after October 2020, by which time the new GPS had been finalised and released.

60. The 'robustness' nevertheless meant that there was nothing included in the baseline that had not been thoroughly tested and ultimately agreed by officials from all agencies and, in the case of the larger items, the Governance Group.

61. While work had focused on the potential projects, other workstreams had been identifying available funding. These numbers changed over the course of the ATAP and RLTP process as more information became available and decisions were made, but we were working to a programme

broadly in the order of $31 million. Final funding sources for ATAP were:

Source of Funding	Amount
Auckland Council	
For Auckland Transport	$8.9 billion
For City Rail Link Limited	$1.3 billion
Central Government	
For City Rail Link Limited	$1.3 billion
NZ Upgrade Programme	$3.5 billion
Covid-19 Response and Recovery Fund	$0.1 billion
National Land Transport Fund	$16.3 billion
TOTAL	$31.4 billion[12]

62. The $3.5 billion for the NZUP programme was new funding from the Crown which was tagged to specific projects. However, as described above, because the NZUP programme took over the Penlink and Mill Road projects that were previously in the Auckland Transport programme, it also 'freed up' $700 million for reallocation to other projects.

63. At this time, the final 'baseline' programme had a total cost of $29.6 billion. This was out of a total funding allocation in the order of $31.3 billion, excluding third party revenue.[13] The baseline programme was approved by the ATAP Governance Group, and reported to and considered by AT's DDC.

64. A analysis of the breakdown of the 'baseline programme', using RLTP figures to avoid confusion, is provided at paragraphs 149 to 157 below. A full list of the projects included in the final RLTP, using ATAP categorisation, is at HB1-100.

65. One of the key decisions concerning the baseline was the agreement - by the ATAP Governance Group, the AT Board and the ATAP parties - to include $3.9 billion in funding for AT's 2021-31 renewals programme.

12 By the end of the RLTP the total funding figure had increased to $32.4 billion, which reflected late announced changes to the NZUP programme, which increased to $4.3 billion, and the inclusion of principal and interest repayments for previous train purchases which had been excluded from the ATAP accounting.

13 Funding figures evolved slightly over different parts of programme development. Final RLTP funding, exclusive of AT User pays Fees was $31.4 billion and the makeup is outlined at page 31 of the RLTP

This was a significant increase on the $3 billion allocation for the 2018-28 programme (although around a third of the increase was needed simply to reflect inflation assumptions). The Governance Group decision approving this increase was critical, particularly as Waka Kotahi-NZTA had previously not funded AT's full renewals programme because of funding caps and scepticism over value for money.

66. This increased funding for renewals as part of the baseline was an acceptance of AT's position advanced to the ATAP Governance Group. AT's Design and Development Committee (**DDC**) had signalled an emphasis on ensuring adequate renewals as a key principle for AT. AT wished to ensure efficient investment by minimising the whole of life costs associated with the programme (i.e. avoiding higher costs later if roads and structures were not renewed at the right time). This acceptance by the ATAP Governance Group of the need for funding prioritisation for renewals also reflected:

(a) recent examples of renewals issues experienced with Wellington's water system and KiwiRail's operation of the Auckland rail network;

(b) Waka Kotahi-NZTA experience of renewals pressure on its own network;

(c) a strong case for additional investment made by AT's subject matter experts.

67. In summary, the baseline programme as finally agreed by the CE Governance Group, after a robust process of scrutiny by the participating agencies, comprised the following elements:

(a) projects which were already committed, or which could not practically or legally be abandoned or altered;

(b) operating costs, which were necessary for network maintenance and operations or public transport services, and therefore largely non-discretionary;

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(c) projects in the NZUP programme, which was funded by Crown allocations and not available for reallocation;

(d) projects or programmes considered to be essential to meeting ATAP policy objectives – these were overwhelmingly related to safety, mode-shift and/or climate change objectives; and

(e) projects related to the renewals programme, which were necessary for longer-term operation of the entire transport network, and therefore met connectivity related objectives, in a way that also supported efficiency objectives through long-term value for money.

Evaluation and prioritisation of 'discretionary' funding projects/programmes

68. With the baseline programme agreed at $29.5 billion, this left approximately $1.8 billion of 'discretionary funding' potentially available for new projects and programmes, and existing projects and programmes which had been excluded from the baseline. The consideration and prioritisation of discretionary projects took place in parallel with the finalisation of the baseline.

69. From AT's perspective, this work actually began in late 2019, with an initial call for proposals for capital projects and programmes from within AT. This produced a 'long list' of some 225 proposals with a total cost of around $22 billion – well in excess of the total capital budget of around $10 billion. This long-list was prioritised internally against similar projects to identify a 'short-list' of the best candidate projects for further consideration. So, for example, public transport projects were compared and prioritised against other public transport projects, using the ATAP objectives, while active mode projects were compared to other active mode projects. For the larger projects, particularly the Rapid Transit Network Projects, more comprehensive work was undertaken to clarify costs, benefits, patronage performance and timing requirements. This ensured we had a good idea of the scale of impact from proposed projects.

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70. This shortlist of AT projects, which comprised around 150 projects and programmes with a value of around $18 billion, was presented to the ATAP Working Group for further prioritisation.

71. The Working Group combined AT's shortlist with proposals from NZTA and KiwiRail, for further prioritisation against the full suite of ATAP objectives. In total, $50 billion worth of projects, from all agencies, were included in the prioritisation.

72. The formal prioritisation was undertaken through a series of workshops, where project owners explained their project to the ATAP Working Group. The Portfolio Investment Appraisal (**PIA**) approach was adopted as the prioritisation methodology, based on its recent use by government to prioritise its Covid emergency recovery fund.

73. In general, the PIA process was regarded as robust and was well received by the ATAP Working Group. However, some concerns were expressed about aspects of the methodology and consequent results. For example, the methodology was considered to overemphasise the criteria related to 'connectivity' (as opposed to mode shift or climate change reduction), which led to unexpected outcomes when the value for money methodology was applied. As a result of these reservations, the outcome of the PIA process was treated as information to be considered alongside other information and evidence, rather than being definitive in its own right.

Evaluation and prioritisation: incorporating growth elements

74. The PIA process excluded growth-related projects, which were addressed in a parallel workstream which focused on identifying priority growth areas and the infrastructure required to support these areas. This work had been commissioned for a number of reasons, however from an ATAP and RLTP perspective, its main purpose was to seek clarity from the Council and Government about which of the large number of 'priority growth areas' should be prioritised for limited available funding. Within this, there was also a need to resolve some differences as to the scale and priority for investment in the Drury development.

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75. Ultimately this workstream identified five priority growth areas, namely the Northwestern growth area, the Drury growth area and the three main Kainga Ora development areas of Tamaki, Mangere and Mt Roskill. For each of these areas there was a range of options from the 'minimum adequate' package to comprehensive investment. For example, options for the Drury area ranged from a 'minimal' package at $243 million to a comprehensive option at $1,637 million. These options were used as an input into the next stages of the prioritisation process, including package testing, and the final programme.

Evaluation and prioritisation: package development

76. Following the individual project assessments, the process moved on to package development and testing.

77. Drawing on the evidence presented to the PIA process or through development of the baseline programme, candidate projects were allocated to 'packages' for further testing. The packages were designed to reflect a weighting towards particular policy objectives – such as mode shift, enabling growth or reducing transport emissions. This part of the process had been set out in the ATAP ToR, with the intent of informing trade-off decisions by the ATAP parties. The assumption was that budget constraints would mean that not all projects could be funded and guidance would be needed on which areas to prioritise. For example, given the signals from the parties, a key trade-off was expected to be between the funding allocation to growth enabling projects, and the funding allocation to projects that supported mode change and emissions reduction.

78. Seven packages were developed as follows:

(a) Mode shift:

- (i) Public transport focus
- (ii) Active modes focus
- (iii) Climate change focus

(b) Growth:

- (i) Intensive Drury option

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(ii) Balanced regional growth

(c) Blended Option 1

(d) Blended Option 2

79. All of the packages included the baseline elements, which, at the time, comprised around $29 billion of the available $31 billion.[14] In practice each of the packages allocated approximately $32 billion which included an element of 'overprogramming' to create more scope for differentiation between packages. This left around $3 billion of unallocated funding for discretionary projects in each package.

80. In carrying out this process, the packages were differentiated from each other as much as possible, in an effort to highlight the different policy choices and learn from the modelling of the projects themselves. Nevertheless, as we advised the Governance Group at the time, the relatively small amount of discretionary funding available for the package elements meant that the baseline programme would deliver the vast majority of regional outcomes. At around 10% of the value of total investment the additional impacts of the package would necessarily be modest – with most impacts being local to the specific projects.

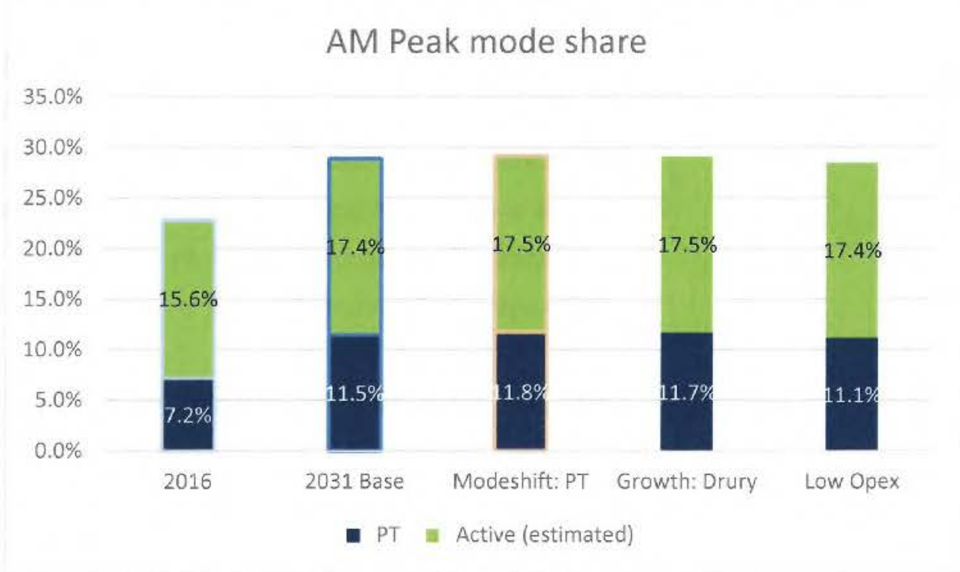
81. The Mode shift: 'Public Transport', 'Growth: Drury' and 'Low Operational Expenditure' packages were modelled using the MSM model described beginning at paragraph 95 below, along with the baseline programme as a comparator. These programmes were chosen for modelling as they included the bulk of projects that could be effectively modelled. The modelling results generally showed very little difference in outcomes between package options.

82. For example, although morning peak mode share for public transport was forecast to increase significantly from 7.2% in 2016 to over 11.1% in

14 As explained above, the final baseline figure was $29.1 billion. However, the evaluation and prioritisation of the discretionary funding was occurring in parallel with finalisation of the baseline.

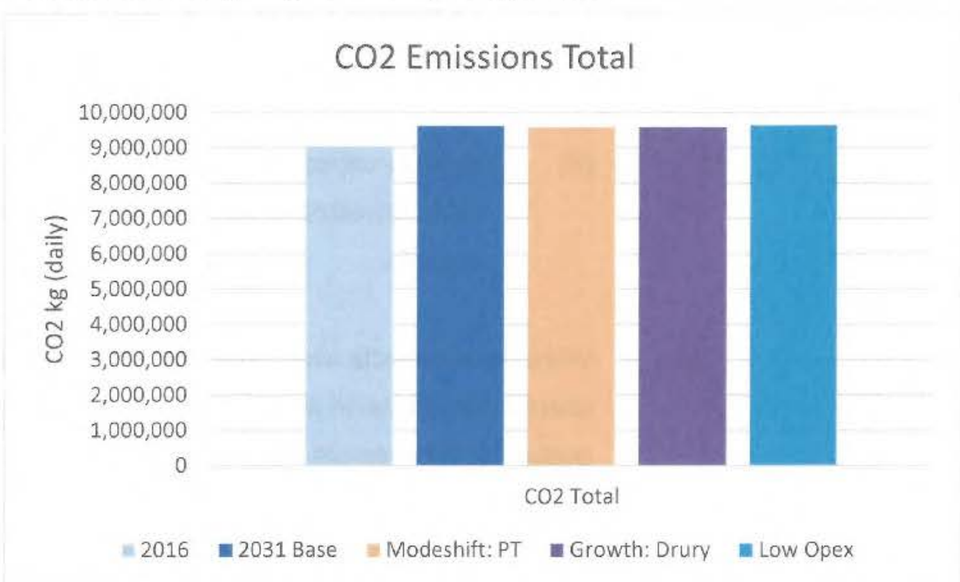
2031, the difference between modelled packages in 2031 was small – ranging from 11.1% to 11.8%, as shown on this graph.

Forecast morning peak mode share for 2021 ATAP package options



83. The difference for daily total CO_2 emissions between the packages was also small, ranging between 9,587,672 kg of CO_2 for the 'Growth: Drury' scenario and 9,623,512 kg for the 'Low Opex' scenario (see graph below). This is a difference of 0.37% between packages.

Forecast total daily CO_2 for ATAP package options



84. Given the relatively small difference between the packages, the final package results were not reported in detail to the Governance Group or

AB [initials]

the ATAP parties. The limited difference between package outcomes was reported verbally to the DDC.

Evaluation and prioritisation: Development of the final package

85. The Working Group moved on to development of the final package. With the PIA and package assessment process not providing definitive outcomes, and unallocated funding limited, the decision was taken to apply a qualitative approach, informed by broad criteria, to final project selection. The approach taken in determining the final recommended package was therefore to:

(a) draw from the shortlist of the highest performing projects identified through previous work;

(b) seek, within available funding, to provide smaller allocations to enable progress across a range of areas, rather than attempting to provide full investment in one or two areas;

(c) seek to address some of the gaps within the baseline programme – particularly the limited scale of support for priority growth areas and limited funding to address the impact of increased cycling programme cost (while the baseline already had strong allocations to rapid transit investment with the City Rail Link, Eastern Busway and Connected Communities);

(d) provide capacity on key Rapid Transit Network routes which were expected to come under pressure towards the end of the decade.

86. Within this, projects were generally selected with an emphasis on mode change and emission reductions outcomes – even if they served multiple goals. So, for example, while funding was allocated to support growth in Drury – the specific projects selected provided enhanced public transport options and connections to the railway network – they also supported emission reductions. Similarly, a large component of the funding allocation to the Auckland Housing Programme sites was intended to

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support use of public transport and active modes, while also mitigating traffic network issues associated with the sites.

87. The recommended package was briefed to the DDC on 24 November 2020 and endorsed by the CE Governance Group on 15 December 2020. An analysis of the discretionary elements of the package is provided at paragraph 154 below.

Other issues

88. The discussion above does not cover issues around operational funding or the challenges of aligning Waka Kotahi-NZTA funding with the programme as they are less critical to the main issue of development of the capital programme. However, they further demonstrate how external constraints limited the outcomes that could be achieved.

89. In particular, the funding that could be made available for new public transport services was constrained by:

(a) increased costs from running existing services;

(b) limited Council operational funding, which comes from rates rather than borrowing and is therefore constrained;

(c) Waka Kotahi-NZTA Financial Assistance Rate rules, which link the level of Waka Kotahi-NZTA funding to the level of Council funding.

90. The latter point meant that, although the Working Group was keen to allocate funding from capital projects to public transport services (within the $16.3 billion available from the NLTF) this was not possible due to funding rules.

91. There were also significant challenges in making the capital part of the programme work from a funding perspective. A key part of this RLTP is the shift away from large scale motorway projects – which are historically fully funded by Waka Kotahi-NZTA – to smaller to medium scale public transport projects delivered by AT. Under Waka Kotahi-NZTA's Financial

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Assistance Rate rules, the latter requires matching funding from the Council. As with the operating programme, Council funding was the constraint. In the end, ATAP addressed this problem with an assumption that Waka Kotahi-NZTA would apply higher financial assistance rates to key AT rapid transit projects.

92. Nevertheless, the effect of the Financial Assistance Rate rules was to limit the allocation of funding to public transport or active modes projects within the AT programme. This is one of the reasons the Squadron Drive interchange, which is fully funded by Waka Kotahi-NZTA, was included in the discretionary programme. Even though there was some Waka Kotahi-NZTA funding still available for allocation, we could not assign it to AT projects within the rules.

Emissions modelling

93. In this section of my evidence I will address the emissions modelling work which underpinned the advice my team and I gave to Board members and the RTC during the ATAP and then RLTP processes. This modelling work was commissioned as an input to Auckland Council's Auckland Climate Plan Te Tāruke-ā-Tāwhiri (**ACP**).

94. This work, which was carried out jointly with the Council's Sustainability Office, began in late 2018. We modelled a number of scenarios to understand the broad type and scale of interventions that might be needed to achieve large scale reductions in transport tailpipe emissions. This meant that, even before RLTP development began, we had a good understanding of some of the key variables around transport emission forecasts and the scale of interventions needed to achieve change in emissions.

MSM modelling

95. Modelling was undertaken using the Auckland Forecasting Centre's Macro Strategic Model (**MSM**), which was, and still is, the best available tool for modelling regional network level effects of larger scale transport interventions. This is because the model is calibrated to Auckland

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conditions, includes land use and population projections based on Auckland Council forecasts, and can model the entire regional network.

96. The model works by combining the variables that impact travel decision-making – such as time costs, vehicle operating costs, parking costs, and perceived costs of congestion or wait time - into a single 'generalised cost' of travel. So, for example, when a new public transport project is added to the modelled network its impact will generally be to reduce travel time – and therefore the generalised cost – along that route. This induces 'trips' on other modes or routes to switch to the improved route. The model then iterates through several cycles, taking account of the effects on the surrounding network as trip patterns change, until a final 'equilibrium' is reached.

97. The model is 'dynamic' in that 'trips' within the model can respond to changes in generalised costs by changing either:

- destination of travel;
- mode of travel (principally between road and public transport modes);
- time of travel;
- route of travel;

So, in the public transport example, the model will take account of the fact that space created on the road network by mode shift will generally be taken up by drivers changing their route or time of travel to take advantage of the improved conditions.

98. As such, the model can, and does, account for the wider effects of projects, generally roading projects, 'inducing' longer trips. It will also take account of increases in cost variables 'deterring' travel and, for example, resulting in shorter trips.

99. MSM is also able to model the impacts of changes in travel speed and/or congestion to estimate overall fuel consumption (fuel consumption per kilometre by speed) and therefore emissions produced (emissions per kilometre by speed), which as discussed later in this affidavit, has a material impact on emissions outcomes.

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100. While MSM has many strengths, it has two limitations relevant for present purposes. The first is that it does not directly model walking and cycling modes to the same level of detail as motorised modes (vehicles and public transport). Changes in these modes are calculated by shifting motorised trips to active and public transport modes based on external factors (for example the expected impacts of work and school travel initiatives). The second is that it does not model the changes in land use that might arise as a result of projects – either intensification due to improvements to the rapid transit network or more dispersed growth ('sprawl') due to improvements to the motorway network.

101. To some extent this is accounted for by the fact that the land use scenarios in the model are provided by Auckland Council experts and take into account expected land use given expected development trends. In the case of the RLTP scenarios, the underlying land use assumes that respectively 38% and 29% of household growth will occur in Auckland's outer urban and rural areas – so expectations of dispersed growth are already built in to the scenario.[15]

102. The scenarios we used for emissions modelling focused on changes to relatively simple variables, which were generally not project related. These simple variables were straightforward to model and understand, while still providing a good indication of the scale of intervention needed for meaningful change. We were also aware from previous ATAP and RLTP work that changes to the investment programme, within plausible funding levels, would only have a modest impact on mode shift and emissions outcomes, so we were keen to explore other variables. I discuss in more detail below the impact of investment programme changes on emissions outcome.[16]

103. It is also important to note that the scenarios were not necessarily expected to be deliverable from a cost, feasibility or political perspective. For example, removing fares from public transport would require another $382 million in funding per year in 2030/31 ($2.8 billion over ten years)

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15 The assumption may be pessimistic as only 16% of building consents have occurred in the rural area since 2013, although 50% were in the outer urban area.

16 See paragraphs 206 to 227.

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and was well outside the scope of the 2021 LTP. The scenarios were intended as indicative tests to establish the scale of effects.

104. A number of modelling runs were undertaken in early 2019 testing combinations of the following variables:

(a) Increased petrol costs associated with increases in the Emissions Trading Scheme (**ETS**) carbon price (as forecast by the Productivity Commission);

(b) Significantly more intensive land use than Auckland Council's baseline forecasts – i.e. 90% of growth occurring within existing urban limits rather than 70%;

(c) An increase in public transport frequency to a bus / train / ferry every five minutes on all routes – to test the effect of major reductions in 'waiting time' which is a significant deterrent to public transport use;

(d) Zero fares on public transport;

(e) Road pricing, in the form of a 69 cents per kilometre charge for the use of motorways and main arterials during the peak periods.

105. With the exception of pricing, individual interventions only had a limited effect on emissions, so we tested all interventions together. The combined impact was forecast as a 6% reduction in emissions in 2028 compared to a scenario without the interventions - with the bulk of the change coming as a result of the road pricing intervention. With the interventions in place, total emissions were forecast to reduce by 1% between 2016 and 2028.

106. Further modelling was undertaken during 2019 and 2020, with updates of various parameters – particularly to include updated input assumptions for fleet emissions published by Waka Kotahi-NZTA. The final run was provided to the Council for the ACP in June 2020.

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107. Over this time, my team, in consultation with Council officers, made a key adjustment to the pricing scenario. This was a change from a charge of 69 cents per kilometre, applying in the peak periods and on motorways and main arterials only, to a charge of 50 cents per kilometre applying to all of Auckland's road network across the whole day. This change was made to partially avoid traffic diversion issues associated with the original scheme. But, more importantly from an emissions perspective, it meant that the charge now applied to all vehicle travel, instead of a proportion of travel in the peak periods, and was therefore much more effective in emissions reduction. And, to repeat, the charge was not necessarily expected to be implementable – the intent of the scenario was to identify scale intervention needed to achieve significant emissions reductions.

108. This pricing scenario - combined with the other land use, ETS and public transport frequency and fare interventions - saw forecast vehicle kilometres travelled in 2028 reduce by 42% and total emissions reduce by 34% compared to a scenario for the same year without interventions. Of the 34% emissions reduction, 29% was the result of pricing, while 5% was the result of other interventions.

109. At Council officer request, a scenario was also run testing a notional intervention that would lead to:

- A 67% reduction in all mechanised trips between 0 and 1.0 km in length;
- A 33% reduction in all mechanised trips between 1.01 and 5.0 km in length;
- A 10% reduction in home based work mechanised trips over 5.0 km in length.

This scenario led to a further 4% reduction in emissions compared to the previous scenarios.

OECD Spine modelling

110. In 2019 and 2020 the OECD undertook a study entitled Decarbonising Urban Mobility with Lane Use and Transport Policies. This study examined the potential impacts of land use and transport policies on transport emissions outcomes.

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111. Despite the availability of MSM, the authors built an entirely new transport and land use model. This model, although not as sophisticated as MSM in terms of modelling network effects, was able to model the effect of price and land use type variables on distance travelled and therefore infer emissions.

112. The study did not attempt to model the impact of infrastructure or service based solutions as a separate scenario. This may have reflected their intended focus on 'policy' interventions – along with the capabilities of their model.

113. Three key scenarios were modelled.

(a) A "Promote public transport" package, which was in fact an extensive road pricing package which combined: a $2,000 per annum vehicle ownership charge; increasing the Emissions Trading Scheme petrol price from $0.16 per litre to $1.16 per litre; increasing the fuel tax from $0.06 per kilometre to $0.56 cents per kilometre; a road pricing scheme with a double cordon surrounding CBD and isthmus, with prices in line with the Stockholm scheme. The public transport element was an 80% reduction in fares;

(b) A 'Promote EV package", which also had elements of a pricing package as it applied the 0.56 per kilometre charge to internal combustion engine vehicles, but exempted EVs from this charge. A $2,000 purchase subsidy for EVs was also assumed;

(c) A number of land use policy packages – which essentially removed restraints on land use development in various parts of Auckland.[17]

17 OECD p 27.

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114. For 2030, compared to their reference case, the OECD modelling forecast:

(a) A 49% reduction in CO_2e emissions under the "Promote Public Transport" package;

(b) A 43% reduction in CO_2e emissions under the "Promote EV package";

(c) Potential further reductions of up to 6%, on top of the public transport or EV packages, from the best of the "Land Use Policy" packages.[18]

115. We had some difficulties with the Study at the time – principally around the description of the options as being 'public transport' or 'EV' related. Our concern was that these elements would be assumed to be the key causal factors, when the main changes were actually the result of essentially distance-based road pricing schemes. For example, Mr Chapman's affidavit (filed in these proceedings) makes this error at paragraph 38 by citing the OECD report as evidence of the gains of reallocating resources towards better public transport.

116. Overall, however, the results reinforced what we were finding from our own modelling – that aggressive road pricing schemes would be necessary to achieve large-scale short-term reductions in emissions.

CURB modelling

117. Although provided with the material discussed above, Council officers based their ACP scenario on outputs from a different model. This was the CURB model used to identify what changes in emissions production across Auckland's various sectors, including transport, would be needed to meet the overall 50% reduction target. CURB is an Excel spreadsheet based model provided by the C40 Organisation to cities to model climate action using city specific data.

18 OECD pp 81-83.

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118. CURB is not a transport model. As the ACP states: "CURB uses generic variables and estimation of outcomes rather than projecting the impacts of specific investment or policies, for example, construction of a rapid transit line or changes to land use policies".[19] Therefore, unlike MSM, CURB does not 'test' the results from potential interventions. Instead, its outputs directly reflect its input assumptions.

119. For the ACP work, the transport scenario included in CURB reflected officer input around assumed mode change and vehicle fleet electrification and efficiency improvements. I understand these inputs were generated by 'backcasting' to establish the scale of change in key variables that would be needed to reach the transport sectors share of the overall emissions reduction target.

120. The value of this approach is that it identifies, at a very high level, the scale of change in key variables needed to reach a particular outcome. However, the limitation is that it does not identify which projects, services or other interventions can actually deliver the assumed change in key variables. So, for example, the modelling reported in the ACP suggests that increasing public transport mode share from 7.8% to 24.5%, cycling mode share from 0.9% to 7% and walking mode share from 4.1% to 6%[20] will lead to a 14% emissions reduction.[21] But it does not demonstrate if or how the change in mode share can be achieved in the first place. A further 10% reduction was expected from remote working and reduced trip lengths.

121. It is also important to note that the ACP assumed other changes to the vehicle fleet in order to support emission reductions by 2030. These were: 100% of the bus fleet to be zero emission; 40% of the light fleet to be electric or zero emission; 18% increase in the fuel efficiency of the remaining light fleet; 8% of road freight to shift to rail; 40% of road freight to be electric or zero emission and a 15% increase in the efficiency of the remaining heavy fleet.[22] This change to overall low emission or more efficient vehicles was forecast to lead to a 55% reduction in emissions[23]

19 ACP, page 51.
20 ACP, page 142.
21 ACP, page 51.
22 ACP, page 47.
23 ACP, page 51.

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– meaning that the vehicle technology changes accounted for nearly 70% of ACP's expected emissions reduction.

122. The CURB input assumptions were described as 'indicative targets', which appears to have led to the impression in some quarters that these had been formalised and had become expected deliverables. In practice, as the document acknowledges, delivery of the actions and changes in the ACAP remained subject to funding in the Council's Long-Term Plan and from other sources. This is an important consideration. Public transport services alone are expected to cost $780 million in 2030/2031 ($7,436 million over the decade), net of the $381 million fare revenue. The indicative target of more than tripling the public transport mode share implies a similar scale of change in public transport network capacity, services and therefore costs – which is well beyond the current capacity of the RLTP (or NLTP). The document also notes that achieving the 'indicative targets' will require action from multiple parties, including the Council and Government, so clearly does not rest of the shoulders of the RLTP alone.

123. One reason for the difference between CURB and MSM results is the more ambitious assumptions for vehicle technology change used as an input to CURB modelling. Other differences between the CURB mode share inputs and the figures for ATAP and the RLTP are explained by their different purpose and methodology. The CURB results provide an indication of the kinds of shifts that would be needed to achieve emission reductions targets, without constraints such as funding. However, the ATAP and RLTP mode shift and emission modelling results show the scale of change we can expect from key interventions when operating within the constraints of the existing land use pattern, transport network and, in most cases, funding availability.

A $1 per kilometre scenario

124. In March 2021, I requested a further modelling run with a toll of $1 per kilometre,[24] applying all day across the Auckland network. Given the focus on emissions outcomes as the RLTP was finalised (as discussed below), the intention was to better identify how hard we would need to

24 Toll values were in 2016 values.

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'pull the lever' of demand management to come close to achieving the kinds of shifts envisaged by the ACP. As before, the intention was not to propose a pricing scheme, but instead to understand and then illustrate, in a simple way, the scale of the challenge in Auckland's context.

125. This $1 per kilometre scenario yielded a 50% reduction in vehicle kilometres travelled and a 43% reduction in CO_2 emissions compared to an unpriced scenario in 2031.[25]

126. For context, the price and scope of these 50 cent and $1 per kilometre all day, all network, scenarios are much higher and more comprehensive than anything previously considered in Auckland. As a comparison, "The Congestion Question" charging scheme, which was supported by Auckland Council and considered by the Parliamentary Select Committee only had a charge of $0.12/km or a fixed charge up to $3.50 and only applied to peak hours of travel in the morning and afternoons.

127. Although they were modelled as pricing schemes, these modelling runs also illustrated the kind of impact which any demand management based intervention – such as road space removal, traffic calmed neighbourhoods or other behavioural change programmes - would need to have in order to reduce overall travel. In short, to achieve a 40% reduction in emissions, a demand management intervention would need to have an effect equivalent to charging drivers $1 per kilometre. Short of widespread road closures, I am not aware of a demand management intervention, other than pricing, that would have this kind of effect.

128. The results of the modelling of the $1 per kilometre charge were reported verbally to the RTC on 23 March 2021. These results demonstrated to AT Board members the challenges in seeking to reduce transport emissions by reducing distance travelled. The results reinforced the view that major policy changes would be needed to effectively tackle transport emissions – including both a shift to low emission vehicles and some form of distance-based road pricing. The RTC members also identified that the kinds of interventions needed to achieve large scale reductions in demand for travel, particularly if pricing based, would have major

25 There are diminishing impacts from increasing the per kilometre charge. This is a typical characteristic of pricing schemes, but also reflects the fact the freight trips, which emit more on a per kilometre basis, make up an increasing share of the remaining traffic.

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implications for the travelling public that would need careful political consideration. This view is reflected in the RLTP text itself.

AT Board member involvement in ATAP

129. As noted earlier, although AT is not an ATAP party, it was closely involved in the ATAP process. The AT Board was kept fully informed throughout, with officers seeking guidance from the Board at key stages, and providing opportunity for the AT Board members to give direction and feedback. This was in order to manage the risk of any misalignment between the final ATAP programme agreed between the Council and the Ministers, and what the AT Board and RTC would be prepared to approve as part of the RLTP.

130. As such, AT Board members had a very good understanding both of the process and the content of the ATAP programme itself, as it developed. Board members provided important input to shape officers' approach to ATAP.

131. Much of the engagement with Board members in relation to ATAP was through a committee of the Board, the Design and Delivery Committee (**DDC**). This briefing began in late August 2020 and initially focused on explaining the nature of the ATAP process and its relationship to the RLTP, along with advantages and disadvantages. As already mentioned, this briefing also specifically confirmed the alignment between ATAP and the draft GPS objectives, providing further assurance that the ATAP direction was also consistent with Government policy.

132. By late September 2020, officers' advice had shifted to the detail of issues the ATAP work was dealing with – particularly development of the 'baseline programme'. We also provided briefing on expected performance, based on the 2018 RLTP, and sought initial guidance on objectives and measures.

133. In September 2020 the RTC was also briefed on the process for developing the RLTP, by reference to the ongoing ATAP programme. This briefing included an attachment setting out the requirements of a Regional Land Transport Plan, including a summary of the section 14

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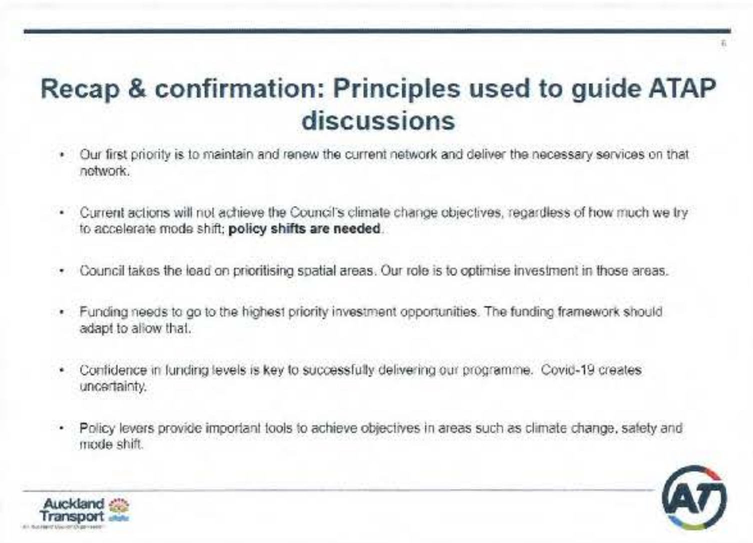
requirement that "When considering the draft RLTP, the RTC must be satisfied that it contributes to the purpose of the LTMA 'to contribute to an effective, efficient, and safe land transport system in the public interest', and that it is consistent with the GPS". A copy of this attachment is at HB1-103.

134. Over the September and October 2020 period the DDC provided two key pieces of guidance relevant to the ATAP process and outcome.

135. First, the Chair of the DDC provided officers with a set of principles to guide our discussions with other agencies as part of ATAP. These principles, which were drafted by the DDC Chair, and confirmed by the DDC on 23 October 2020, are as follows.



136. Although aligned with some of the advice already provided, these principles demonstrated an early recognition by DDC members that the emerging ATAP/RLTP investment programme would not, of itself, have the scale of effects needed to achieve Council – and by implication, government – objectives across climate change, safety and mode shift. They recognised that wider policy interventions would be needed to achieve the kinds of shifts envisaged by Council and Government.

137. Secondly, as already explained above, the DDC emphasised to AT officers the need to ensure that a robust renewals programme was included in ATAP. Based on the case put to the Working Group by AT officers, and supported by evidence from AT's asset management

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specialists, the inclusion of a $3.9 billion allocation for renewals was approved by the ATAP Governance Group and eventually the ATAP parties.

138. At the end of November 2020, the DDC was further briefed on the emerging ATAP/RLTP programme, including an indication of the likely order of magnitude of expected results, and was broadly comfortable with the programme (in the context of available funding and other constraints). The focus of advice and consideration therefore moved towards securing funding for the programme – which was dependent on changes to Waka Kotahi-NZTA funding rules.

139. In December 2020 the AT Board Chair and Deputy Chair joined the team of officers briefing Auckland Council's Planning Committee on the ATAP/RLTP. This briefing included the AT Board Principles for ATAP (described above) and an outline of expected results from the programme – including what was at the time expected to be a 5% increase in emissions between 2016 and 2031.

Preparation of RLTP proper – RTC's involvement

140. With the ATAP programme agreed by the Governance Group, AT turned its attention to the process of formally preparing and approving the RLTP.

141. As explained above, it was always envisaged that ATAP would form the basis for the RLTP programme, and ATAP had been prepared with that in mind. A draft RLTP programme which was derived from ATAP was therefore prepared. This was considered by the RTC at a workshop in late January 2021. At that workshop, the RTC expressed a desire to include a set of smaller projects and programmes which had been omitted from the ATAP programme. The RTC agreed that the RTC Chair would write to the Mayor to propose these changes for consideration by the ATAP parties (as ATAP had not yet been finally approved by the Council and Ministers)

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142. The proposed changes were:

(a) a $100 million increase to the Minor Improvements Programme, which addresses small scale safety, operational and community projects. This programme had been removed to enable funding reallocation to other priorities, but the RTC was keen to retain it to enable AT to better address community and local board desire for small scale projects;

(b) a $30 million allocation to enable the purchase of electric ferries as part of an initial trial;

(c) $10 million towards the Waiheke Island Ten Year Transport Plan, which provided funding for small projects on Waiheke – primarily related to safety, public transport and cycling;

(d) $10 million for the Community Safety Fund, which provided for the completion of a number of projects expected by local boards

143. To enable this reprioritisation within the existing funding level, the RTC proposed the following reductions:

(a) Corporate and Customer technology reduced by $45 million from $394 million to $349 million;

(b) PT Safety, Security and Amenity and other capital programmes reduced by $40 million from $223 million to $183 million;

(c) Connected Communities programme reduced by $40 million from $615 million to $590 million;

(d) AT Strategic Future Planning reduced by $10 million from $32 million to $22 million;

(e) AT Accessibility Improvement Project reduced from $55 million to $40 million.

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Finalisation of ATAP

144. The Council's Planning Committee was briefed on the proposed programme and outcomes at a workshop on 3 February 2021. At this workshop, some Committee members raised concerns over the greenhouse gas emissions in particular, but did not request any specific changes to the programme.

145. Cabinet considered the ATAP programme on 22 February 2021. The Cabinet paper, a copy of which is at HB1-113, covered the expected climate outcomes from the ATAP programme in detail. This included the modelled emission results from the ATAP programme along with the forecast impact of expected policy shifts, such as the clean car standard and biofuels mandate. The paper also raised concerns over the level of funding allocated within the programme to support key housing development and reduce Auckland's housing shortage. It presented Cabinet with the option of either agreeing to the ATAP programme as it stood; or, agreeing to reprioritisation of the programme to increase the allocation to transport investments to support the Auckland Housing Programme by $321 million. In the event, Cabinet agreed in principle to the overall programme, subject to amendments to the programme to increase funding for projects to supporting housing.

146. The Cabinet's requirement of extra funding to support housing objectives meant that further refinement of the ATAP programme was necessary. After a series of discussions, and further briefing to the Planning Committee on 4 March 2021, the Minister and Mayor agreed a series of changes to the programme that:

(a) incorporated the changes proposed by the RTC, set out in paragraphs 142 and 143 above;

(b) increased funding for transport related to the key Auckland Housing Programme areas by $321 million. Of this $321 million, the Minister advised that $100 million would come from the Crown, while the remainder came from reprioritisation of the ATAP programme (with advice on prioritisation coming from AT)

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– including a $20 million reduction from the renewals programme.[26]

147. These reductions came from projects that were categorised as 'essential'. This reflected a number of factors, including:

(a) a desire to avoid reductions to named discretionary projects that had been, by that stage, identified in the Council's Draft Long-Term Plan – and therefore become more 'essential' – along with projects named in the Regional Fuel Tax consultation;

(b) a change in circumstances affecting Project Next and the Greenfields Infrastructure programme over the course of ATAP development which enabled them to be reprioritised with limited negative impact;

(c) a general desire not to remove any of the new elements included in the discretionary programme – many of which were also housing related anyway;

(d) limited other reprioritisation opportunities as the remainder of the programme was either committed or essential.

148. By this stage, options for reprioritisation from within the AT programme had effectively been exhausted and were now beginning to cut into the renewals programme.[27]

Composition of the draft RLTP programme

149. With these refinements complete, the agreed ATAP programme essentially became the draft RLTP programme. The main elements of the programme were as follows[28].

26 The changes were: $124 million reduction in 'Project Next' – which was AT's contribution to a national integrated ticketing system; $60 million reduction from the Greenfield Transport Infrastructure Fund, which reflected retiming of projects in light of slower than expected development in the northwestern growth area; $20 million reduction from the Network Performance and Intelligent Transport Systems programme; and $20 million reduction from the renewals programme.

27 Note, due to the constraints of funding rules, no further funding could be assumed from Waka Kotahi-NZTA.

28 A full list of the projects included in the final RLTP, using ATAP categorisation, is at HB1-100.

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150. The baseline component of the programme had total value of $30.3 billion out of total package of $32.5 billion.[29] Some of the larger elements within the baseline included:

(a) AT Operating Expenditure (net of other revenue, such as fare revenue), which is mostly funding for public transport services, at $7.5 billion;

(b) the total for projects in construction or under contract: $6.7 billion;

(c) the New Zealand Upgrade Programme and the Covid Recovery Fund at $4.4 billion;

(d) the AT renewals programme at $3.9 billion;

(e) Waka Kotahi-NZTA and KiwiRail maintenance, operations and renewals at $1.9 billion

(f) Funding allocation to City Centre to Mangere and Northwestern rapid transit which was advised as non-discretionary by MoT, $1.8 billion

(g) Projects regarded as 'essential': $4.0 billion

29 For simplicity, the following paragraphs and figures are based on the final RLTP figures – but this does not change the analysis. The final RLTP total is higher than the ATAP total due to changes in the NZUP programme and the inclusion of loan repayment costs for previous train purchases that had been excluded from the ATAP accounting.

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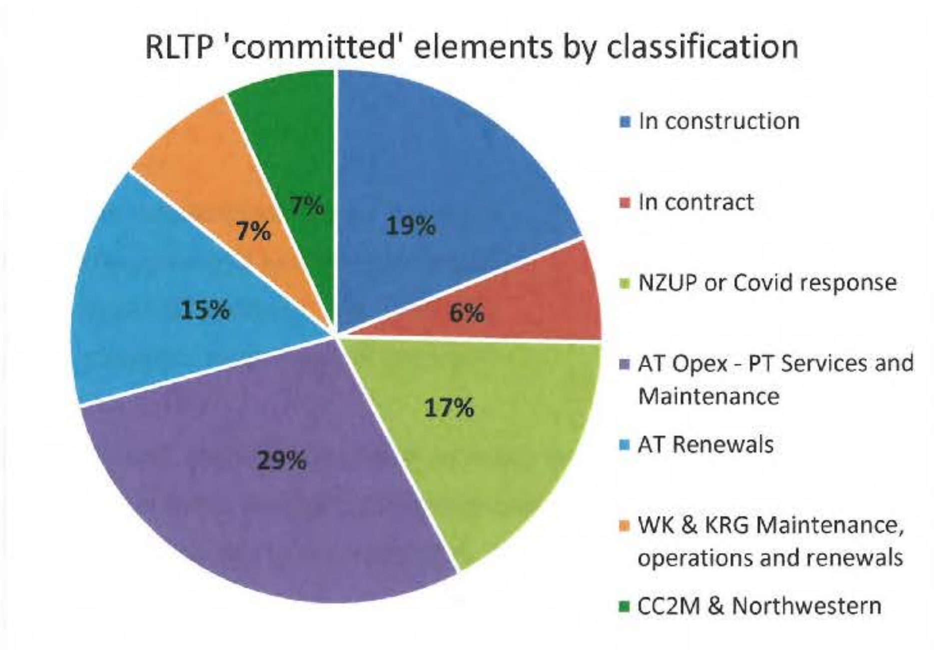
151. A breakdown of the categories of "committed" investment is shown below.



152. Of the $4.0 billion worth of programmes and projects that were categorised as 'essential', 80% was directly related to better travel options, safety or spatial priorities. Key examples include:

(a) $899m million for the safety programme;

(b) $412 million for new trains necessary to support the City Rail Link project;

(c) $583 million for the Connected Communities programme of buslane, cycling and safety improvements;

(d) $306 million for the ongoing cycling programme;

(e) $220 million for level crossing removal to support the City Rail Link.

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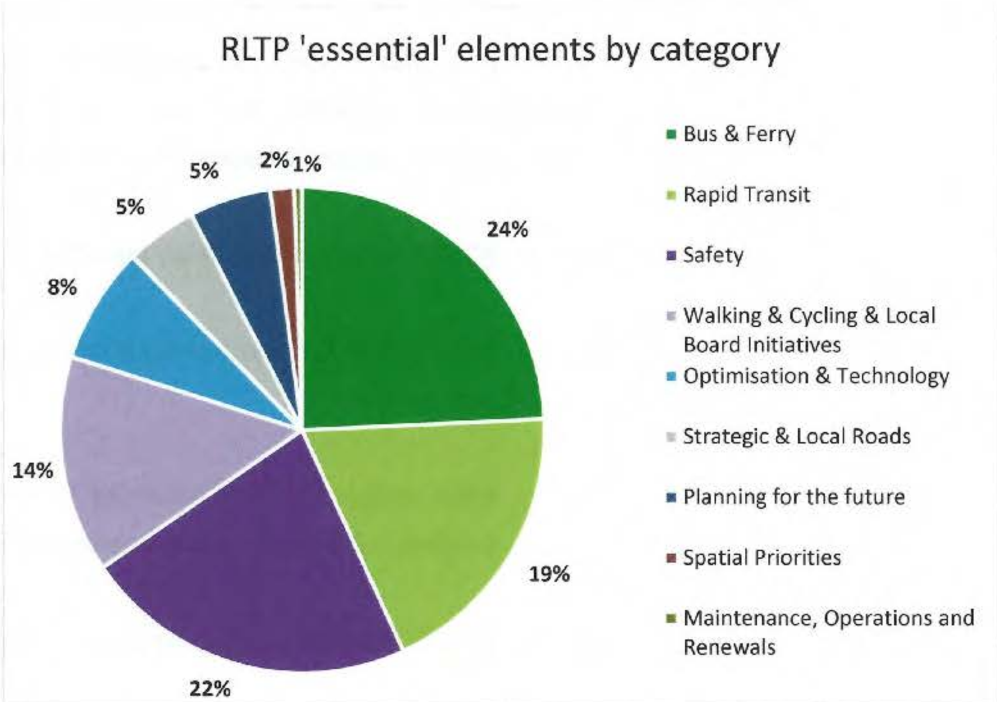
153. Within the remaining 20%, a large proportion also indirectly supported these objectives, such as:

(a) the Lake Road/Esmond Road and Environmental Sustainability Infrastructure within the Strategic and Local Roads category; and

(b) Business case, designations and property for the Additional Waitemata Harbour Crossing, which is investigating multimodal solutions, and KiwiRail Strategic Future Planning within the "Planning for the Future" category.

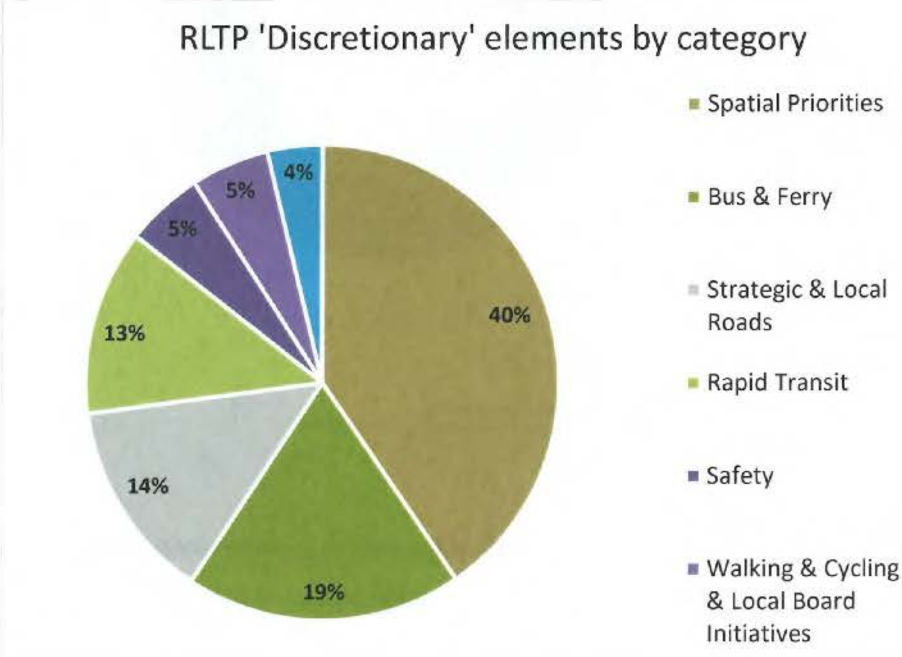
Other projects, such as Intelligent Transport Systems and the Grafton Gully Improvements Business Case also support improved connectivity for freight. A breakdown of the categories of "essential" investment is shown below.



154. Within the final $2,066 million discretionary programme, 83% of the programme directly supported either spatial priorities, better transport options or safety. Of the remainder, the 14% categorised as 'Strategic and Local Roads' projects were either multi-modal in nature and predominantly supported better travel choices, or supported freight or

HB

spatial priority/housing development outcomes (for example, Squadron Drive). The Optimisation and Technology projects, meanwhile, supported either electric vehicles, freight optimisation or AT's core operating programmes. Overall, the discretionary projects were highly aligned to both ATAP and GPS objectives. A breakdown of the discretionary programme is provided in the figure below.



155. In terms of the final RLTP programme, as shown in the figure below from the RLTP itself, 57% is allocated to new capital improvements while 43% is allocated to maintenance, operations and renewals. 49% of the capital improvements programme is allocated to public transport, while walking and cycling receives 8%. Spatial priorities and safety receive 7% and 6% respectively. 24% of capital improvements go to Strategic and Local Roads, but 90% of this category is committed, with the remainder mostly being multi-modal or supporting spatial priorities. Optimisation and Technology, Planning for the Future and Local Board priorities make up

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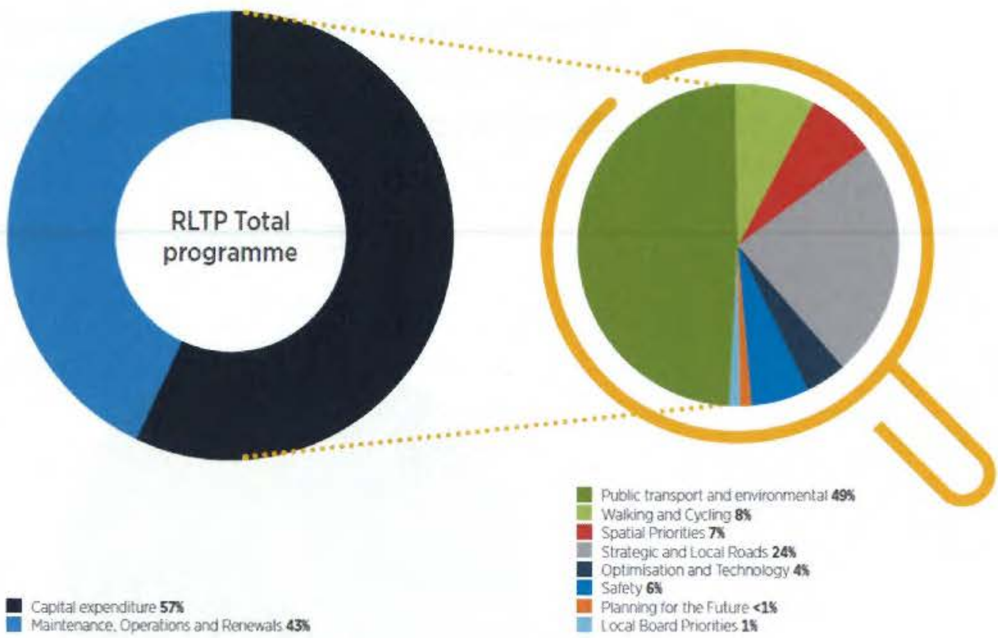
the balance of the improvements programme and these are generally weighted towards better transport choices outcomes.



156. Of the 43% allocated to maintenance, operations and renewals, over half (55%) is funding public transport operations, while the remainder supports efficient maintenance of the existing transport network.

157. Overall, the total programme is dominated by investment in public transport improvements and services, and therefore offers strong support for the better transport options and emission reductions GPS outcomes.

Minister of Transport's letter

158. An important factor in the discussions at this time was a letter from the Minister of Transport to the Mayor of Auckland dated 22 February 2021, a copy of which is at HB1-128. In the letter, the Minister strongly supported the ATAP programme and highlighted its consistency with emissions reduction goals, as follows:

> Clearly the investments we make through ATAP need to be consistent with our shared ambition to decarbonise transport, and from this point of view it is pleasing that the modelling shows that the proposed programme would result in a 13 percent decline in emissions per person over the next decade, achieved through a 91 percent increase in public

HB. [initials]

> transport trips and a 43 percent increase in walking and cycling trips. This shows that the proposed ATAP investments will offer Aucklanders better transport choices and that the package has a meaningful impact on emissions.

159. The Minister then went on to refer to the challenges of population growth before highlighting the importance of the infrastructure investment as one of many tools needed to achieve emission reductions – including policy changes. The Minister observed that:

> These decarbonisation measures are a positive start and for the first time, puts us on track to reduce transport sector emission in Auckland. However, more clearly needs to be done. It is important that the proposed ATAP package proceeds in order for a range of important investments that will give Aucklanders greater transport choice to proceed. Once the package is in place, I am keen to engage with Auckland Council and Auckland Transport further to consider initiatives that we can co-operate on to advance our shared ambition to decarbonise Auckland's transport system.

160. This letter was provided to AT, including to the Board members and RTC who were in the course of preparing and approving the RLTP. From my own perspective, I regarded the Minister of Transport's endorsement of the ATAP programme (and therefore the proposed RLTP programme) from a better travel choices and regional transport emission perspective as indicating that he:

(a) saw the programme as achieving meaningful emission reductions (in the context of the challenge of population growth); and

(b) expected emission reductions outcomes to be achieved by a wider range of interventions than investment alone; and

(c) saw the programme as being consistent with the GPS.

161. With the last set of refinements to the programme agreed, the revised ATAP programme, incorporating the above changes, was then approved by Cabinet on 8 March 2021.

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Continuation of preparation and finalisation of draft RLTP

162. Development of a draft RLTP document had begun in late January 2021 and was circulated to the Deputy Chair of the RTC in an early form on 19 February 2021 and then to the Chair and Deputy Chair on 22 February 2021. The full RTC received the draft on 23 February 2021. I note that this draft included reference to the initial 6% modelled increase in emissions (before wider government emissions reduction interventions were taken into account).

163. At a workshop on 25 February 2021, the RTC indicated that it was happy for the draft RLTP to go to the Planning Committee for endorsement – although this would have been subject to resolution of the final issues around reallocation of funding to support housing outcomes.

164. The final form of the draft RLTP continued to evolve. This reflected the fact that (as already explained above) the Council and the Ministers were still engaging on refinements to ATAP. During this period, we also updated our emissions reduction calculations to include the expected emissions from policy shifts, such as the clean car discount and biofuels mandate, that had been advised by the Minister. These changes provided a more accurate overall picture of forecast emissions reductions out to 2031.

165. On 11 March 2021, the Council's Planning Committee unanimously endorsed the ATAP and the draft RLTP for consultation. The following day, 12 March 2021, the ATAP programme was formally announced by the Minister and Mayor.

Public consultation

166. On 23 March 2021 the RTC approved the draft RLTP for consultation. As the emission forecasts had changed to take account of updated information from MoT, officers provide specific briefing on the new estimates, noting that:

> Projecting transport emissions is challenging and requires integration of a number of information sources. Nevertheless, the initial estimate is that the combination of the RTLP package and government's announced changes

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should yield a slight decrease in transport emissions between 2016 to 2031 - despite a 22 percent increase in Auckland's population over the same period. Beyond this, rapid reductions in emissions are predicted after 2031 as more and more of the vehicle fleet becomes electrified. If the Climate Change Commission's proposals for improved vehicle fleet are realised, the Commission's figures indicate a further emissions reduction in the order of 12 percent is possible in 2031.

167. The officer's report to the RTC said that the RTC would be provided with an assurance framework which would set out how statutory and legislative responsibilities had been addressed through the RLTP's development and in the document itself.[30]

168. Public consultation on the draft RLTP took place between 29 March and 2 May 2021 using the special consultative process. Approximately 5,800 submissions were received. The RTC deliberated on these submissions, including the submission from All Aboard Aotearoa, in workshops on 10 May and 24 May 2021, and considered potential changes to the draft RLTP as a result.

RTC decision to recommend approval of RLTP

169. The RTC made its decision recommending approval of the final RLTP to the AT Board on 18 June 2021. The report to the RTC and the minutes of the meeting are attached to the affidavit of Jenny Chetwynd, so I will not do so here.

170. The recommended RLTP included changes arising out of consultation. The executive summary of the officers' report to the RTC advised:[31]

> [In terms of consultation] there were a wide range of responses from the public, local boards, Planning Committee, and stakeholder groups. The local boards were strong in their support for more investment in footpaths and asset renewals. There was also strong support for investment in travel choices, safety, and asset management from the public and stakeholder groups.

30 Paragraph 44.
31 Paragraphs 2 to 6.

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There were two particular areas of criticism of the RLTP – that the programme did not do enough to address climate change and should be substantially reprioritised to increase investment in sustainable modes; and, that the programme does not do enough to address congestion and needs reprioritisation to address freight connectivity issues.

A number of changes are proposed following feedback from the consultation process and the announcement on 4 June 2021 from the Minister of Transport on the New Zealand Upgrade Programme (NZUP); however significant changes to increase or reprioritise the programme are limited by funding constraints and the impact to other priority areas to enable an effective, efficient and safe transport system in the public interest.

The committee must also be satisfied that the RLTP is consistent with the GPS. The analysis at Attachment 5 shows the RLTP is consistent with the GPS as it seeks to achieve a set of objectives that are consistent with the four GPS investment priorities, follows an investment direction that is consistent with the GPS, and, is forecast to achieve outcomes that are consistent with the Primary Outcomes and delivery expectations included in the GPS.

171. In terms of key changes to the RLTP, the officers' report advised that:[32]

Although the RLTP is consistent with the outcomes in these key GPS priority areas, we agree with the submitters that it is desirable to seek better outcomes in terms of emission reductions and improving freight connectivity (amongst other areas). However, we are also cognisant that there is limited opportunity to reprioritise the RLTP towards one area without compromising other GPS priorities or the overall contribution to efficiency, effectiveness, safety, or the public interest. Scenario testing as part of ATAP indicated that any significant reprioritisation of activities is unlikely to make a significant difference to greenhouse gas emissions.

Although there is limited flexibility for major change, several refinements are proposed address more localised issues. These reflect areas where there is significant feedback from consultation and/or local boards; there is a community expectation as a project was included in the previous RLTP; planning was underway; they can be funded within the current funding arrangements; and they are consistent with the GPS and the intent of ATAP.

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32 Paragraphs 30 and 31

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172. The report also advised that the RTC could not "remove or amend any regionally significant' expenditure on activities that are funded from sources other than the National Land Transport Fund [such as NZUP projects]; or remove or amend a significant rail activity proposed by KiwiRail".[33]

173. Some of the more significant changes to the RLTP were:[34]

(a) An additional $20 million investment over ten years in new footpaths, responding particularly to local board advocacy in this area;

(b) Inclusion of $12.5 million (uninflated) to address safety and efficiency issues with the intersection of Dairy Flat Highway (DFH) and the Avenue Intersection;

(c) Providing a 25% local share for Hill Street Intersection (Warkworth);

(d) Progressing the Business Case for Lake Road by spreading the allocated funding such that $1m is allocated in each of 2021/22 and 2022/23 financial years;

(e) Auckland-Wellington Regional Passenger Services - including commentary to the effect that work was underway to investigate the feasibility of a North Island inter-regional passenger rail service operating on the North Island Main Trunk Line to provide alternative travel options and work towards a low carbon transport system that enables economic growth;

(f) Modifying the text and tables to reflect the Minsters' announcement on 4 June 2021 of changes to the NZUP;

(g) Changes to the AT capital and operating programmes to align with Council's LTP, as well as updates to the Waka Kotahi-NZTA and KiwiRail programmes. These are set out in Ngā

33 Paragraph 32.
34 Officers' report, paragraph 31.

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ritenga-ā-pūtea me ngā rauemi / Financial and resource impacts;

(h) Including commentary to demonstrate AT's commitment to work with Local Boards around the funding and allocation of smaller local projects that improve community outcomes;

(i) Various technical changes to ensure that the RLTP fully met the requirements of the LTMA and remained consistent with the ATAP;

(j) Acknowledgement of the Clean Car Package announced by the Minister of Transport on 13 June 2021.

174. The additional projects within the programme were included on the basis of 'overprogramming' – i.e. the extra costs could be absorbed in the course of delivering the overall programme, for example through unanticipated delays.

175. In terms of emissions impacts, the report said:[35]

> The RLTP's key contribution to emissions reduction is investment in infrastructure and services support mode shift away from private vehicles and towards public transport and active modes. Additionally, the RLTP also contributes through the electrification of public transport services, like buses and trains.
>
> With this investment and confirmed future government policy as at May 2021 (fuel efficiency standards and biofuel requirements), transport GHG emissions are expected to reduce by approximately 1% (between 2016 and 2031) – despite Auckland's population being expected to grow by 22% over the same period. This based on the regional transport model outputs including vehicle emissions parameters published by Waka Kotahi-NZTA and the MoT. Over the 2021-31 period, the reduction in emissions is estimated to be in the order of 5% – despite Auckland's population being expected to grow by 16%.
>
> Draft national emissions targets to 2030, for the entire country for all sectors, is a 20% reduction on 2019. The MOT is currently consulting on actions

35 Paragraph 33

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necessary to meet the target, and by the end of 2021, they are required to announce policies that achieve the target.

176. A full analysis demonstrating how the RLTP met the requirements of section 14 of the Land Transport Management Act was provided to the RTC as an attachment, and a copy is at page JC1-1069 of exhibit JC1 to Ms Chetwynd's affidavit. The RTC specifically resolved that it was satisfied that the RLTP complied with the LTMA including that it:

(a) contributed to the purpose of the LTMA: and

(b) was consistent with the GPS.

177. I was present at RTC meetings throughout the RLTP process, including on 18 June 2021. One of the themes of these discussions was the challenging position faced in preparing the RLTP. Policy documents such as the GPS and ACP rightly set high ambitions for reducing transport sector emissions. However, these ambitions could not be achieved by an investment strategy alone – particularly as neither the GPS nor ACP materially changed the level of transport funding available.

178. Very early on, Board members recognised, and were keen to emphasise, that significant new policy tools would be required to achieve substantial emission reduction outcomes. This was reinforced by the further modelling evidence officers provided them over the course of RLTP development. However, these kinds of policy shifts required change that was well beyond the scope of the RLTP or the role of the RTC. The response, from both officers and the RTC, was to ensure that the RLTP itself emphasised the need for policy shifts as part of an integrated plan to address emissions. The intent was to highlight the need for further change and encourage decision makers to promptly tackle the more significant policy shifts that will deliver deeper emissions reductions. The RLTP therefore stated:

> For Auckland to successfully meet its challenges and realise its full potential over the long term, investment in infrastructure and services must run alongside some significant policy and regulatory changes. The RLTP includes a number of policy responses, many of which require significant advocacy from Auckland to progress.

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179. At the same time, both officers and Board members recognised that the policy shifts needed to achieve the scale of change envisaged by the ACP – for example extensive distance based road pricing - would have major negative social, economic and cultural implications for Aucklanders, along with major equity impacts.[36] Decisions to advance such policy shifts were outside the ambit of the RLTP, and required trade-offs between complex policy considerations which were the role of elected representatives to make, and had not yet been made in the formulation of either the GPS or the ACP.

Endorsement by Council's Planning Committee on 24 June 2021

180. The RTC's resolution on 18 June 2021 also included a recommendation to the Council's Planning Committee to endorse the RLTP. The Planning Committee met on 24 June 2021 to consider this recommendation. I co-wrote the report to the Planning Committee.

181. This meeting (which I attended) is discussed in the evidence of Megan Tyler, which I have read. I confirm her evidence about that meeting. The Planning Committee resolved to endorse the RLTP for submission to the AT Board for approval.

Decision by AT Board to approve RLTP

182. On 28 June 2021 the AT Board met to consider the RTC's recommendation approve the RLTP. The agenda included an officers' report, largely written by me. (This, together with the minutes, is attached to the affidavit of Jenny Chetwynd so they are not exhibited here.) The Board also received a copy of the full proposed RLTP, which included Appendix 9 "Consistency with S14 of the LTMA". This was the same

36 Most commentators would argue that road pricing schemes aimed at achieving congestion reduction and efficient use of the network will have a net positive welfare/wellbeing outcome. In general, I agree, although the outcome very much depends on scheme design. In this case, the increase in generalised cost of travel associated with the pricing mechanism is far in excess of typical schemes focused on congestion removal and so large that the outcome in terms of economic, social and cultural wellbeing would in my view be negative.

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analysis which had been provided to the RTC. That analysis demonstrated how the RLTP:

(a) contributed to the purpose of the LTMA;

(b) was consistent with the GPS. This included separate discussion of each of the four strategic priorities in the GPS, including the climate change priority.

183. This analysis concluded that the RLTP was consistent with the 2021 GPS because it:

(a) sought to achieve a set of objectives that were consistent with the four GPS priorities;

(b) followed an investment approach that was consistent with the GPS;

(c) was forecast to achieve outcomes that were consistent with the Primary Outcomes and delivery expectations in the GPS.

184. The analysis also said that this conclusion was consistent with the fact that the RLTP itself derived from the ATAP programme, which was:

(a) developed in conjunction with the MoT and Waka Kotahi-NZTA and proposed to Cabinet, indicating that these agencies considered the RLTP to be consistent with the GPS:

(b) agreed by Cabinet, who were advised of the anticipated results (i.e. the emissions outcomes), which supported the overall conclusion that the ATAP programme, and the RLTP, were consistent with the GPS.

185. At the meeting, there was discussion and questioning by Board members on various issues, including climate change. The minutes are attached to Ms Chetwynd's evidence. They record that:

> The Chair asked management to provide a summary of investments which would reduce or steady carbon dioxide emissions over the investment period.

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> Mr Bunn responded that the RLTP included significant investment in rapid transit and active modes such as walking and cycling. He noted the RLTP included:
>
> • An increase in scale of the Rapid Transit Network including the Eastern Busway, City Rail Link, North Western Busway, new rail stations and the purchase of additional rolling stock to support the rail fleet.
>
> • A reduction in emissions made by the bus and ferry fleets through electrification.
>
> • Supporting adoption of electric vehicles and the clean car discount through charging infrastructure (noting that the benefits of the clean car discount have not been included in the RLTP).
>
> • 200km of safe cycling infrastructure.
>
> • $10 million of public transport related operational expenditure.
>
> The Chief Executive noted that whilst there was less than $200m of discretionary funding available under the RLTP in the first three years, much of this was weighted to delivering emission reductions, including projects such as Airport to Botany.

186. The minutes go on to state:

> Ms Reynolds [a Board member] noted that the RLTP does not achieve Council or Government targets for reducing carbon emissions and asked what was being planned to help deliver to these targets, including policy changes to accelerate mode shift. The EGM Planning and Investment [Ms Chetwynd] advised that AT is committed to working with Auckland Council to use all available levers (such as road pricing, fuel charges and reducing vehicle kilometres travelled) to deliver the 2030 and 2050 targets.
>
> Support would be required from other agencies and the private sector. A more detailed plan would be brought to the board for discussion in August and December 2021.

187. The Board resolved (amongst other things) to:

(a) note that the RTC was satisfied that the RLTP complied with the LTMA, including that it:

(i) contributed to the purpose of the LTMA: and

(ii) was consistent with the GPS.

(b) note that the RTC had recommended the RLTP for approval and the Council's Planning Committee had considered and endorsed the RLTP for approval;

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(c) approve the RLTP.

188. A copy of the full resolution is attached to Ms Chetwynd's affidavit.

Hīkina te Kohupara

189. The Ministry of Transport's Green Paper Hīkina te Kohupara – Kai mauri ora ai te iwi: Transport Emissions: Pathways to Net Zero by 2050 (**Hīkina**) was released in May 2021. A copy is at HB1-130.

190. There was insufficient time to refer to Hīkina in the Section 14 Analysis. Nevertheless, I consider that Hīkina is relevant and helpful in describing the potential transport sector pathways to meeting the Net Zero target by 2050. As such, it indicates how the MoT broadly expects the GPS climate change priority of "Transforming to a low carbon transport system that supports emissions reductions that align with national commitments" to be realised. This provides context for considering the impact of the RLTP in the context of total emission reduction.

191. Hīkina places considerable emphasis on the need for, and benefits of, a shift to public transport and walking and cycling, which is not in dispute. However, consistent with the RLTP, it also emphasises the need for a range of other policy interventions. These include different forms of road pricing, along with improvements to the light and heavy vehicle fleets. This is also consistent with the Minister's letter to the Mayor and the Cabinet decision referred to earlier, which indicated that a wide range of interventions will be needed to achieve substantial emissions reductions. I take from this that neither the Minister or Cabinet, nor the Minister's department expect infrastructure investment to carry the load on its own.

192. Annexure B to Hīkina provides modelling results showing the contribution of the following three intervention "themes" to emission reduction pathways in 2035:[37]

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37 Hīkina, at page 105.

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(a) Theme 1: Land-use changes; public transport improvements and pricing (including parking, congestion and distance-based pricing);

(b) Theme 2: Phasing out the importation of ICE light vehicles by 2035; banning the use of all ICE light vehicles in 2050; adoption of biofuels in light vehicles and buses and electrifying the PT bus fleet by 2035;

(c) Theme 3: Energy saving and logistic improvements (such as freight routes optimisation; freight consolidation and improved last mile efficiency); mode-shift from road freight to rail and to coastal shipping; adoption of biofuels for road freight and accelerating uptake of electric medium trucks.

193. The modelling figures enable one to indicatively identify the contribution of "Land use and public transport" interventions and "Combined Pricing Effects" to reducing emission within Theme 1. Direct figures are given for reductions from Theme 2 and 3. For the four different pathways outlined in Hīkina, the emissions reduction impacts are therefore as follows.

Share of total emissions removed by, intervention type, in 2035 compared to reference case[38]

	Pathway			
Intervention	One	Two	Three	Four
Theme 1: Land use and Public Transport	2.0	1.4	0.7	4.2
Theme 1: Pricing	8.0	5.6	3.3	14.8
Theme 2 – changes to the light fleet	21.0	22.0	23.0	19.0
Theme 3 – changes to freight	9.0	7.0	6.0	9.0
Share of total emissions removed in 2035	40.0	36.0	33.0	47.0

194. The Land Use and Public Transport intervention, which is the intervention most analogous to the RLTP, is expected to reduce emissions by between 0.7% and 4.2% compared to the reference case. This scale of change is consistent with the modelled 3% emission reduction achieved by the RLTP itself (excluding the impacts of additional fleet efficiency).

38 My calculation based on the figures in Hīkina at pages 147 to 154.

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195. This demonstrates that the kinds of reductions achieved by the RLTP are broadly consistent with the scale of impact expected from similar interventions in the Ministry's Hīkina pathways. Given that Hīkina represents the broad pathway to meet GPS priorities, in my opinion this supports a conclusion that the RLTP is consistent not only with the policy objectives but the broad scale of effect expected.

196. It also demonstrates that infrastructure investment to achieve mode shift is also expected to have a small impact on overall emissions and play a relatively small role in total emissions reductions.

197. Hīkina also estimates the additional buses required under each pathway, with results ranging between an increase of 80% to an increase of 400%. Assuming the increase in public transport service kilometres is of a similar scale, these scenarios would also require an increase of between 80% to 400% in funding for public transport services, which, as noted, is forecast at $780 million per year in 2030/31. This would require significant new funding sources.

198. Finally, it is worth noting that some form of congestion pricing and additional distance based pricing is currently envisaged in all of the pathway scenarios, and particularly in pathway 4. This is a further indicator that the MoT at least expects that achieving emission reductions targets will take much more significant interventions than those fitting within the scope an RLTP investment programme.

PART TWO – RESPONSE TO SPECIFIC ALLEGATIONS MADE BY THE APPLICANT

199. In this part of my evidence, I respond to particular claims or allegations made by the applicant in its statement of claim or evidence filed on its behalf, where they relate to matters within my knowledge or expertise.

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Implication that the AT Staff Report and the Section 14 Analysis were the only material available to the RTC and Board

200. At paragraph 70 of the statement of claim, the applicant alleges that the "Auckland Transport Analysis" and the "RTC Decision Document", which the RTC relied on in making its decision on 18 June 2021 to recommend approval of the RLTP to the Board, contained material inaccuracies, omissions and irrelevancies. The "RTC Decision Document" was the report prepared by AT officers (including myself) entitled "2021-2031 Regional Land Transport Plan", to assist the RTC in considering and making a decision on the proposed RLTP. I refer to this document as the "AT Staff Report". The "Auckland Transport Analysis" was a document which was attached to the AT Staff Report, entitled "How the draft RLTP 2021-2031 meets the requirements of section 14 of the LTMA". I call this the "Section 14 Analysis".

201. I will respond below to each of the specific criticisms of the AT Staff Report and the Section 14 Analysis. But first I would like to address the implication that the RTC relied *only* on the advice and information in these documents, when it made its decision. This is not the case.

202. In the first place, each of the RTC members brought their own experience and knowledge to the performance of their decision-making task. For example, the Chair and Deputy Chair are two of the most experienced professionals in New Zealand in relation to transport and land use planning.

203. Secondly, RTC members had been closely involved in development of ATAP and the RLTP, and the policy issues relevant to those documents, prior to the decision on 18 June 2021, and were thoroughly familiar with those issues. For example:

(a) Those RTC members who were AT Board members (i.e. all of them except the one KiwiRail member) were exposed to extensive material about the impacts of transport and other investment as part of their role on the AT Board. They had also received several briefings on development of the draft RLTP, had access to various drafts of the document as well as the

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feedback following public consultation – including submissions from All Aboard Aotearoa and organisations with similar views. Finally, they had the benefit of the views of their colleagues who had been more directly involved in the process either as DDC representatives, or, in the case of the Waka Kotahi-NZTA and KiwiRail representatives – on the ATAP Governance Group;

(b) The five RTC members who were also DDC members had been extensively briefed on ATAP and RLTP development in a process that began in earnest in August 2020. Decisions by the DDC (relating to the principles guiding ATAP and the prioritisation of renewals) shaped the development and content of the ATAP, as discussed above. The Chair and Deputy Chair of the RTC had also participated in presentations to the Council's Planning Committee and had discussions with the Mayor and other politicians around the issues associated with the RLTP;

(c) RTC Representatives from Waka Kotahi-NZTA and KiwiRail had been on the ATAP Governance Group and therefore played a key role in overseeing development of the ATAP/RLTP programme and had a deep understanding of the programme – along with extensive exposure to transport issues in their main professional roles.

204. I confirm based on my own interactions with the RTC and its members that they were fully conversant with the issues surrounding the RLTP, including the need for it to contribute to the purpose of the LTMA and to be consistent with the GPS, and were actively engaged in those issues. The AT Staff Report and the Section 14 Analysis were obviously important in drawing together relevant information, however these reports were provided to the RTC against the background of an existing detailed understanding of the RLTP process and its legal and policy aspects.

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Claim of wrong advice as to the impact on emissions of investment in infrastructure and services

205. The applicant claims that the Section 14 Analysis "wrongly advised the RTC that investment in infrastructure or services only has a very minor impact on total emissions. In fact, investment in infrastructure is a key factor in transport emissions".

206. This is presumably a reference to paragraph 31 of the Section 14 Analysis, which states:

> In addition, as the points below illustrate, there is little ability to further reduce overall emission through RLTP direct investment in infrastructure and services.
>
> Fundamentally, investment in infrastructure or services only has a very minor impact on total emissions, whether positive or negative. Even the biggest projects may only account for changes in the order of one percent of total. Scenario testing as part of ATAP development, along with analysis of other scenarios as background to the Te Tāruke ā Tāwhiri (Auckland Climate Plan), shows that plausible changes to the programme are unlikely to yield materially different results. External variables such as demand associated with population growth or improvements in fleet efficiency have a much larger impact on total emissions.

207. This statement was based on my involvement in, or exposure to, Auckland transport strategic planning exercises, using the macro-strategic model, over a period of a decade. These demonstrate only a limited shift in emissions at a regional level when changing variables related to infrastructure or services.

208. The statement was also made in the context of the analysis of a ten-year transport programme within Auckland's existing network and land use. If we were working with a blank slate in terms of land use and transport network, or a time period of several decades (and associated budgets), there would be more scope for change. However, both the RLTP and the short term targets the applicant refers to are within 10 years, not 30 or 50.

209. It is also worth noting at this point that for many of the variables we deal with at the regional level, relatively small changes in percentage points

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can disguise major impacts at sub-regional or local level. So, to describe the regional impact of a proposed change as 'small' does not mean that this change is not justified or worthwhile – particularly where we are dealing with mode shift, improvements in access or changes in congestion or travel time. In fact, for a single intervention, such as an individual project, to cause a percentage point shift in a regional variable will generally mean it has a very big impact locally. So, for example, the City Rail Link will have a big impact on the operation of the rail network and access to the city centre, along with time savings along the western line in particular. However, its impact on regional level vehicle kilometres travelled[39] (**VKT**) will only be very small in percentage terms – which is more of a reflection of the scale of regional VKT. Consequently, projects are ultimately prioritised and funded on the basis of their localised rather than regional impacts.

210. The challenge with emissions, however, is that the scale of reduction needed – to meet Paris targets, for example – is not set at the local level. Even large local changes remain small in comparison to regional or national level targets.

211. The 2016 ATAP study provides a good example of the small impact of investment and infrastructure at a regional level. This study, undertaken by officials from AT, the Council, MoT and Waka Kotahi-NZTA, with support from consultants, was the longest, largest and best-resourced piece of transport strategic analysis undertaken in Auckland over the last decade.

212. Initial phases of work tested three different scenarios within a fixed funding level. These were: The Auckland Plan Transport Network (**APTN**), originally proposed by the Council; a 'capacity constraints focus' option, which emphasised increased motorway capacity; and an 'Employment Centres focus', which included a mix of public transport and roading investment focused on improving travel to main employment centres. As the study had a time horizon of three decades, it was able to allocate $9 billion worth of discretionary funding to different investment

39 VKT is the measure of total distance travelled by all the vehicles in the relevant fleet – such as cars and light vehicles, buses and trucks. It is the measure of total demand for road travel.

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priorities within each scenario – significantly more than was available for the 2021 ATAP / RLTP work.

213. Findings from the initial phases of the work were published in the 2016 ATAP Interim Report, a copy of which is at HB1-288, which noted:

> Model results show that it is possible to deliver some improvement in performance against the ATAP objectives, compared to APTN. The most significant difference is for congestion levels on the strategic network (largely motorways) due to earlier and different levels of investment in motorway widening. At the regional level, however, there is relatively little difference between the packages for key measures by the end of the third decade. This is because the infrastructure programmes tested only change a small part of the overall transport network. This suggests that changing the mix of investment within current expenditure levels will not achieve a 'step-change' in regionwide performance.

214. Under 'Key Learnings', the Interim Report concluded that "it is possible to deliver better results [than the APTN] by changing the mix of improvements, within existing funding constraints, but this will not deliver a major improvement in regional outcomes over and above the current plan (the Auckland Plan Transport Network)."

215. Although the Interim Report was not focused on transport emissions, it did examine a range of other results that could indicate likely outcomes, such as public transport mode share. As can be seen from the graph

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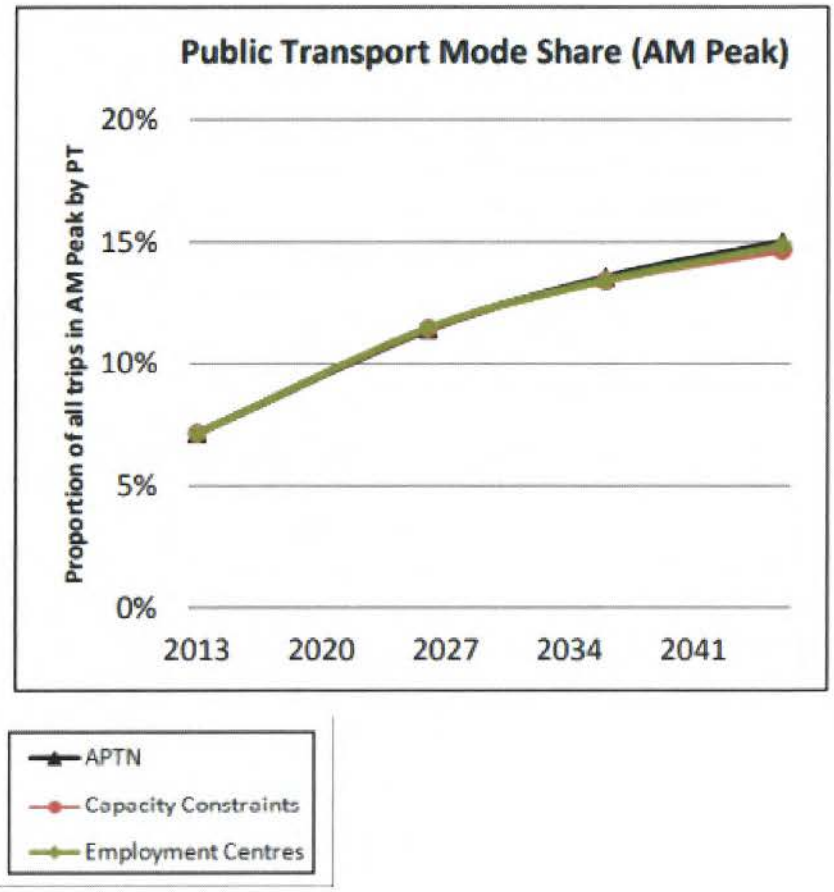
below, there was very little difference in public transport mode share between the three scenarios – even across three decades.



216. Work for 2018 ATAP also demonstrated that substantial changes in projects had only minor effects at a regional scale (although this was not highlighted in the final report). In this case, the modelling tested a shift in the mix of projects from the 2017 ATAP programme, reducing the emphasis of roading projects and increasing public transport. The modelling assumed:

(a) Addition of the light rail line from Mt Roskill to the Airport, bus lanes on the Ellerslie Panmure Highway (with the removal of general traffic lanes), and bus lanes from Botany to Manukau via Te Irirangi Drive (replacing a previously proposed route via East Tamaki);

(b) Upgrade of the North Western Busway to light rail along the whole corridor;

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(c) Removal of the Mill Road / Papakura Expressway, the East West Link (a new four lane expressway link between SH1 at Penrose and SH20 at Onehunga), Papakura to Drury motorway widening, some greenfield related projects and the east-west connections bus route (and adding back general traffic lanes).

217. This reasonably substantial shift in the programme towards public transport at the expense of some large roading projects – which was well beyond the scope of what we could consider in the 2021 ATAP/RLTP – yielded a forecast increase public transport mode share for the 2028 morning peak from 13.4% to 13.6%.[40] Total daily emissions were, meanwhile, reduced by 0.3% – a minor change.[41]

218. The above studies focus mainly on the impact of large scale public transport or roading investment. Evidence for the impact of cycling was available from the 2017 Auckland Cycling Programme Business Case Demand and Economic Assessment, a copy of which is at HB1-330. This forecast that the proposed high investment option, which included 225km of new cycleways at a total estimated capital cost of $852 million, would increase average daily modelled distance cycled in 2026 by 179,300 kilometres, or 103% (from 174,500 kilometres in the do minimum scenario to 353,800 kilometres in the high investment scenario). This modelled outcome was expected to underestimate actual results because, for example, the model does not capture the 'network effects' of combining larger elements of the network. However, it is also important to note that the increase in kilometres cycled is not necessarily mode shift from driving – as some of the increase will come from walking, public trips and car passengers.

219. The Cycling Programme Business Case did not estimate emissions reduction from its high investment programme. Nevertheless, if we assume that all of the 179,300 km increase in distance travelled came from mode shift from driving, this would only account for around 0.5% of the 32 million kilometres per day forecast to be travelled by private

40 ATAP Update March 2018 – Comparison of 2016 and ATAP Scenarios for 2026, draft version, Slide 5. A copy of this document is at HB1-457.

41 ATAP Update March 2018 – Comparison of 2016 and ATAP Scenarios for 2026, draft version, Slide 14

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vehicles in 2026.[42] Emissions reductions would likely be of a similar scale.

220. Although minor, an emission reduction in the order of 0.5% for $852 million still compares well to some of the other results outlined above. However, by 2020, we had much more experience in delivering cycling facilities and the estimated per kilometre cost had increased from around $3.8 million per kilometre to over $8 million per kilometre – taking the cost of delivering the high scenario to around $1.8 billion.

221. Further evidence is provided by more recent work on a revised Programme Business Case for Cycling and Micromobility. This work modelled the impacts of delivering the full Strategic Cycle Network (see diagram below) across Auckland compared to a 'Reference Case' scenario. Estimated costs for the Full Network are in excess of $5 billion (even after allowing for more recent innovations to reduce the construction cost per kilometre via changes in design standards and road space reallocation). Modelling results forecast cycling share of daily distance travelled in 2028 to increase from 1% in the reference case to 3.7% with the full Strategic Cycle Network. As noted above, this modelling is likely to underestimate the full effects as it does not capture the 'network 'effect'. Compared to the reference case, completion of the Full Strategic Cycling Network is expected to save 44,000 tonnes of CO_2e per year in 2028.[43] Although we do not have a total transport

42 This figure is calculated by linear interpolation between the 2016 and 2031 modelled VKT outcomes.

43 Auckland Cycling and Micromobility Business Case, Cycling Demand and Economic Assessment, Flow Transportation Specialists LTD, page 14. A copy of this document is at HB1-479.

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emission estimate for 2028, this figure would be equivalent to 1% of pre-Covid transport emissions.

Strategic Cycling Network

222. Compared to some other projects of similar scale, the Strategic Cycling Network delivers a large shift in daily travel relative to its estimated cost (given the revised delivery approach, which was established post finalisation of the RLTP). However, the forecast effects are unfortunately minor in the context of total regional emissions.

223. In terms of the other items covered in the first bullet point of paragraph 30 of the Section 14 Analysis, I comment as follows.

(a) Emissions modelling outcomes for a couple of large-scale public transport projects were confirmed as part of the background – for example, modelling for the City Rail Link showed a 0.5% reduction in VKT and 0.5% reduction in CO_2 emissions;

(b) As noted above,scenario testing for the 2021 ATAP/RLTP packages showed a 0.4% difference in emissions between the best and worst performing packages, from an emissions

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perspective. This demonstrates the very limited scope for different results within the constraints of the committed and essentials package and overall available funding;

(c) Modelling for the ACP over several rounds showed modest results, in the order of a 5%, from a combination of public transport service improvements, zero public transport fares, fuel price increases and assumed land use intensification. Although modelled as indicative examples rather than serious proposals, I note that this would be an ambitious and expensive set of changes to implement together (and in most respects well beyond the scope of the RLTP). The zero fares intervention alone would require around $2.8 billion in additional funding over ten years;

(d) The 4% reduction forecast from the assumed switch to active modes, modelled as part of the ACP (described in paragraph 109 above) is also modest in the context of total emissions. Unfortunately, this scenario was not linked to a specific set of identifiable and implementable projects or other interventions to achieve the assumed shifts, so could not be readily translated into real world results.

224. In summary, the modelling evidence demonstrated that investment in infrastructure and services has only a minor impact on regional scale emissions. This limited impact is explained by a number of factors as follows:

(a) The limited effect of these projects, particularly the large-scale public transport projects, on travel behaviour outside the peak periods (which accounts for the majority of VKT). This is explained at pages 35 and 36 of the RLTP itself.

(b) The fact that the urban form of the city is already largely set, leading to a wide distribution of trip origins and destinations. For example, the typical Aucklander currently travels an average of 10.9 kilometres to work, 5.9 kilometres to reach preferred shopping destinations and 8.6 kilometres to reach preferred

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social / personal destinations, with an average of 8.2 kilometres across all trip purposes.[44] These distances tend to support the use of motorised modes, although this may change with E-Bikes. More widely, in terms of the discussion to follow, it also suggests that Aucklanders will struggle to significantly reduce their distance travelled without also losing access to opportunity;

(c) Even a major investment programme like the RLTP only changes a limited proportion of the network at one time;

(d) Because they tend to compete for the same markets (i.e. the city centre or other large employment centres and commuting or education journeys) non-car driver modes tend to cannibalise each other. We see this in the census journey to work data, where although public transport mode share in particular has increased since 2001, most of this shift appears to have come from car passengers and other categories, while car driver mode share has barely changed;[45]

(e) Spare road capacity created by public transport is subject to the same laws of induced traffic and triple convergence that apply to road capacity projects. This means that while there will still be an overall benefit in terms of time savings, some of the VKT reduction will be eroded by travellers taking advantage of these savings by shifting routes or taking longer trips.

Response to arguments made by Mr Litman and Mr Chapman as to impact on emissions of investment in infrastructure and services

225. As I understand it, the thrust of the evidence of Mr Chapman and Mr Litman on this issue is that large roading projects in particular can have an impact on emissions by inducing additional travel and more extensive land use patterns which then result in more fuel consumption and emissions. At a purely theoretical level, I do not disagree with this.

44 The New Zealand Household Travel Survey Analysis of the Auckland Results for the period 1989-2018, Richard Paling, September 2021, page 29.

45 Car driver mode share, which represents the best indicator of actual vehicle trips, only dropped from 70.1% in 2001 to 69.4% in 2018. This data is from Analysis of the 2018 Census Results, Richard Paling, October 2020.

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However, in the present case the particular context of Auckland and the RLTP must be taken into account.

226. More importantly, for induced travel to occur in the context of the RLTP modelling, the generalised cost of travel would need to reduce from the point of view of existing drivers in 2016.[46] In practice, the 22% population growth between 2016 and 2031 means that new demands for driving exceed the increase in road capacity (which largely predates 2021). The result, as the RLTP notes, is an increase in congestion between 2016 and 2031. This would be expected to deter any additional induced traffic, due to an increase in the generalised cost of car travel, and that is what the results indicate. Overall per capita travel remains constant between 2016 and 2031 and the overall increase in VKT predicted in the modelling is due to population growth.

Claim of wrong advice to the RTC that no plausible changes could be made to the RLTP programme that would yield materially different results

227. The applicant claims that the Section 14 Analysis "wrongly advised the RTC that no plausible changes could be made to the RLTP that would yield materially different results. In fact, as recognised in the Planning Committee's resolution of 24 June 2021 changes to the mix of transport investment in the RLTP that result in a reduction of emission could and should have been made".

228. There are two parts to this claim: the plausibility of changes to the RLTP yielding materially different results, which I have already addressed above in this affidavit; and the implications of the Planning Committee resolution.

229. In relation to the Planning Committee, its resolution was (relevantly) to:

> c) endorse the final 2021-31 Regional Land Transport Plan for submitting to the Auckland Transport Board for final approval.

46 2016 being the base year for modelling.

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d) note Auckland Council's commitment to Te Tāruke-ā-Tāwhiri to halve emissions by 2030 requires further change to transport and land use policy and the mix of transport investment.

e) note that, as requested by the Planning Committee on 11 March, council and Auckland Transport staff are jointly developing a Transport Emissions Reduction Plan for Auckland that will identify the pathways to support the required emissions reductions reflected in Te Tāruke-ā-Tāwhiri, which includes:

i) investigating the mix of future complementary transport investments that support emissions reduction;
ii) investigating vehicle fleet and fuel decarbonisation; Planning Committee 24 June 2021 Minutes Page 5
iii) investigating land transport pricing reform;
iv) investigating urban growth management;
v) investigating road space reallocation;
vi) investigating behaviour change;
vii) investigating addressing inequities arising from the impacts of decarbonisation,
viii) reporting the approach to the Transport Emissions Reduction Plan for Auckland to Environment and Climate Change Committee and the Auckland Transport Board in August 2021 with a progress update by December 2021.

230. The applicant's claim appears to refer to resolution d), which notes that further change to transport and land use policy and the mix of transport investment will be required to halve emissions by 2030. This is consistent with the statements made in the RLTP and the Section 14 Analysis.

231. The applicant's additional claim that the resolution "recognised... changes to the mix of transport investment in the RLTP that result in a reduction of emission could and should have been made" is not in my opinion supported by the text of the resolution itself.

Claim of wrong advice that roading projects do not increase emissions

232. The applicant claims that the Section 14 Analysis "wrongly advised the RTC that roading projects do not increase emissions. In fact, increased roading capacity generates more traffic over time because it encourages

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driving and enables car-dependent development (a phenomenon known as induced demand)".

233. The applicant also claims that the Analysis "wrongly advised the RTC that the Penlink and Mill Road Highway projects would together have decreased carbon dioxide emissions by 2031. In fact, those projects would have increased carbon dioxide emissions."

234. I consider that these claims misrepresent what the Section 14 Analysis actually said. The relevant extract is as follows:[47]

> It is not a given that roading projects will automatically lead to increased tailpipe emissions. For example, Penlink is likely to result in a net reduction in tailpipe emissions as it significantly shortens the connection to the North Shore and reduces congestion while managing demand through tolling. As an illustration, a modelling test for the 2031 year shows that removal of the Penlink and the full Mill Road project (as originally announced in the NZUP package) would lead to a very small (0.15%) increase in CO_2 emissions due to an increase in total VKT and higher congestion. Remaining projects will also make important contributions to other objectives including safety, connectivity overall effectiveness and freight access – or may be multi-modal in nature.

235. The Section 14 Analysis does not claim that roading projects do not increase emissions. Rather, it states that "it is not a given that projects will automatically lead to increased tailpipe emissions", which is subtly but importantly different. Evidence for the statement in the Section 14 Analysis was provided within the same paragraph, which noted the case of the Penlink project where the combination of factors was likely to result in a net reduction in tailpipe emissions. These factors are:

(a) a shorter route, which would reduce travel distances;

(b) reduced congestion, which would reduce emissions per kilometre travelled; and

(c) tolling, which in the case of the Penlink project was deliberately designed to keep demand within the one-lane per direction capacity of the project.

47 Paragraph 31, fourth bullet point.

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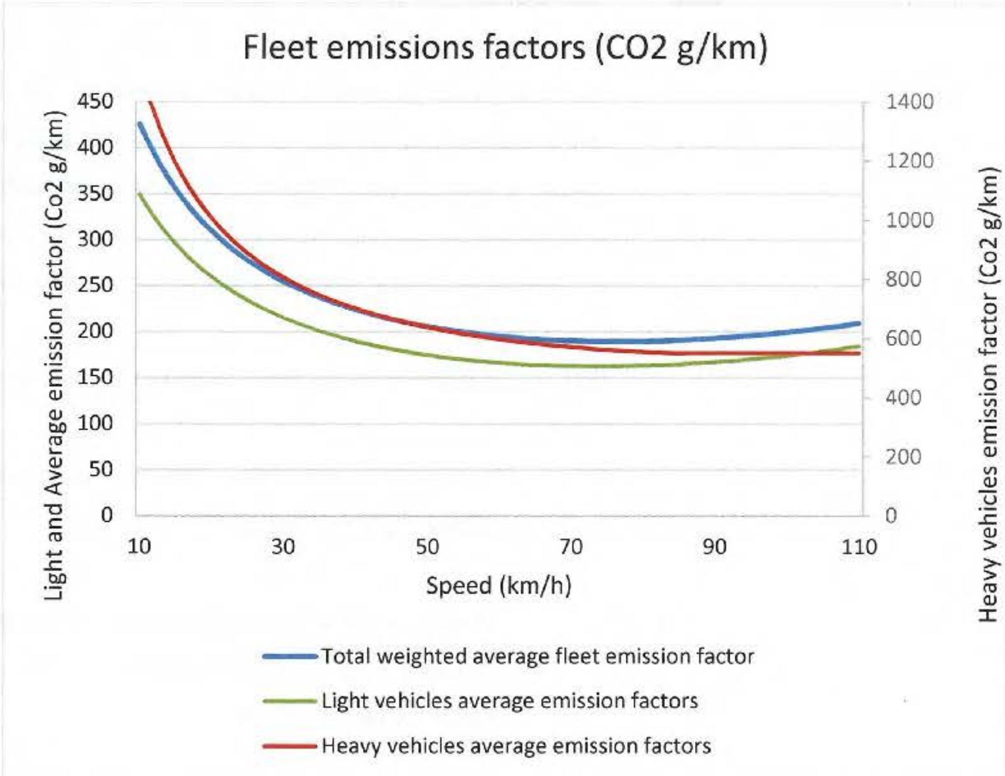
Importantly in this case, the inclusion of a toll charge designed to manage demand placed a practical limit on the induced demand that might otherwise result from the project.

236. This is supported by the modelling result cited in the same paragraph, which saw VKT and congestion, and therefore emissions, *increase* when Penlink and Mill Road were removed from the RLTP package (all other elements held equal).

237. The diagram below plots the relationship between vehicle speed and emission factors in CO_2 g/km.[48] It demonstrates that as speeds are decrease due to increasing congestion or other interventions, such as capacity reduction, emissions per kilometre travelled are expected to increase for all vehicles. This is likely to be part of the reason that emissions increase when Penlink and Mill Road are assumed to be removed from the network in the modelling described above. The relationship is also very relevant to the discussion below on the impact of lane removal.



48 This diagram uses information from VEPM6.1, which was used in the RLTP modelling.

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238. The conclusion reached for Penlink is also supported by the RCAT analysis undertaken by Auckland Council and NZTA officers, which rated Penlink as having a 'neutral' impact on emissions.

239. The report, *Congestion and emissions mitigation: A comparison of capacity, demand, and vehicle based strategies,* by Bigazzi and Figliozzi, a copy of which is at HB1-514, also provides useful guidance on this subject. The report focuses on the potential emissions reductions from roading projects that increase roading capacity (eg by adding lanes), thereby reducing congestion, increasing travel speed and generating induced travel. Their work demonstrates that, assuming a medium level of induced demand, the emissions impacts from roading capacity projects will depend heavily on the initial traffic speed and the consequent change in travel speed as a result of the project.

240. As shown in the graph below,[49] this analysis estimated that projects that lift the average speed of a section of arterial road from 16 to 24 miles per hour (25 to 38kph), which is the kind of average speed range that parts the Auckland network operate at, could result in peak period emissions reductions of around 7% (from that section of road). This is after allowing for the impact of an 8% increase in travel as a result of induced demand.[50] Meanwhile, projects leading to speed improvements at highway speeds are likely to have minor, or even negative, impacts on emissions.

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49 *Congestion and emissions mitigation: A comparison of capacity, demand, and vehicle based strategies,* by Bigazzi and Figliozzi, pg 544.

50 Figures are drawn from Table 3 of *Congestion and emissions mitigation: A comparison of capacity, demand, and vehicle based strategies,* by Bigazzi and Figliozzi, pg 544.

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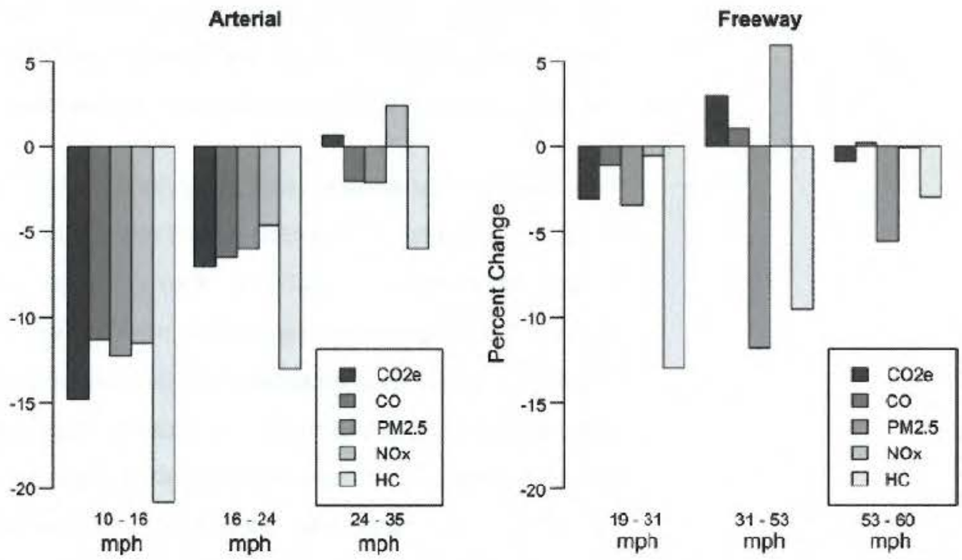

Fig. 3. Percent change in peak period emissions from CBS.

241. These results are in line with expectations from consideration of the speed-emissions curve, which shows that vehicle emissions per kilometre increase rapidly as average traffic speeds decline. Most motorists will have experienced this in the form of:

- higher fuel consumption per kilometre during stop start, around town driving – especially in congested conditions; and

- lower fuel consumption per kilometre while driving at uncongested open road speeds.

242. As this work demonstrates, projects that free up low speed, congested traffic can potentially achieve significant emission reductions which may be in excess of the additional emissions associated with induced demand. These effects are also important when considering claims about the impact of road space reallocation (discussed below).

243. So, although the authors are generally pessimistic about the prospects for emissions reductions from roading capacity improvements, they acknowledge that "the largest potential emission reductions for all pollutants are on heavily congested arterials". This is also evidence that roading projects will not automatically result in increased tailpipe emissions – even when additional induced traffic is included.

Claim of wrong advice that there was no available funding to provide further reallocation of road space

244. The applicant claims that the Section 14 Analysis:

> ...wrongly advised the RTC that there is no available funding to provide further reallocation of general road space towards cycling and other sustainable modes. On the contrary:
>
> (i) Around $2.1 billion of the total funding available under the RLTP is discretionary
>
> (ii) The renewals budget in the RLTP can (and should) be used to fund the reallocation of road space towards sustainable modes
>
> (iii) Reallocation of road space can (and should) be delivered as part of other projects that are planned under the RLTP would affecting the available budget
>
> (iv) Auckland Transport made a choice not to allocate further funding for, and not to reallocate further road space towards, sustainable modes in the RLTP.

245. The relevant statement in the Section 14 Analysis is as follows:[51]

> General road space reallocation towards cycling and other sustainable modes has also been proposed by submitters as a way of addressing climate issues. This is already occurring as part of the wider cycling programme and projects such as Connected Communities that will provide for bus lanes, bus priority and cycling and safety improvements. As noted, there is no available funding for further reallocation.

246. This was (and is) a correct statement. I respond to the applicant's specific points as follows.

"Around $2.1 billion of the total funding available under the RLTP is discretionary".

247. This is correct, but it is also moot as the ATAP/RLTP process had allocated this funding to projects to meet policy objectives, so it was no longer 'available'. And, as noted in paragraph 154 the discretionary funding was overwhelmingly allocated to projects that supported either mode change and/or emission reductions, freight improvements, or sustainable growth so was consistent with GPS strategic priorities.

51 Paragraph 31, fifth bullet point.

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"The renewals budget in the RLTP can (and should) be used to fund the reallocation of road space towards sustainable modes".

248. *Some* of the renewals budget could theoretically have been used to fund other projects, including the reallocation of road space towards sustainable modes. However, the AT Board and RTC were well aware of these trade-offs and saw an appropriate level of renewals funding as a higher priority (in this respect so did the ATAP Governance Group, Cabinet and the Planning Committee who also approved the programme).

249. In any event, for the reasons already described, had the renewals budget been retained at $3 billion it would not have materially changed the overall tailpipe emissions outcome.

250. Nevertheless, AT has work underway to ensure maximum possible coordination between delivery of the renewals programme and delivery of other improvements projects, such as safe cycling infrastructure.

"Reallocation of road space can (and should) be delivered as part of other projects that are planned under the RLTP without affecting the available budget".

251. This is correct and, as noted in the Section 14 analysis itself, is already occurring as part of the RLTP programme. Outside of the RLTP programme, AT is also pursuing changes, for example through the 2022 Parking Strategy review, that will support faster and easier road space reallocation.

"Auckland Transport made a choice not to allocate further funding for, and not to reallocate further road space towards, sustainable modes in the RLTP."

252. Apart from the allocation to the renewals programme, which is discussed above, this statement is incorrect. As already noted, the discretionary programme, along with the non-committed components of the 'baseline programme', is overwhelmingly allocated towards sustainable modes or sustainable growth projects.

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Claim of wrong advice about road space reallocation and its effects

253. The applicant claims that the Section 14 Analysis wrongly advised the RTC that:

> gains from deterring car travel through lane reallocation would be offset by increased emissions and congestion. In fact, reallocating road space to other modes would reduce emissions and congestion;
>
> Reallocating road space without additional effective alternatives would materially reduce the RLTP's contribution to the objective of the LTMA in respect of the effective and economic, social and cultural public interests. In fact, reallocating road space to other modes would itself provide effective alternatives, promote safety and contribute to the purpose of the LTMA.

254. Again, I consider this this claim misrepresents what the Section 14 Analysis says. The relevant text is as follows:[52]

> In practice, it is also likely that gains from deterring car travel through lane reallocation alone would be largely offset by the increase in emissions associated with increased congestion and diversion amongst the remaining traffic. Reallocation of general traffic lanes without additional effective alternatives (which cannot be funded) would also materially reduce the RLTP's contribution to LTMA objectives around effectiveness and economic, social and cultural public interests.

255. This part of the Section 14 advice related to the impacts of "*lane reallocation alone*" and "reallocation of general traffic lanes *without additional effective alternatives*" (my italics). This advice is clearly referring to lane removal and this was because there was no further funding to support other infrastructure projects.

256. The issue is somewhat moot anyway, because even lane removal costs money and all funding was allocated. Nevertheless, to illustrate the point, removing a lane, for example by barricading it off, does not automatically turn that space into a cycleway or busway. Further infrastructure is required to convert the road space into something that is safe to use – particularly because intersections will require treatments, for example with raised speed tables. Even the simplest projects – such as changing an existing painted cycle lane into a protected cycle lane with the minimum safe physical separation – will cost at least $1m per kilometre, so require material funding to complete at any meaningful scale. More recent (post-RLTP) estimates for safe cycling infrastructure, where we

52 Paragraph 31, fifth bullet point.

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assume the reallocation of existing parking spaces, are in the order of $5 million per kilometre. However, the cost from more complex projects is likely to remain in the order of $8 million per kilometre.

257. The evidence underpinning this part of the Section 14 Analysis was derived in part from our analysis of the model outputs when developing the RLTP. These showed that reductions in emissions per kilometre, associated with reductions in congestion, were at least as important as reductions in distance travelled in contributing to the RLTP's overall emission reductions. The implication was that interventions, such as large-scale lane removal, that lead to an increase in congestion or a reduction in local road travel speeds, will also lead to an increase in emissions per kilometre travelled for remaining traffic. This increase would likely largely offset the emissions reduction associated with reduced traffic. In practice, I would only expect this to occur in the context of small percentage changes in overall kilometres travelled – but that is the current context for RLTP outcomes.

258. This dynamic can also be seen by reversing the findings from Bigazzi and Figliozzi's analysis. Based on that analysis, we could expect that a road capacity reduction that reduced travel speeds from 24 mph to 16 mph would lead to an emissions increase of around 7%, even after allowing for deterred traffic.

259. The best evidence, however, comes from a modelling run undertaken after the RLTP was complete. In this run, we tested a scenario, which assumed completion of the 2021 RLTP programme, where all multiple lane local roads, eg arterial roads, were reduced to one lane in each direction. We also removed a lane in each direction from all of the motorway system. This reduced motorway lane kilometres by 18%, arterial lane kilometres by 17% and total lane kilometres by 8.5%. No other changes were made.

260. This was a relatively 'crude' scenario, as lane capacity was only removed from the road 'links' rather than the intersections (which are typically the main constraint on the local road network). However, we were advised by the Auckland Forecasting Centre, which runs the MSM model, that the results would have been more severe, in terms of congestion impacts, had the reduction in intersection capacity been fully modelled.

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261. Compared to the 2021 RLTP, this scenario saw vehicle kilometres travelled reduce by 4.6%. Importantly, the reduction came largely from a reduction in average trip length of between 4% and 6%, depending on time of day, rather than a shift to public transport – with morning peak car mode share only reducing by 0.6%.

262. With the reduction in travel demand being lower than the reduction in road capacity, the scenario saw congestion increase by over a third in the peak periods and nearly triple in the interpeak period, with motorways becoming heavily congested across the workday. Due to the congestion, average travel speeds in the scenario decline by 11 to 12%, dropping from 36kph to 32kph in the morning peak – effectively moving Auckland's network down the speed / emission curve.

263. The reduction in average travel speed means that average CO_2 emissions per kilometre increase by 3.7%, largely offsetting the impact of the reduction in VKT. The net emissions reduction forecast from this large-scale lane reduction programme therefore ends up being 1%. This is also consistent with the general finding of limited emissions impacts from changes in infrastructure.

Economic, social and cultural effects of lane removal

264. The modelling evidence also indicated the negative impact of a large scale lane reduction programme on economic, social and cultural outcomes.

265. In this case, the proxy measure used is accessibility to employment, which along with accessibility to essential services, is a "proposed indicator" in the GPS.[53] This measures the number of jobs available to the average Aucklander in a 30 minute car trip or a 45 minute public transport trip. The measure is drawn from extensive evidence relating overall city productivity to its "effective density", which is the number of potential jobs / employees available in a reasonable travel time.[54] The outcomes are largely the same whether taken from the perspective of the

53 GPS, page 24. Essential services are shopping, education and health facilities.

54 Alain Bertaud's "Cities as Labour Markets", February 2014, provides a useful discussion of this issue.

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citizen seeking access to jobs or the employer seeking access to labour market. Access to social, cultural and recreational opportunities will change in the same way as access to employment – although at different scales.

266. In 2031, even with the RLTP in place, around 71% of commuting to work is still expected to occur by private vehicle – so remains critical to labour force participation and employment availability to workers. In the lane reduction scenario, the increase in congestion and consequent decline in travel speed means that morning peak private vehicle access to employment within 30 minutes drops by 22%, from 266,066 in the 2031 RLTP scenario to 208,058 in the lane removal scenario. In this scenario, access to employment in 2031 would also be 11% lower than the 2016 figure of 233,647 – despite employment numbers increasing by 17% over the same period. This reduction is not offset by an increase in access to public transport, which drops by 5%, from 108,160 in the RLTP to 103,166 in the scenario due to the impact of congestion on bus operations.

267. The modelling figures demonstrate that a widespread lane reduction programme would lead to a very significant reduction in access to employment / labour force opportunities, which would in turn impact on individual and collective economic welfare. A similar impact on access to other social and cultural opportunities – including access to essential services – can also be expected. In my opinion, the results provide clear evidence of the negative impact on effectiveness[55] and economic, social and cultural wellbeing.

Response to arguments made by Mr Litman and Mr Chapman on issues around road space reallocation and disappearing traffic

268. Consideration of these modelling results provides a useful point to address some of the arguments made by Mr Litman and Mr Chapman in relation to road space reallocation.

55 In relation to the GPS, a "land transport system is effective when it moves people and freight where they need to go in a timely manner" (page 47, Appendix 2).

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269. In general, Mr Litman and Mr Chapman appear to have interpreted the text in the second half of paragraph 31 bullet 5 as relating to the reallocation of road space to public transport or active modes, rather than the narrower case of lane removal referred to in the text.

270. It is worth restating that reallocation of road space towards public transport and active modes is a key part of the RLTP's approach to achieving GPS outcomes. This is clear from the RLTP document itself and the Section 14 Analysis.

271. Consequently, there is no dispute over the broad principles that favour reallocation of road space to effective public transport and active modes projects, although differences clearly remain about the scale of impact in an Auckland context.

272. The relevant difference is over the effectiveness and economic, social and cultural impact of lane removal. Here, both affidavits argue that lane reallocation will lead to disappearing traffic. Mr Litman's argument is that this disappearing traffic "tends to improve the efficiency of the transport system, measured as the number of people transported over a given road or the number of destinations that people can reach within a given time period". As we shall see below, however, there is little to suggest that potential disappearing traffic effects would offset the serious negative impacts large scale lane reduction would have on network efficiency or access to employment and other opportunities.

273. In relation to disappearing traffic, Mr Chapman's argument quotes from ITF, who in turn rely principally on the study "Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence" by Goodwin et al. The "European Commission study" cited by Mr Litman,[56] meanwhile, is not a formal study – it describes itself as a "handbook" illustrating the concept of traffic evaporation using case studies from a selection of European cities.[57]

274. The Goodwin study assessed 70 case studies where reductions in traffic capacity had occurred – whether as part of a deliberate plan or an

56 Affidavit of Mr Litman, paragraph 39.
57 'Reclaiming city streets for people – Chaos or quality of life?' European Commission, page 9

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unexpected event such an earthquake destroying a bridge. The results from these studies show a general reduction in trips – with 50% of the cases showing overall traffic reductions, taking affected and alternative roads altogether, which were greater than 14% of the traffic which originally used the affected road.[58]

275. The ITF, as quoted in para 40 by Mr Chapman, goes on from this statistic to conclude that "reallocation of road space does not simply shift traffic from one place to another, but leads to an overall reduction in the number of motor vehicles on roads."[59]

276. The Goodwin study itself is more nuanced. In the conclusion it states that:[60]

> It would be wrong to use as a universal rule of thumb that 16%, or 25% (or any other standard percentage) of traffic will conveniently disappear as a matter of course whenever road capacity is reallocated. It would also be wrong to assume that no traffic would disappear, particularly in a situation where continuance of existing traffic levels would imply significant change to traffic speeds. The effects of a particular capacity reduction will be influenced by the circumstances of the case.

277. Other relevant points from the Goodwin paper are:

(a) Traffic flows may reduce, or appear to reduce, in a particular area as a result of trips shifting to other routes, other times of the day or because capacity improvements are provided elsewhere[61] (which is trip re-allocation rather than disappearance);

(b) as well as rerouting and retiming – a proportion of traffic can 'disappear' due to a very extensive set of behavioural responses. These include, but are not confined to, changes in choice of mode, destination and trip frequency. These responses differ from individual to individual and from place to place";[62]

58 Goodwin, page 55.
59 ITF, page 12.
60 Goodwin, page 56.
61 Goodwin, page 57.
62 Goodwin, page 57.

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(c) The evidence suggests that "traffic does 'disappear' in response to reductions in road capacity, but only to the extent it needs to do so";[63]

(d) The scale of impact will be situation specific and depend on factors such as the nature of the network and existing levels of congestion; the type of trip affected; the relative attractiveness of alternative locations; other policy variables; the relative attractiveness of other modes; scheme design; and information and marketing;[64]

(e) Unexpectedly high reductions in localised traffic occur because there is considerable random churn in individuals behaviour within the average values generally used by models.[65] This means that travellers will generally find it easier to respond to reductions in road-space than typically assumed in models. So, for example, at any given time a proportion of people are changing trip patterns, jobs or housing and can therefore adjust their plans to respond to changes in the transport network relatively easily;

(f) There will be disbenefits to people whose travel conditions or opportunities will be worse as a result of the road space reallocation, but these may be smaller than expected, and will need to be weighed against the positive outcomes from the lane reallocation;[66]

(g) As summarised in the final paragraph, "the most important responses to a scheme may be governed by the extent to which the scheme tilts the balance in a decision that people may be making anyway, during the natural development of their lives."[67]

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63 Goodwin, page 57
64 Goodwin, page 61.
65 Goodwin, page 58.
66 Goodwin, page 61.
67 Goodwin, page 70.

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278. What are the implications of this for lane removal in Auckland? As with the rest of this debate, the first issue is scale. The Goodwin paper deals with what are, in a regional context, generally relatively small-scale network changes. The paper does not attempt to address whether these changes materially reduced overall trip demand at a regional level.

279. The paper also deals with trips, not distance travelled. As one of the identified responses to reductions in road capacity is trip diversion to other routes, reductions in distance travelled will almost certainly be smaller than the reported reductions in trips.

280. The paper is also not intended to address what might occur if a metropolitan area attempted to use large scale lane removal as an emission reduction strategy. We can infer, however, that it was relatively straightforward for travellers to adjust to many of the small scale-projects included in the paper as part of their day to day lives. This will be because a typical city transport network will provide a number of alternatives for routes, modes or destinations – especially in the European cities that made up the bulk of the study.

281. However, we can also infer that as road capacity reductions become more widespread, then the opportunities to adjust as part of "the natural development of their lives" will reduce as well. And, importantly, the extent of any *unexpected* disappearing traffic will also be smaller.

282. So, in Auckland, we could expect small lane removal projects to occur with very little negative impact on drivers as there are opportunities to adjust. But these will also have very little effect on regional scale emissions.

283. If we are to use lane removal as a tool to achieve material reductions in emissions then, because traffic only adjusts to the extent it needs to, we would need to remove significant capacity in order to encourage significant change. This is reflected in the modelling results described above – where an 8% reduction in lane capacity is needed to deliver a 4.8% reduction in VKT.

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284. Recent network data also suggests that reductions in distance travelled will not be straightforward to achieve. For example, the period mid-2015 to mid-2017 saw road network conditions deteriorate significantly due to increases in demand (largely due to population growth). For example, morning peak congestion on the arterial network increased by 25%. This is analogous to the effect of lane removal and should theoretically have 'disappearing traffic' in the form of a reduction in per-capita VKT. However, the indicators suggest that per-capita VKT *increased* over the period, and for several years afterward, presumably as a result of improved economic conditions.

285. In terms of the lane removal scenario described above, the Goodwin evidence suggests that there may be some potential for further unexpected additional traffic disappearance. This would be in the form of key behavioural change elements not taken into account by the model, which would be:

(a) errand swapping, trip chaining and car sharing – the effects of which are difficult to quantify but are likely to have only small impacts one way or another;

(b) trip reduction / suppression – which may have a small useful VKT reduction impact if the alternative was working from home, but otherwise represents a loss of access to economic, social or cultural opportunity for those who have to reduce their trip-making;

(c) change of job location and change of housing location – which is likely to represent a significant reduction in wellbeing due to either higher costs or lower quality in the case of housing or a 'second best' employment outcome;

(d) changes in land use – which would result presumably encourage more intensive development closer to the centre but at a higher price.[68]

68 The higher price occurs due to the higher land costs closer to the centre.

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286. However, while the elements not considered in the model may lead to a further reduction in VKT, they would also likely lead to a reduction in economic, social and cultural wellbeing due to restricted access to opportunities in the Auckland context.

287. On the other hand, the potential for these unexpected traffic disappearance effects to occur is reduced by the widespread nature of the congestion impacts in this scenario. These would limit the practical opportunities for travellers to adapt to new conditions, at low cost, as part of their day to day lives. In this case, however, travellers would still face the negative welfare impacts of driving in more congested conditions.

288. In conclusion on this issue:

(a) While the concept of disappearing traffic is attractive, the available evidence is for localised changes in trips, rather than distance travelled, and has not been demonstrated in terms of metropolitan or regional level effects (at least as presented by Mr Litman and Mr Chapman). In addition, the deliberate road space reduction schemes are generally drawn from European cities with very different land use and transport conditions to Auckland;

(b) Net traffic reductions across a wide area are not a given, diversion or traffic retiming may occur and results will depend on a variety of factors;

(c) Unanticipated disappearing traffic, i.e. not predicted by a model, is more likely to occur at a smaller scale, where people can adapt easily, and implicitly is less likely at a larger scale where it becomes harder to adapt;

(d) The disappearing traffic is actually a disbenefit for those that had to change behaviour, but this may be outweighed by benefits to the wider community;

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(e) Many of the variables driving changes in travel behaviour associated with disappearing traffic are already captured by the MSM model;

(f) MSM modelling of a large scale lane removal scenario has shown this would result in:

(i) limited mode shift, but some reduction in trip length;

(ii) only minor reductions in emissions; and

(iii) significant increases in congestion and therefore significant reductions in access to employment opportunities – which would reduce effectiveness, and negatively impact economic, social and cultural outcomes Aucklanders who need to travel by car.

289. Given the above, I remain of the view that emission gains from large-scale removal alone would, in the context of Auckland over the next decade, be largely offset by increases in emissions associated with congestion diversion.

290. I acknowledge that *small-scale* traffic lane removal would be unlikely to result in material impacts on LTMA objectives around effectiveness and economic, social and cultural public interests – but will equally have a limited effect on emissions.

291. However, as the modelling evidence shows, *large-scale* lane removal would have a material negative impact on LTMA objectives around effectiveness and economic, social and cultural public interests – particularly through a reduction in access to economic opportunities.

292. Given the above, the statement in paragraph 31, bullet point 5 of the Section 14 Analysis would have been more precise if it had referred to "Large scale reallocation of general traffic lanes without additional effective alternatives", but this is immaterial in the context of the advice as a whole.

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293. I acknowledge it is possible that MSM will be missing some 'disappearing traffic' effects. However, the effects of large-scale lane removal are likely to be negative from a welfare/wellbeing perspective (which is the issue at hand). It may in fact be that the modelling of the RLTP programme, which includes significant road space reallocation to other modes and therefore allows for easier adaption with more limited congestion effects, is underestimating traffic reduction and therefore emission reduction effects. These would, of course, further support AT's statement of consistency with the GPS. However, I suspect that any impact would be small at the regional level.

294. Finally, a large-scale lane removal programme would have called into question consistency with the GPS "better travel options" priority. Lane removal does not improve transport choices, as no new alternative is provided, and access to places for earning, learning and participating in society is reduced.

Claim of failure to consider environmental wellbeing

295. The applicant claims that "They purported to explain to the RTC how the RLTP supports economic, social and cultural wellbeing, but made no mention of environmental wellbeing, the adverse impacts that the RLTP would have on environmental wellbeing, and the importance of environmental wellbeing for economic, social and cultural wellbeing".

296. Presumably this refers to paragraph (iv)(a) of the Section 14 Analysis. I set out (iv) in full:

> **(iv) In the public interest:** In addition to the above, the RLTP contributes to the public interest as follows:
>
> (a) Supporting economic, social and cultural wellbeing by investing in new transport capacity, particularly in the public transport network, to ensure that the transport system can accommodate Auckland's future growth and still function effectively. This includes delivering a forecast 60% increase in access to employment by public transport and a 14% improvement in access to employment by private vehicle between 2016 and 2031.
>
> (b) Significant investment to support growth and new housing in the spatial priority areas in a manner that supports sustainable transport outcomes and reduced congestion.

(c) Supporting a safer transport system, by adopting the principles of Vision Zero and targeting a significant reduction in deaths and serious injuries on Auckland's roads.

(d) Developing the public transport and the cycling networks, to encourage greater take-up of these more sustainable modes. The RLTP expects:

- 64% of new trips in the AM peak will be taken up by public transport and active modes; and
- 200 kms of new or improved cycling infrastructure will be delivered.

(e) Providing an investment programme that, along with initiatives already signalled by Government, will contribute to emission reductions goals by achieving a reduction in emissions between 2016 and 2031 - despite a 22 percent increase in Auckland's population over the same period. When coupled with other policy levers promoted in the RLTP, much larger reductions in GHG emissions could be achieved.

297. Contrary to this claim:

(a) the whole of paragraph (iv) is related to the LTMA public interest test. Subparagraph (a) deals only with economic, social and cultural wellbeing. However, subparagraphs (d) and (e), although not explicitly using the word 'environment', refer to initiatives that will improve environmental wellbeing – still within the overall context of the LTMA public interest analysis;

(b) the Section 14 Analysis also deals extensively with environmental aspects in the context of consistency with the GPS;

(c) the RLTP itself deals extensively with environmental impacts and therefore wellbeing.

Claim of failure to draw RTC's attention to certain modelling

298. The applicant also claims that "They failed to draw the RTC's attention to Auckland's Transport's modelling of the expected emissions impacts of the RLTP programme itself (as distinct from the impacts of anticipated government improvements in vehicle efficiency and planned government interventions), being a 6% increase in emissions between 2016 and 2031."

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299. The 6% figure is not directly relevant to the Section 14 assessment, in particular because it relates to the 2016-2031 period, rather than 2021-2031 period to which the RLTP applies. Nevertheless, RTC members were aware of this figure. It is, for example, noted in the final RLTP which states:

> Our transport modelling forecasts that Auckland's per capita transport emissions will reduce by 13 percent between 2016 and 2031. However, the 22 percent increase in population over the same period means that the region's total emissions are expected to increase by six percent between 2016 to 2031.

300. This is, of course, before accounting for the impacts of government initiatives which, when combined with the RLTP, are forecast to deliver a 1% reduction between 2016 and 2031.

301. Previous briefings to the DDC, AT Board and the RTC had also covered this point.

Alleged incorrect claim of consistency with GPS because RLTP was derived from ATAP

302. The applicant alleges that "They wrongly advised the RTC that consistency between the RLTP and GPS 2021 could be inferred from the fact the RLTP was derived from the Auckland Transport Alignment Project. In fact, it was wholly irrelevant to the RTC's assessment of consistency between the RLTP and the GPS 2021".

303. It is not correct that advice on RLTP consistency with the GPS was based solely on ATAP. However, neither is ATAP wholly irrelevant to that question.

304. As I discuss earlier in this affidavit, the entire ATAP process (as its name suggests) is designed to ensure *alignment* between the RLTP and GPS objectives. The objectives that underpinned ATAP and therefore the RTLP were aligned with the GPS' strategic priorities . The GPS sets out Government policy in this area, and the Minister of Transport and MoT were participants in the ATAP process. Cabinet signed off on the ATAP programme. From AT's point of view, this strongly suggested the

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Government considered ATAP to be consistent with the GPS. Paragraphs 43 to 46 of the Section 14 analysis cover the same ground.

305. Be that as it may, AT did not rely solely on ATAP as the reason for concluding that the RLTP was consistent with the GPS. Rather, in paragraphs 7 to 39 of the Section 14 Analysis, it independently assessed the RLTP for consistency with the GPS, including through discussion of each of the strategic priorities in the GPS. The statement about Government agreement to ATAP and its incorporation within the GPS was merely "implicitly supporting" this conclusion of consistency which had already been reached (paragraph 40). The Section 14 analysis was included in the RLTP as Appendix 9, as required under section 16 of the LTMA.

Claim that RTC was presented with a binary choice between approving the RLTP as prepared and the 2018 RLTP remaining in effect

306. The applicant alleges that the RTC was wrongly presented with a binary choice between approving the RLTP as prepared and the existing 2018 RLTP remaining in effect.

307. It is not correct that the RTC was presented with such a binary choice. The RTC was aware that that it could modify the draft RLTP before deciding whether to recommend approval by the AT Board. At the same time, however, it wanted to know the implications of not recommending approval to the Board, and it requested and received advice on that question.

308. The RTC did in fact make changes to the draft RLTP before recommending approval to the Board, as outlined above in paragraphs 164 and 171 to 173.

Claim of inconsistency with the GPS

309. The applicants allege that the RLTP is inconsistent with the GPS, in various ways set out in paragraph 71 of the statement of claim. I understand that this is one of the legal matters for the Court to determine, so I will simply respond to some of the factual matters underlying the claim.

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310. The ATAP/RLTP programme was developed within the $16.3 billion transport funding allocation for Auckland specified in the GPS. This provides context for the consideration of the scale of effects that could be reasonably expected from the RLTP investment programme. While $16.3 billion may seem like a large amount, especially when combined with matching funding from Council and Crown funding sources, its ability to change the transport network and therefore travel behaviour is limited. This is particularly when just maintaining, operating and renewing the existing network will consume the best part of $13.4 billion.

311. Hīkina makes a similar point in relation to the investment levels in the NLTF (and therefore the GPS):[69]

(a) "Emissions reduction is a significant step change in investments for the NLTF (sic), which will always be far beyond what the NLTF could do or was ever intended to do";

(b) "The main current constraint of the NLTF is that more than three-quarters of the fund over the next ten years is already allocated to maintaining the existing transport network, funding public transport services, Road to Zero initiatives, public private partnership repayments and completing large projects for new infrastructure that are already underway. This limits how much impact investment through the existing NLTF can have on reducing emissions over and above current initiatives."

These comments apply equally to the RLTP programme as I have explained above.

312. At paragraph 71(a) of the statement of claim, the applicant alleges that the RLTP is inconsistent with the GPS's strategic priority of transforming to a low carbon transport system that supports emissions reductions aligned with Aotearoa New Zealand's commitments under the Paris Agreement and the Zero Carbon Act".

69 Hīkina, page 24.

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313. I note that the climate change priority is in fact worded as follows: "Transforming to a low carbon transport system that supports emission reductions aligned with national commitments, while improving safety and inclusive access". As described in the Section 14 Analysis, the RLTP achieves consistency with this GPS priority by:

(a) investing heavily in projects and programmes that enable mode shift to public transport and walking and cycling;

(b) supporting overall emission reductions, in the context of current and expected wider government policy changes;

(c) substantially improving safety outcomes, and improving inclusive access by both private vehicle and public transport

314. At paragraph 71(b) of the statement of claim, the applicant alleges that "Contrary to the associated priority outcome in GPS 2021, the RLTP does not make investment decisions that support the rapid transition to a low carbon transport system, that materially reduce harmful emissions, and that give effect to the emissions reduction targets in the CCC Advice".

315. In my view this claim is incorrect, and overlooks the wider context of GPS objectives:

(a) Where there was scope for the investment decisions in the RLTP programme – i.e. in the discretionary category – the projects entirely support some combination of better transport choices, freight, emission reduction or safety outcomes. Even in the essentials programme, where there was no practical discretion, 80% of the investments, excluding renewals, directly contribute to the four GPS objectives, while the bulk of the remaining 20% contributes to the objective indirectly;

(b) In the period 2016 to 2031 harmful emissions from volatile organic compounds are forecast to reduce by 74%, nitrous oxides by 48% and particulate matter by 70% – although these changes are overwhelmingly the result of forecast changes in vehicle technology;

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(c) The RLTP programme helps give effect to the Climate Change Commission's targets. It does not and cannot achieve the target on its own, but it does make a contribution, and as already explained it I do not consider that investment in infrastructure alone was expected to meet this target.

316. In paragraph 71(c) of the statement of claim, the applicant alleges that:

> In particular, Auckland Transport's modelling forecasts that under the RLTP:
> (i) Transport emissions in Tāmaki Makaurau Auckland will increase to 6% above 2016 levels by 2031;
> (ii) Even allowing for improved vehicle efficiency and planned government interventions, transport emissions in Tāmaki Makaurau Auckland will only reduce to 1% below 2016 levels by 2031; and
> (iii) There will be no per capita reduction in vehicle kilometres travelled.

317. In relation to (i) and (ii), the relevant assessment period for the RLTP is 2021-2031, where emissions are forecast to reduce by 5% with delivery of the RLTP and planned Government interventions. In terms of (iii), the GPS climate change objective does not include any requirement for a per capita reduction in vehicle kilometres travelled.

Response to evidence of Mr Litman on consistency with the GPS

318. In his affidavit, Mr Litman makes the general argument that the emissions reduction results of the investment programme are insignificant given the level of investment and are therefore inconsistent with the GPS.

319. I understand his main points to be that under the investment programme:

(a) total regional VKTs will increase by 22% by 2031 (with the associated increases in congestion and safety problems that result from increasing use of private vehicles); and

(b) total carbon emissions will increase by 6% or decrease by 1% if the modelled impact of central government's Clean Car policy and a shift to biofuels are taken into account. He says that "Either way, this is far short of national goals and targets."

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320. Mr Litman also says that:

(a) "A 1% reduction in emissions after $37 billion worth of investment over the course of the decade is insignificant. It is smaller than the statistical uncertainty in this type of modelling" and "represents no material progress towards the greenhouse gas emission reductions targets"; and

(b) "the RLTP is modelled to give rise to a substantial increase in total VKTs. As recognised in the GPS itself (see section 2.6, page 25) reducing VKT is essential for reducing emissions from the transport system. I consider failing to reduce VKTs also risks undermining the other strategic priorities of the GPS of improving travel options and, the safety of the transport system and freight connectivity."

321. I respond to these criticisms as follows.

322. Firstly, the reference to VKT in section 2.6, page 25 of the GPS does not recognise that reducing VKT is essential for reducing emissions from the transport system, as alleged. This reference simply includes VKT as a "proposed indicator". While a per capita VKT reduction could be inferred to be a desirable result from a number of the interventions described in the GPS, it is notable that that the GPS sections on Better Transport choices and Climate Change do not identify reductions in either per capita or total VKT either as primary outcomes or co-benefits.

323. Much of Mr Litman's argument nevertheless rests on increases in VKT, which he implicitly links to the investment programme. This argument ignores the impact of the forecast 22% population increase, despite this challenge being highlighted in the RLTP[70] and the Section 14 Analysis.[71]

324. It is clear from the RLTP figures that it is population increase which is driving the increase in total VKT. A 22% increase in population and a 22% increase in VKT means that per-capita VKT will be constant

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70 Page 36.
71 Paragraph 27.

HB

between 2016 and 2031[72] and the growth is coming from more people travelling, not the existing population travelling more.

325. The constant VKT per capita result signals that other investment related factors such as induced traffic, which is generally emphasised by Mr Litman and Mr Chapman, are not a causative factor in the total regional result. If induced traffic was a factor, one would expect an increase in VKT per capita.

326. I acknowledge that a much larger reduction in VKT per capita would be desirable from a policy perspective. However, as described above the RLTP is working within the constraints of available funding, existing and predicted land use and travel patterns, along with the relatively modest impact of infrastructure and services at a regional scale. The RLTP modelled result does at least indicate an end to the historic trend which has seen Auckland's VKT per capita increase over time.

327. By ignoring population growth, in my opinion Mr Litman's argument is using the wrong comparator in making his claims for an insignificant impact from investment. The correct comparator for considering the results of the RLTP is the 'do nothing' scenario, in which no new investment occurs and other key variables remain unchanged. In this case, as the RLTP observes, we would otherwise see an emissions increase of around 22% in line with population and therefore VKT growth – instead of the 1% reduction.[73]

328. Without the RLTP investment, the demand for additional travel arising from population growth means we could also expect to see significantly worse performance against other key RLTP outcomes. We could expect significantly lower shift to public transport and active modes, no 67% reduction in deaths and serious injuries, and much smaller improvements to accessibility to employment by public transport or private vehicle.

72 The actual modelling results forecast a very minor reduction in daily VKT per capita from 22km per person to 21.8km per person

73 Although the key variable here is improvements in overall vehicle fleet efficiency, rather than the impacts of projects themselves.

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329. So, to summarise on this point, RLTP performance needs to be considered in the context of the challenges associated with Auckland's forecast population growth. In my opinion Mr Litman's comments might have been more relevant if he had addressed this context.[74]

330. More widely, Mr Litman's judgements on significance also provide little evidence as to the scale of effect that we could reasonably expect from transport investment in a city like Auckland over a relatively short time period. The discussion in paragraphs 206 to 224 above deals with these issues of scale. Nevertheless, to support Mr Litman's claim that there are "many real world examples of the dramatic impact investment decisions can have on vehicle traffic (and thus emissions)" I would expect reference to a city which is more comparable to Auckland than Paris, and an example that deals with the impact of investment alone rather than a combination of policy and investment levers.

331. Mr Litman concludes by stating that much larger vehicle travel and emission reductions could be achieved if a different mix of investments and policies were pursued. In particular, "reprioritisation away from the new highways that are planned under the RLTP, and the budget for renewing the existing road assets".

332. I do not agree with this conclusion. The full RLTP and Section 14 analysis shows that there are virtually no *new* highways planned in the RLTP. As the Section 14 Analysis indicates and is shown in Appendix 6, the overwhelming bulk of investment in highway capacity is already committed and in implementation. Paragraph 24 of the Section 14 Analysis, which states that, "all significant road capacity construction will end in around 2027" underscores this. The only item that could potentially be considered a 'new highway' is the Penlink Expressway, but reallocation of its \$830m costs, some of which are funded by tolling, would not materially change the RLTP outcome from an emissions perspective – even if possible.[75]

74 Mr Litman also says that the change is within "the statistical uncertainty of this type of modelling". However, I am advised by the Auckland Forecasting Centre that modelling uncertainties will apply equally to the 2016 and 2031 figures. Therefore, any uncertainties do not materially affect the validity of the measure reported, which is the percentage shift between 2016 and 2031.

75 The Penlink project is funded by NZUP and therefore outside the scope of the RTC's decision making discretion in the RLTP.

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333. I also note that, at paragraph 37, Mr Litman asserts that "much of the budget is allocated to building new roads and renewing existing ones". This statement is factually incorrect and misleading, for the reasons given above.

334. On the subject of renewals, underfunding a renewals programme will either lead to increased whole of life costs as fixing roads subject to critical failure is more expensive than the renewal; or, eventually serious disruption for the movement of freight and buses[76] (along with private vehicles) and therefore negative impacts on the better travel choices and freight objectives. In this regard I note the feedback from public consultation, which saw managing transport assets as the item that most saw as either 'very important' or 'moderately important'. I also reiterate that any plausible reduction in the renewals programme will only have a minor impact on overall emission outcomes. Further, climate change is only one of four strategic priorities in the GPS.

335. Overall, Mr Litman's opinion that there should have been reallocation away from new highways and renewals (in order to achieve more substantial reductions in emissions) is not plausible, in my opinion. There is little or no investment in new highways that could be reallocated in a way which materially affects emissions, while the long-term costs and likely disruption to public transport and freight outcomes in particular associated with underfunding a renewals programme, make this option undesirable and impractical.

Claim relating to various climate change treaties, declarations, and instruments

336. The applicant refers in its claim to various treaties, declarations and instruments relating to climate change, to support the allegation that the RLTP does not satisfy the purpose of the LTMA. These documents include:

(a) The IPCC's Special Report on Global Warming published in 2018;

76 As the need to renew roads is primarily drive by heavy vehicles, roads that have high volumes of freight and or buses, especially double decker buses, would likely be the first to see problems.

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(b) The Paris Agreement;

(c) The Climate Change Response (Zero Carbon) Amendment Act 2019;

(d) The Local Government Leaders' Climate Change Declaration 2017;

(e) Declaration of climate emergency by the Government and Parliament;

(f) Climate Change Commission advice to the Government.

337. AT was of course aware of developments occurring both internationally and nationally in the climate change area, and this includes knowledge of the treaties and declarations etc listed above. However, these documents were not regarded as directly relevant to the preparation and approval of the RLTP, which had to occur within its own specific statutory context of the LTMA.

Conclusion

338. I understand the applicant contends that the RLTP is not consistent with the GPS because the investment package does not achieve a sufficient level of emissions reduction.

339. Linked to this is the contention that the RLTP could have achieved a materially different result by shifting funding away from roading projects and renewals, and towards projects that reallocate road space to public transport and active modes.

340. I disagree with both these contentions.

341. Despite the GPS's aspirational language, AT did not regard it as Government policy that an investment programme must achieve 'transformational' change on its own. For a start, the NTLF and other available funding sources do not provide anywhere near the scale of

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funding required – for example to tackle the operational costs of major increases in public transport services. Moreover, there is a broad recognition – including in the GPS itself, the Minister's letter, Hīkina and indeed some of the evidence of Mr Chapman and Mr Litman – that a combination of measures well beyond investment prioritised through the RLTP and NLTP will be needed to achieve substantial emissions reductions.

342. While these policy interventions are beyond the scope of the RLTP to implement, the RTC has recognised these changes will be needed: and indeed advocates for them in the RLTP itself. If key policy tools were available, I am confident the RTLP results would show much larger reductions in emissions.

343. Further, as set out in the RLTP and Section 14 Analysis, as well as the discussion above, there was no scope to reallocate funding away from projects solely focused on roading capacity. All of the substantial highway capacity projects were already in construction; while the NZUP programme was Crown funded, consistent with the GPS, and outside the scope of the RTC to change. At the same time, any meaningful reallocation of the renewals programme would have the effect of either inefficiently increasing whole of life costs in the long-term, thereby reducing funding for public transport and active modes improvements; or eventually disrupting the operation of the road network, impacting on bus and freight movements.

344. In addition, the RLTP programme, particularly the improvements projects, is overwhelmingly focused on better transport choices and emission reduction, safety and housing outcomes, while also supporting freight. The capacity improvements programme and the increase in renewals made up a relatively small portion of the total funding.

345. Even if greater reallocation away from roading capacity projects had been possible, it would not have materially changed emissions outcomes. This was demonstrated in multiple prioritisation exercises and their associated modelling runs, along with observed trends of the network itself.

HB. PB

346. None of this is to deny that major change is needed in order to meet transport emission reductions goals – these changes are absolutely necessary. However, it is clear that major decisions (outside the ambit of an RLTP) are still to be made by Government and Council over timing and approach.

347. Based on my experience and expertise in this area, the options for achieving this fall into two broad categories:

(a) Rapid change, which will require implementation of comprehensive and high price distance-based pricing schemes – supported by recycling the revenue into public transport and cycling capacity. There is no other intervention that achieves the necessary scale of change. This will, however, have a substantial negative impact on economic, social and cultural wellbeing – particularly from an equity point of view;

(b) Less disruptive change, which can be achieved primarily through a much greater emphasis on shifting to low emissions vehicles – supported by continued priority investment in better transport choices. This will, however, take longer to achieve substantial emissions reductions.

348. What we cannot afford to do, in my opinion, is delay serious changes in policy in the expectation that meaningful emissions reductions can be achieved through investment in public transport and active modes alone. These investments are critical to other objectives and can contribute, but will simply not be attractive enough for most trips, in the Auckland context, to achieve the scale of change needed to reach the net zero target by 2050. This is a key message of the RLTP – once a dispersed city form is in place, the impact of infrastructure in shifting transport behaviour is limited and other tools are needed.

349. In preparing and approving the RLTP, the RTC and AT Board were very much alive to the importance of addressing the issue of climate change, so far as they could, and the need to deliver an RLTP which supported Government policy in that regard. In AT's view it has done that, whilst also delivering major positive results – particularly in the area of safety

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and better transport choices, including a step change improvement in coverage and operation Auckland's rapid transport network in particular.

350. It is recognised that the contribution in absolute emissions reductions terms is relatively modest. However, there were significant limits on doing more, including:

(a) overall budget constraints and the committed nature of part of the programme;

(b) current land use and travel patterns in Auckland, which means that public transport and cycling interventions will struggle to compete for many of the journeys Aucklanders make – particularly outside of the peak period;

(c) high population growth in Auckland;

(d) the need to simultaneously satisfy the other strategic priorities in the GPS; and

(e) the inherently limited ambit of a RLTP.

351. The RLTP itself outlines the broader policy interventions needed to achieve emissions reduction at scale, and this can be supported by

HB. [initials]

investment decisions such as those in the RLTP. However, the RLTP alone cannot 'solve' the problem of Auckland transport emissions.

Signature of deponent:

Hamish Phillip Bunn

Affirmed at Auckland on 25 February 2022

Before me:

Signature **Beth Ford**
Solicitor
Auckland

Name
A Solicitor of the High Court of New Zealand

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"HB1"

EXHIBIT NOTE

This is the annexure marked HB1 referred to within the affidavit of **HAMISH PHILLIP BUNN** affirmed at Auckland this 25th day of February 2022 before me:

Signature..

A Solicitor of the High Court of New Zealand

Beth Ford
Solicitor
Auckland

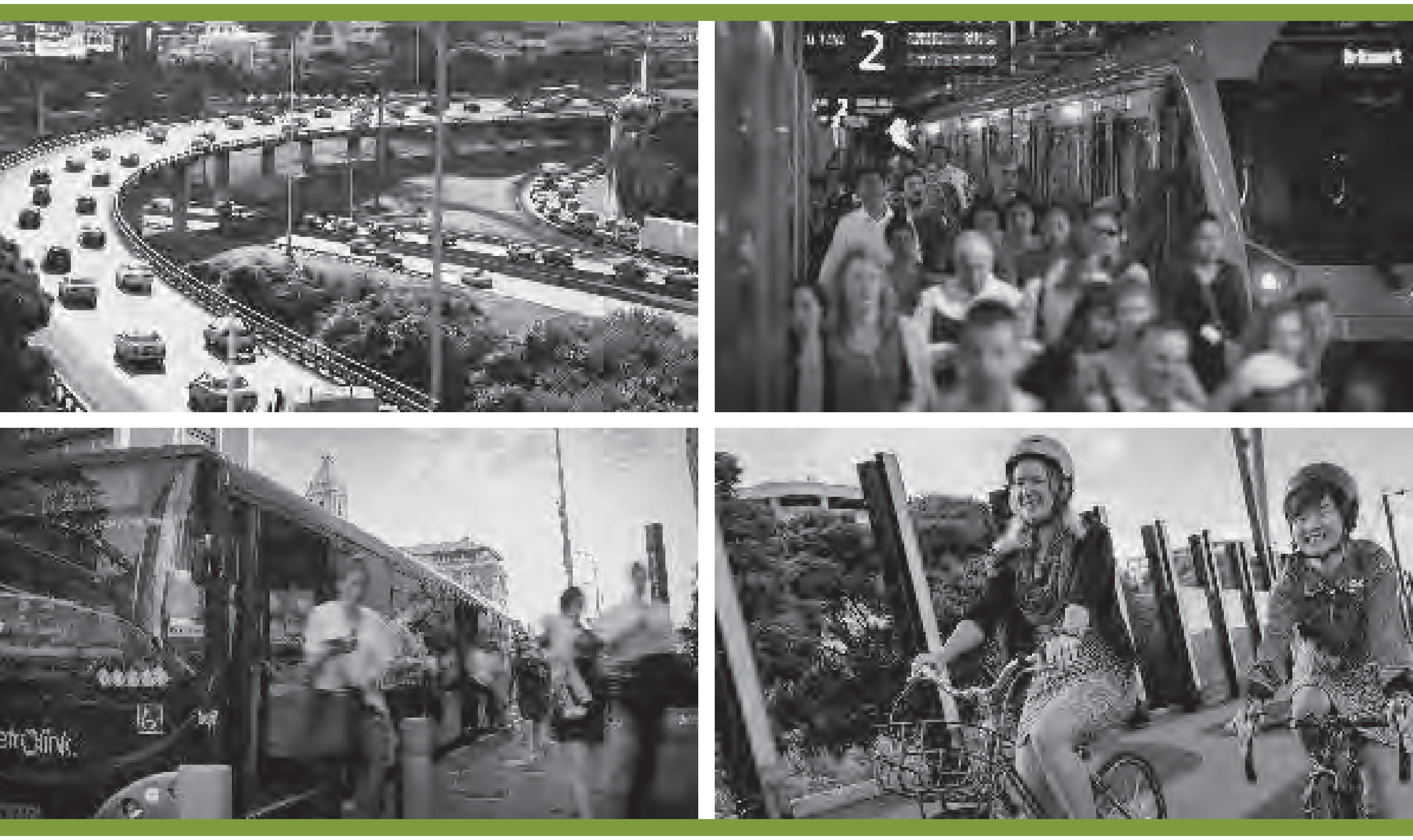
HB1-001

BC5979

Auckland Transport Alignment Project

Recommended Strategic Approach

September 2016



Ministry of Transport
Te Manatū Waka

The Treasury

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Auckland Transport

State Services Commission
Te Komihana O Ngā Tari Kāwanatanga

NZ Transport Agency
Waka Kotahi

Contents

Foreword

We are all familiar with the pressures that Auckland's population growth puts on the city's transport system. This growth is expected to continue in the foreseeable future, with Auckland expected to grow by around 700,000 people - or more than half of New Zealand's total expected population growth - over the next 30 years.

It is essential that the Government and Auckland Council are on the same page when it comes to how we can best plan for and meet the growing transport demand that flows directly from population growth. This is why we decided to set up the Auckland Transport Alignment Project (ATAP).

The completion of ATAP means we have a common understanding of how and where Auckland is likely to grow, what the transport priorities are and when they need to be addressed.

ATAP has recommended we focus on getting more throughput on the existing network because this is where most growth in travel demand will happen. It has also concluded we need to better target what we invest in. ATAP has identified the following priorities for additional funding over the next decade:

- New and upgraded roads to unlock land for housing in the northwest, the south and the north
- The first phase of the Northwestern Busway from Westgate to Te Atatu to provide for growth, increased access into the city centre and help tackle congestion on the Northwestern Motorway
- Motorway improvements to address congestion and provide for ongoing growth in the northwest, south and southwest
- Upgraded access to Auckland Airport from the east to address congestion and improve journey reliability of bus services and safety for cyclists
- Ongoing investment to improve Auckland's rail network for both passengers and freight, including more electric trains and extending electrification to Pukekohe.

ATAP has also found that Auckland needs to capitalise on the very real opportunities emerging transport technologies present - both in terms of the network itself and how it is used - for meeting the city's transport needs.

Lastly, ATAP has concluded that to achieve a step-change in the performance of Auckland's transport system we need to begin laying the groundwork to move towards smarter pricing.

I look forward to working with the Mayor of Auckland and Auckland Council on how we can best implement this ambitious strategic approach, and address the funding implications.

Hon Simon Bridges,
Minister of Transport

When Auckland's eight local authorities amalgamated in 2010, much was expected of the new, unified Auckland. One expectation was that Auckland would engage in more fruitful collaborations with Government. The Auckland Transport Alignment Project delivers on that expectation.

Since the new Auckland was formed, employment has grown by 190 thousand people, or 30 percent. We need a transport system that gets these people from where they live, to where they work, with as little time lost to congestion as possible. That is why the Government and Auckland Council agreed - improving access to employment was a primary objective.

ATAP also aims to improve public transport use. We are already seeing an unprecedented increase. Public transport is growing faster than any other major transport mode, up by 36 percent over the last six years. The stand-out is rail, where we have doubled patronage.

Auckland's growth throws us many challenges. The biggest constraint is not lack of people wanting to use our roads, trains, buses, ferries and cycleways. It is our ability to prioritise and fund additional capacity.

ATAP is a major step forward. Through ATAP, we have agreed Auckland's transport priorities and a 30 year investment prioritisation programme. Now we need a sustainable funding track. Auckland will pay its way, but that should not mean an increasing share of costs to be carried by ratepayers. We need a fairer, more efficient funding system. That is why I welcome the focus on road pricing.

Road pricing offers a mechanism that can manage demand and fill the funding gap, while delivering the optimal programme. Our next challenge is to design a system that gets this balance right and is acceptable to Aucklanders.

Auckland is more than ready for that conversation. We have spent five years preparing for it and building a broad consensus. We have a programme, now let's fund it and give growing successful Auckland the transport system it needs to be the world's most liveable city.

Len Brown,
Mayor of Auckland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Executive Summary

i. As joint transport funders with a shared interest in a successful Auckland, the Government and Auckland Council have worked together to identify an aligned strategic approach for the development of Auckland's transport system. This report presents joint officials' recommended strategic approach. It builds on work reported in two previous documents: the *Foundation Report* (February 2016) and the *Interim Report* (June 2016).

ii. A sharp recent increase in Auckland's population is placing significant pressure on our transport networks, and this will be compounded by substantial projected population growth over the next 30 years. While a very significant programme of infrastructure investment is under way and committed, we will need to do things differently to effectively address this challenge.

iii. We identified four critical transport challenges that need to be the focus of our efforts over the next decade:

- Enabling a faster rate of housing growth, particularly in new greenfield growth areas
- Addressing projected declines in access to jobs for people living in large parts of the west, and some parts of the south
- Addressing increasing congestion on the motorway and arterial road network, particularly at inter-peak times
- Increasing public transport mode share on congested corridors.

iv. We considered a range of options for addressing Auckland's transport challenges to see how we could get better returns than from current plans.

v. Changing the mix of investment would deliver improvements in some areas, but it cannot deliver a step-change in performance across the region, and would struggle to keep pace with projected demand growth.

vi. We also looked at options to substantially increase or bring forward new infrastructure investment, or to shift to a greater focus on influencing demand. We concluded that neither of these approaches alone is sufficient to address Auckland's transport challenges.

vii. Instead, we need to better balance transport demand with the capacity of our infrastructure and services. This requires a fundamental shift to a greater focus on influencing travel demand through smarter transport pricing, and accelerating the uptake and implementation of new technologies, alongside substantial ongoing transport investment, and getting more out of our existing networks.

viii. Our recommended strategic approach therefore contains three integrated elements, as illustrated in *Figure 1*.

ix. Implementing this approach will provide much better returns than current plans, delivering better access to employment, reduced congestion, and increased public transport mode share. This does, however, rely on the three elements being progressed in an integrated manner. In particular, the main benefits will not be realised until we shift to smarter transport pricing.

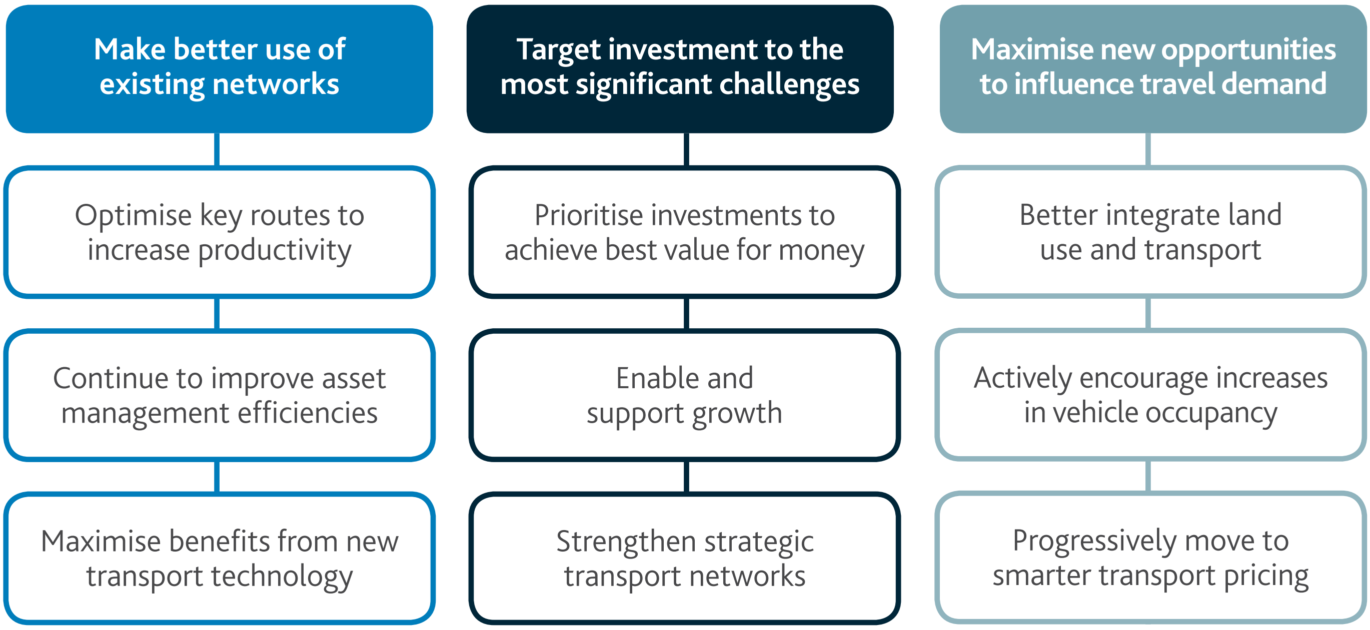

Figure 1.

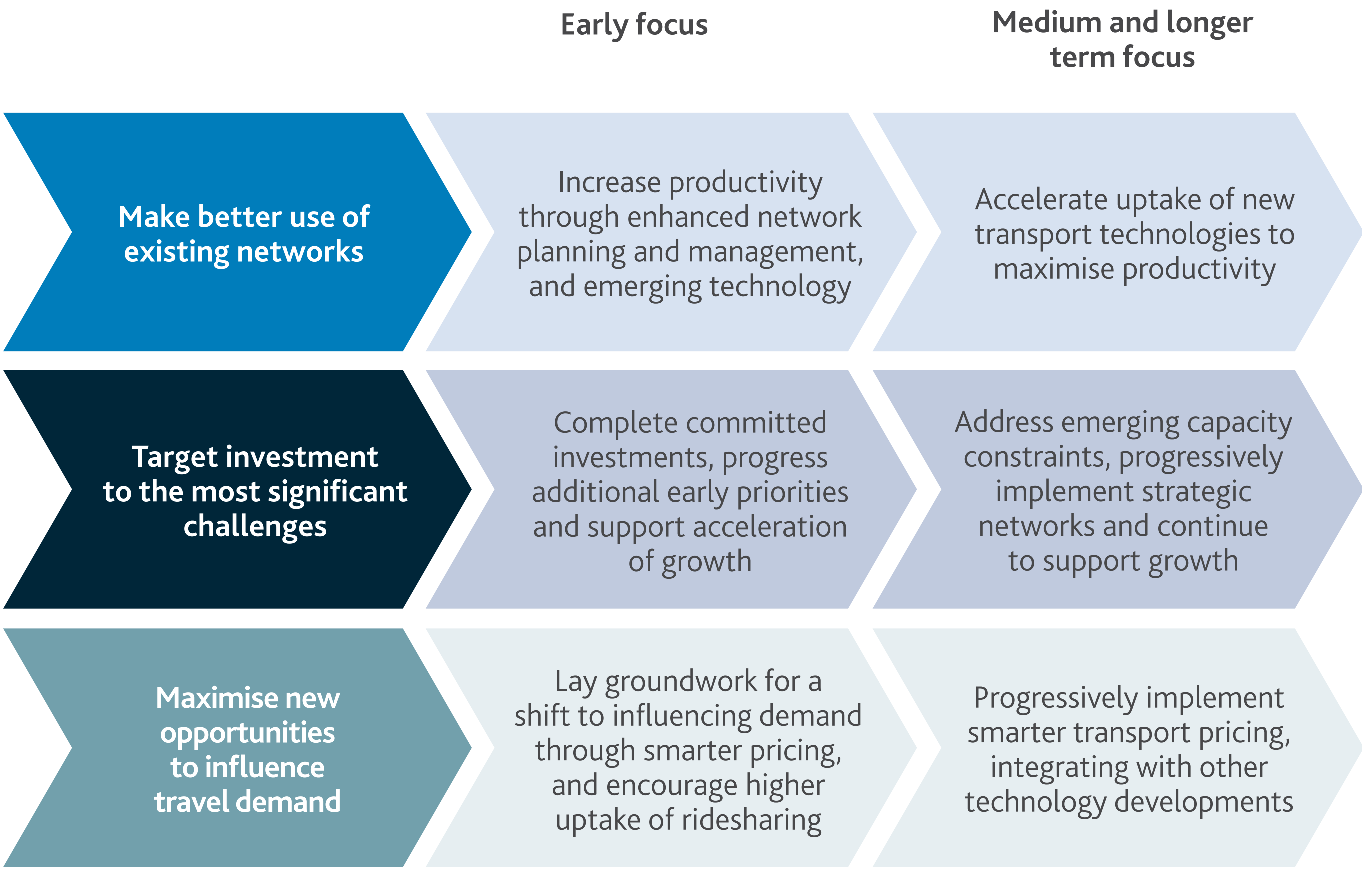

Figure 2.

x. The recommended strategic approach will need to be progressively delivered through infrastructure investment, policies and services over the next 30 years. To give an indication of how the approach could be applied, we developed an indicative package of the types of interventions likely to be needed, as well as the overall scale and sequencing of investment. Our broad approach is shown in *Figure 2*.

xi. The indicative package is not an investment programme, as individual projects need to go through statutory processes to proceed. However, it provides an illustration of the type and quantum of investment that is likely to be required to implement the strategic approach.

xii. We have placed greater emphasis on the first 10 years because many of our current assumptions about the location of housing and employment growth and the timing and impacts of technological change become less accurate after this period. The estimated expenditure in the first decade, from 2018-2028, is around $24 billion. Over the 30-year period, estimated expenditure totals $83 billion, nearly half of which represents capital expenditure, with the remainder a combination of asset renewals, maintenance and operational costs.

xiii. The expenditure identified for the first decade exceeds the funding expected to be available from current funding plans by around $4 billion. Auckland Council and the Government will need to consider options to address this gap, ahead of the next round of statutory funding decisions in 2018.

xiv. The indicative package outlines interventions for the three decades from 2018. This does not mean that we can wait until 2018. A number of actions can be taken now to set us along the path towards our recommended strategic approach. The sooner we start, the sooner we can expect the benefits.

Recommendations

We recommend the Government and Auckland Council adopt the recommended strategic approach, which contains the following key components:

a. Make better use of existing networks

b. Target investment to the most significant challenges

c. Maximise opportunities to influence travel demand.

To implement the strategic approach, we also recommend:

a. Government, Auckland Council, Auckland Transport and the NZ Transport Agency incorporate the strategic approach into their statutory strategic documents

b. Government and Auckland Council work together to consider options and agree on an approach to address the funding gap by mid-2017, to inform statutory funding documents

c. Early establishment of a dedicated project to progress smarter transport pricing, with a view to implementation within the next 10 years

d. Review of investment processes to ensure they align with the strategic approach

e. Government and Auckland Council consider whether statutory changes are required to support ongoing joint strategic transport planning

f. Complete work on identified priority actions as soon as possible.

The Auckland Transport Alignment Project

1. As joint transport funders with a shared interest in a successful Auckland, the Government and Auckland Council agreed in August 2015 to work together on the Auckland Transport Alignment Project, to identify an aligned strategic approach for the development of Auckland's transport system that delivers the best possible outcomes for Auckland and New Zealand.
2. This report has been jointly prepared by officials from the six agencies involved in the project[1], and presents our recommended strategic approach. It includes an indicative package of measures, covering the broad timing and scale of interventions, and estimates of costs and benefits, together with the nature, scale and timing of the funding gap for the recommended strategic approach. It also sets out recommended implementation actions.
3. This report marks the completion of the Auckland Transport Alignment Project, and builds on the work reported in two previous documents: the *Foundation Report* (February 2016) and the Interim Report (June 2016). A companion document, *Auckland Transport Alignment Project: Supporting Information* presents the background information to support this report.
4. In a number of areas, including safety and active modes (walking and cycling), the views of central and local government are already well aligned on the priorities and likely level of future funding. We have therefore taken as given, the initiatives that are already underway in these areas, including the *Safer Journeys Action Plan*, the *Auckland Road Safety Plan*, and the *Urban Cycleways Programme*.
5. While the focus of this report is on the transport system within Auckland, it is important that this is considered within its broader inter-regional context, particularly the linkages between Auckland and the Upper North Island. We note and support the initiatives that are currently underway to strengthen the strategic connections to Northland, Waikato and the Bay of Plenty, including the Auckland to Northland corridor initiatives ('Connecting Northland') and the Waikato Expressway.

Project Objectives

The focus of the Auckland Transport Alignment Project is to test whether better returns from transport investment can be achieved in the medium and long-term, particularly in relation to the following objectives:

i. To support economic growth and increased productivity by ensuring **access to employment/labour improves** relative to current levels as Auckland's population grows

ii. To **improve congestion results**, relative to predicted levels, in particular, travel time and reliability in the peak period and to ensure congestion does not become widespread during working hours

iii. To **improve public transport's mode share**, relative to predicted results, where it will address congestion

iv. To ensure any increases in the financial costs of using the transport system **deliver net benefits to users** of the system

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[1] Ministry of Transport, Auckland Council, NZ Transport Agency, Auckland Transport, The Treasury, and the State Services Commission.

Auckland's Transport Challenges

6. Auckland is growing quickly: the city's population is projected to increase by 45% to 2.2 million over the next 30 years, accompanied by a 40% increase in jobs to over 850,000. Continued strong growth in visitor numbers is also expected. This growth places pressure on transport networks, reducing performance and increasing congestion. Left unaddressed or without alternatives for travel, congestion will reduce the opportunities that Auckland's growth can provide.

7. The most significant projected transport challenges over the next decade are:
   - Enabling a faster rate of housing growth, particularly in Special Housing Areas and greenfield areas live-zoned[2] in the Auckland Unitary Plan.
   - Addressing projected declines in access to jobs for people living in large parts of the west, and some parts of the south.
   - Addressing increasing congestion on the motorway and arterial road network during peak periods, and increasingly at other times of the day, which adversely affects the efficient movement of freight and services.
   - Increasing public transport mode share, particularly along high volume, congested corridors.

8. In addition to these focus areas, there is a need to continue to make improvements to road safety and active modes (walking and cycling).

9. Transport is Auckland Council's largest and central Government's fourth largest investment area. A combination of catching up on past under-investment and accommodating Auckland's growth has resulted in transport expenditure in Auckland increasing from $500m per year in 2000 to $2.1 billion in 2015[3] , as illustrated in the following graph.

10. Overall, the challenge for Auckland's transport system is to support the city's growth in a way that is affordable and provides value for money, while also delivering benefits to Auckland and New Zealand as a whole.

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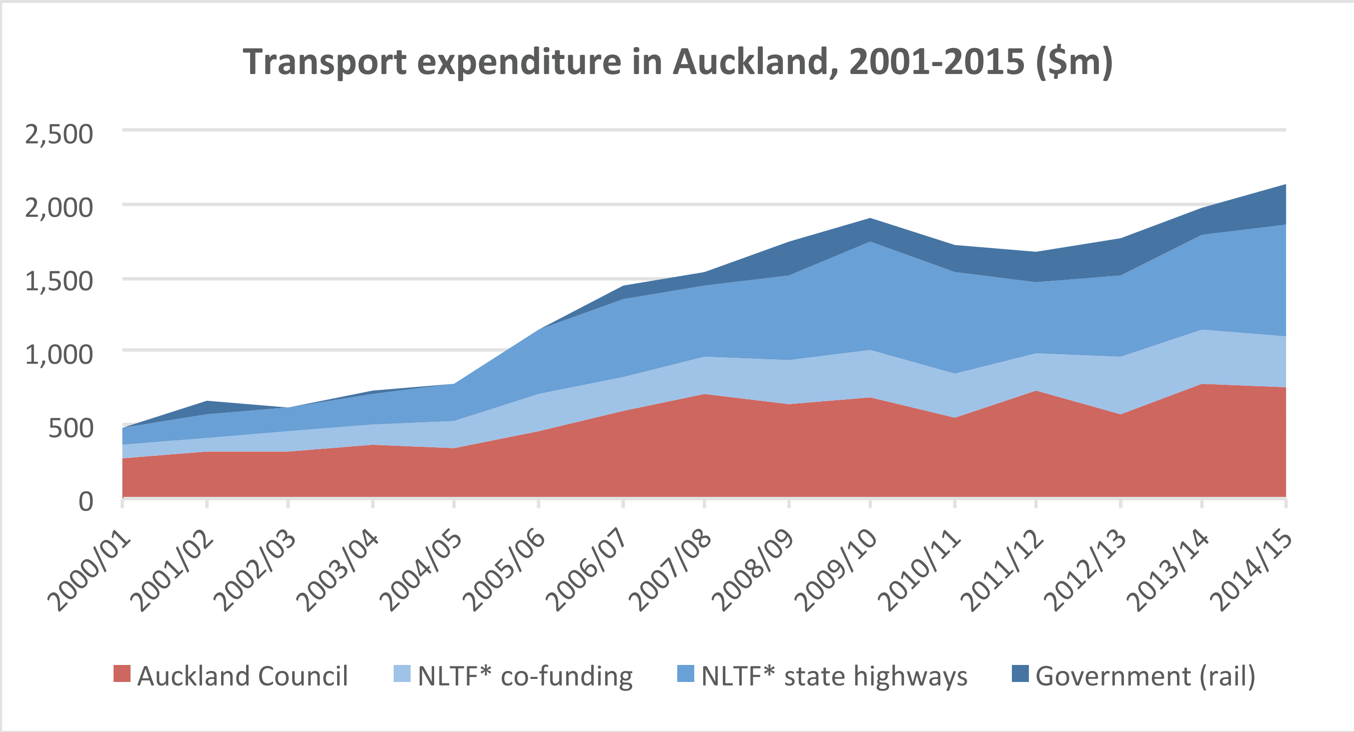
[2] "Live-zoning" means a residential or business zone where development can occur, rather than a future urban zone where structure planning is required.

[3] Includes all public expenditure on land transport, including capital and operations, but excludes debt servicing.



*NLTF denotes funding from National Land Transport Fund.

Strategic Choices

11. In common with most cities in the world, the response to growing travel demand in Auckland has been to increase road capacity and to provide public transport, walking and cycling infrastructure and services. Relatively little attention has been paid to influencing that demand.

12. This has involved a substantial increase in investment over the past 15 years, which has delivered significant benefits through the expansion of Auckland's motorway network, the modernisation of the rail network and the construction of the Northern Busway. This approach is continuing through a programme of committed and agreed investments in projects such as the Waterview Connection, the City Rail Link, the Auckland-Manukau Eastern Transport Initiative (AMETI), the Puhoi-Warkworth extension of the Northern Motorway, the Accelerated Motorway Package and the East-West Link.

13. While these investments will make a positive difference, our analysis shows that Auckland's fast rate of growth and challenging physical geography mean congestion and access to employment are unlikely to improve in the next decade from recent levels[4]. In particular, access challenges are expected to become most significant in the west and some parts of the south due to lengthening travel times and a relative lack of local employment.

14. We examined options for changing the mix of what we invest in (spending the same amount as current plans but on different priorities) to consider whether this could achieve better returns. This would generate improvements in some areas, but not a step-change in performance across the region, and will struggle to keep pace with projected demand growth.

15. To achieve that step-change in performance we need a different approach. We looked at two future pathways:

Mainly focus on building more transport infrastructure	A greater focus on influencing transport demand
This pathway substantially increases or brings forward our investment in transport infrastructure to respond to demand, and to support growth.	This pathway shifts to a greater focus on influencing transport demand through taking advantage of new transport technologies, making full use of network capacity, and using a smarter transport pricing system.

16. Our analysis has shown we cannot rely solely on either approach.

17. Simply increasing investment to build our way out of the problem is unlikely to be cost-effective in the long run and will struggle to deliver significant access and congestion improvements. In part, this is because providing new transport infrastructure in existing urban areas is increasingly expensive due to costly land acquisition or tunnelling. It can also have significant amenity impacts.

[4] Our base year for analysis is 2013. Since 2013 Auckland has experienced rapid population growth and increased congestion, with average peak time travel speeds on the State highway network declining by 9% (from 61 to 56 km/h).

18. Conversely, Auckland's substantial projected growth, current challenges and uncertainties about the timing and effects of new technologies mean we cannot solely rely on influencing travel demand either.

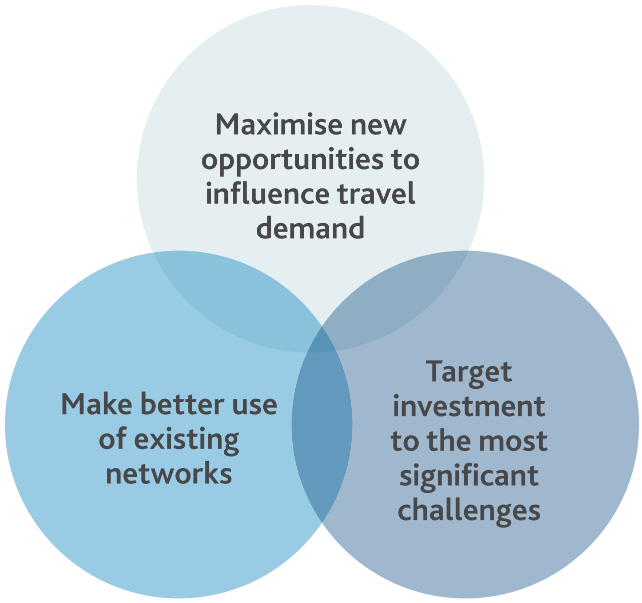
19. Instead, we need to better balance transport demand with the capacity of our infrastructure and services. This requires a fundamental shift to a greater focus on influencing travel demand through smarter transport pricing and accelerating the uptake and implementation of new technologies, alongside substantial ongoing transport investment, and getting more out of our existing networks.

Recommended Strategic Approach

20. To address Auckland's transport challenges and get better returns from the transport system, we need to better balance transport demand with the capacity of our infrastructure and services. Over time, this means influencing travel demand patterns through smarter transport pricing and accelerating the uptake and implementation of new technologies.

21. Our recommended strategic approach contains three integrated elements, each with three key components, as outlined below.

22. Our analysis shows that implementing this approach will provide better returns than current plans, and deliver positive results against the key objectives of access to employment, congestion, and public transport mode share. This does, however, rely on the three elements being progressed in an integrated manner. In particular, the main benefits will not be realised until we shift to smarter transport pricing.



Make better use of existing networks	Target investment to the most significant challenges	Maximise new opportunities to influence travel demand
Optimise key routes to increase productivity	Prioritise investments to achieve best value for money	Better integrate land use and transport
Continue to improve asset management efficiencies	Enable and support growth	Actively encourage increases in vehicle occupancy
Maximise benefits from new transport technology	Strengthen strategic transport networks	Progressively move to smarter transport pricing

Make better use of existing networks

23. The vast majority of Auckland's future transport footprint already exists today. Most growth in travel demand will need to be accommodated on the existing networks, meaning we need to be much smarter about how we use them.

24. Developing transport technology provides exciting new opportunities to get more out of our existing networks by increasing vehicle throughput and occupancy levels. Maximising these benefits will require optimising key routes to increase their productivity.

Optimise key routes to increase productivity

25. Parts of Auckland's existing transport network have crucial national, city-wide and local functions to enable the efficient movement of people, goods and services.

26. Much of Auckland's motorway network carries significantly higher traffic volumes than anywhere else in New Zealand, and parts of the arterial network carry traffic volumes greater than most State highways elsewhere in New Zealand. For these roads significant through-movement is of primary importance.

27. Many arterial roads also have a variety of other, potentially competing uses, including providing access to local centres. Many Aucklanders live along these roads, which are the focus of substantial future growth.

28. We need a stronger focus on network-level strategic planning to identify and manage these routes. This includes clear criteria to help balance different user requirements, and to address conflicts between through-movement and amenity. While there has been substantial progress in identifying these key routes and developing a framework to help resolve competing issues, this work needs to be completed with urgency.

29. Once the framework has been finalised, some difficult decisions will need to be made to enable increased productivity, such as removing on-street parking, upgrading intersections, extending bus lane operating hours, or introducing freight priority measures. There will also need to be an increase in accompanying investment to enable these changes.

Continue to improve asset management efficiencies

30. Over half of Auckland's future transport investment will need to be on maintaining, operating and renewing existing and future assets. This has implications for the amount of funding available for investment in new transport infrastructure.

31. A relatively large proportion of local roads maintenance and renewals expenditure is not currently co-funded from the National Land Transport Fund. Agreement is needed on appropriate levels of service and required funding for asset management. While progress has been made through the "One Network Roads Classification" process, it is important that this agreement is reached as soon as possible.

32. Our analysis has also highlighted the need for ongoing improvements in asset management efficiencies, including greater use of technology to remotely monitor assets to help inform the optimal timing for intervention. We consider there are opportunities for further efficiency improvements in this area, with the potential for substantial overall savings.

Maximise benefits from new transport technology

33. We are on the cusp of a paradigm shift in transport technology. Emerging transport and related technology has the potential to significantly improve the performance of Auckland's transport network over the next 30 years. The outcome could be much more efficient use of existing transport infrastructure, vehicles and services and better value for money from future infrastructure and service investments. However, it is unclear when we will be able to implement new technologies in Auckland and what their real-world impacts will be.

34. In the short-term, increasing our use of intelligent network management presents significant opportunities to get more out of our transport networks through additional throughput. Focus areas include more comprehensive real-time understanding of network use, better data processing capability to support network management decisions and more effective travel demand management tools (e.g. adaptive traffic signals, dynamic lanes and traveller information provision). Specific funding provision for these types of activities in the next round of statutory funding plans would help to highlight their importance.

35. In the medium to longer-term, connected and autonomous vehicles, combined with ride-sharing, have the potential to help increase vehicle throughput (particularly on motorways), reduce traffic accidents, and improve travel time reliability. This could present opportunities to defer or avoid future investment in additional road capacity. These benefits will take some time to materialise, especially if there are institutional, regulatory or infrastructure barriers to their adoption. A coordinated work programme is needed to identify and remove unnecessary barriers and facilitate the uptake of connected and autonomous vehicles.

HB1-019

Target investment to the most significant challenges

36. To ensure the best possible returns from transport investment, we need to focus on addressing Auckland's most significant challenges in providing safe and efficient access to employment, addressing road and public transport congestion and supporting growth. We have identified strategic priorities for investment over the next 30 years, and where efforts should be focused in the short-term (early priorities, 2018-28).

Prioritise investments to achieve best value for money

37. Our framework for identifying early priorities is set out below. It provides a basis for assessing the extent to which different investment options will effectively target the most significant first decade challenges (as outlined in paragraph 7), and the extent to which an investment is likely to deliver value for money. The key assessment measures are the impact on throughput of people, goods and services, travel speeds, and enabling growth.

		Potential to deliver value for money in first decade		
		High	**Medium**	**Low**
Extent to which the investment targets the most significant first decade challanges	**High**	Highest priority to be progressed in the first decade	Secondary priority to be progressed in the first decade	Unlikely to be first decade priority
	Medium	Secondary priority to be progressed in the first decade	Unlikely to be first decade priority	Not a first decade priority
	Low	Unlikely to be first decade priority	Not a first decade priority	Not a first decade priority

38. Achieving best value for money requires identifying the right solution in the right part of the network at the right time. This means that investments should recognise the strengths of each part of the network:

- Public transport: access to concentrated activity centres (e.g. the city centre, major employment areas) where there is little or no capacity to take additional vehicle traffic.
- Roads: access for people, goods and services to wide transport catchments with diverse trip origins and destinations.
- Rail: providing a dual function of high capacity public transport backbone and strategic freight connections, especially to/from the Ports of Auckland and Tauranga.
- Walking and cycling: serving higher intensity areas, short-to-medium length trips and extending the reach of strategic public transport corridors.

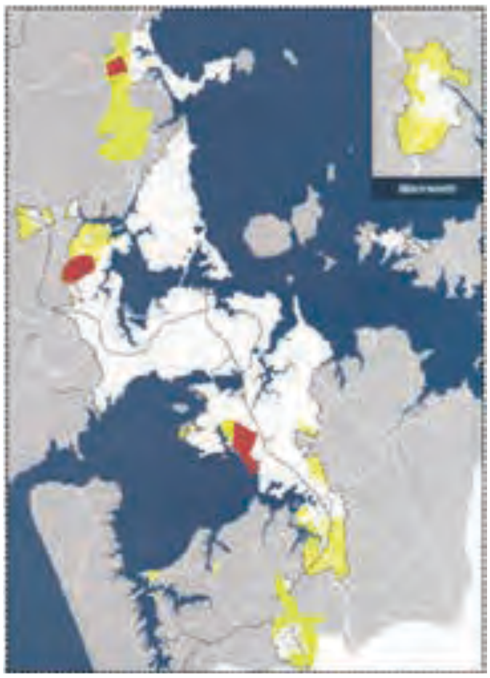
39. As we move towards a greater focus on influencing patterns of demand, investment will also be required to assist the take-up of new technologies that improve vehicle throughput and occupancy rates, and to support the implementation of smarter transport pricing. It will also be important to ensure that investments will continue to stack up in a future with much greater use of transport technology.

Enable and support growth

40. New urban growth areas in the north, west and south will need substantial investment in transport infrastructure before significant development can occur. Some of this investment is required to 'open up' land for development, alongside larger scale improvements needed to better connect these areas to the rest of Auckland.

41. Transport investment within the existing urban area is also necessary to unlock growth, by improving access and making redevelopment more market attractive.

42. We have identified a number of potential transport investments to support and enable growth. Early investment is needed in areas 'live-zoned' by the Auckland Unitary Plan and through Special Housing Area processes, and to protect routes and secure land for longer-term networks.



New future urban land

New "live zoned" urban areas

Strengthen strategic transport networks

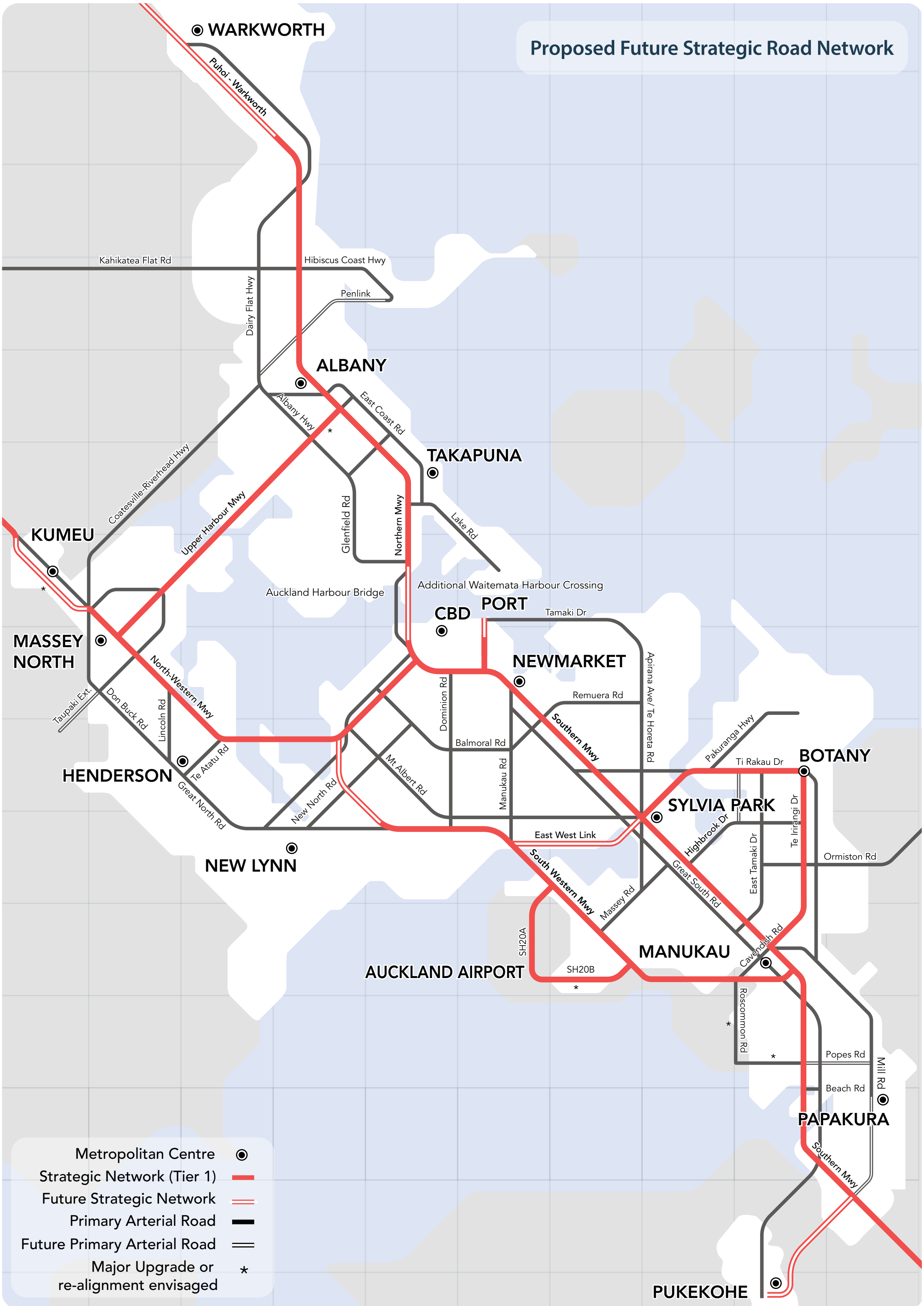
43. Auckland's strategic road, rail and public transport networks are the most critical elements of the city's transport system. It is essential to maintain and develop strong, safe and resilient strategic networks that can cope with increased demand.

44. Although there are some opportunities to add new corridors, options are limited in existing urban areas. A targeted investment approach is required to address the impacts of growth and to ensure that these core parts of the network have sufficient capacity to operate effectively.

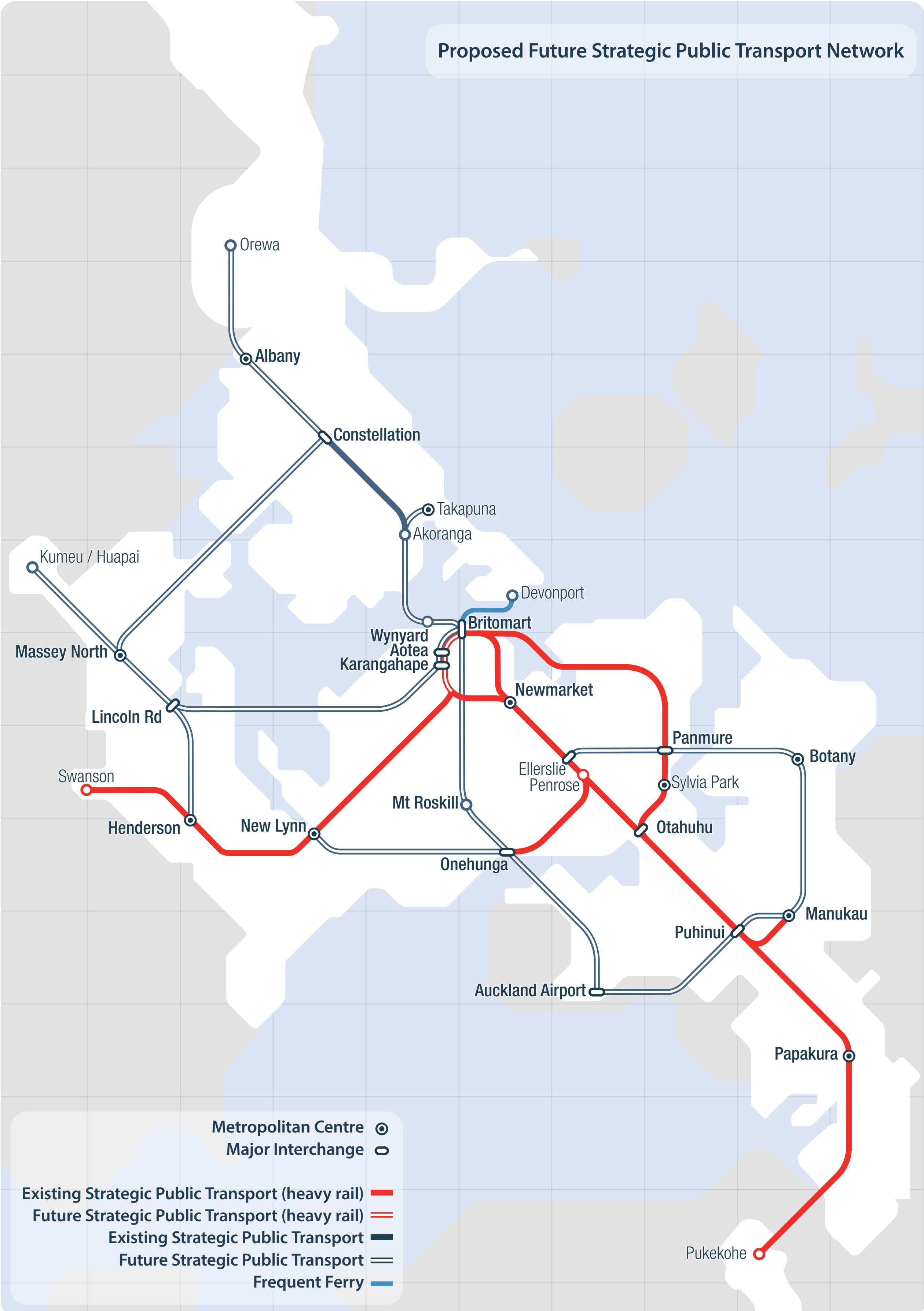
45. Our recommended approach to the development of the strategic road and public transport networks is summarised in the following table, although further work is required to determine which parts of the primary arterial road network should have strategic functions. The maps that follow illustrate our agreed view on how these networks will need to develop over the next 30 years.

	Strategic Road Network	Strategic Public Transport Network
Description	• Backbone of the road network, providing for a wide variety of travel and the highest traffic volumes. • Core links between major parts of Auckland and the rest of NZ, carries heaviest freight volumes and provides access to Port and Airport. • Through-movement of people and goods is primary consideration and access is limited or controlled.	• Backbone of the public transport network, providing for high volumes of travel to major employment centres, especially into the central area. • Frequent, high capacity services operating along corridors separated from private vehicles and unaffected by road congestion. • Passenger rail network shares corridor with freight.

Approach	• Primarily focus on improving the efficiency of existing corridors by better balancing demand and capacity.
	• Provide new corridors in greenfield areas to support growth and improve connections to existing urban areas.
	• Focus additional capacity primarily on outer parts of the network, along the Western Ring Route and improving Port and Airport access.
	• Maximise benefits from new technology to increase vehicle throughput and occupancy levels.
		• Two key drivers for prioritising development of the strategic public transport network:
		  o Addressing emerging capacity constraints as demand increases
		  o Expanding the network to improve overall corridor efficiency and throughput.
		• Mode choice for strategic network improvements should be driven by capacity requirements to meet forecast demand, integration with the wider network and achieving value for money.


Proposed Future Strategic Road Network
WARKWORTH
Puhoi - Warkworth
Kahikatea Flat Rd
Hibiscus Coast Hwy
Penlink
Dairy Flat Hwy
ALBANY
Albany Hwy
East Coast Rd
TAKAPUNA
Coatesville-Riverhead Hwy
Upper Harbour Mwy
Glenfield Rd
Northern Mwy
Lake Rd
KUMEU
Auckland Harbour Bridge
Additional Waitemata Harbour Crossing
CBD
PORT
Tamaki Dr
MASSEY NORTH
NEWMARKET
Remuera Rd
Apirana Ave/ Te Horeta Rd
North-Western Mwy
Taupaki Ext.
Don Buck Rd
Lincoln Rd
Dominion Rd
Southern Mwy
Pakuranga Hwy
Balmoral Rd
Ti Rakau Dr
BOTANY
HENDERSON
Te Atatu Rd
Mt Albert Rd
Manukau Rd
SYLVIA PARK
Te Irirangi Dr
Great North Rd
New North Rd
Highbrook Dr
East West Link
Ormiston Rd
East Tamaki Dr
NEW LYNN
South Western Mwy
Great South Rd
Massey Rd
Cavendish Rd
SH20A
MANUKAU
AUCKLAND AIRPORT
SH20B
Roscommon Rd
Popes Rd
Mill Rd
Beach Rd
PAPAKURA
Southern Mwy
PUKEKOHE
Metropolitan Centre
Strategic Network (Tier 1)
Future Strategic Network
Primary Arterial Road
Future Primary Arterial Road
Major Upgrade or re-alignment envisaged

HB1-023



Proposed Future Strategic Public Transport Network
Orewa
Albany
Constellation
Takapuna
Akoranga
Kumeu / Huapai
Devonport
Britomart
Wynyard
Aotea
Karangahape
Massey North
Newmarket
Lincoln Rd
Panmure
Botany
Ellerslie
Penrose
Sylvia Park
Swanson
Mt Roskill
Otahuhu
Henderson
New Lynn
Onehunga
Manukau
Puhinui
Auckland Airport
Papakura
Pukekohe
Metropolitan Centre
Major Interchange
Existing Strategic Public Transport (heavy rail)
Future Strategic Public Transport (heavy rail)
Existing Strategic Public Transport
Future Strategic Public Transport
Frequent Ferry

Maximise new opportunities to influence travel demand

46. A stronger focus on improving the balance between transport demand and the capacity of our infrastructure and services is critical to achieve a step-change in the performance of our transport system.

47. Stronger land-use and transport integration is required to reduce the need for longer trips during peak times. Auckland's rapid growth makes this challenging, but also presents opportunities to better match housing and employment locations to transport capacity and send more consistent signals to the market about the timing and location of development.

48. New and emerging technologies also provide opportunities to influence travel demand in ways that have not previously been possible. In particular, this includes moving over time to a smarter transport pricing system, which varies charges according to time and location. There are a number of challenges that will need to be addressed to take advantage of these opportunities, but the sooner we are able to start, the earlier we can expect to see the benefits.

Better integrate land use and transport

49. Land use lies at the heart of travel demand patterns. The location of Auckland's households, employment, education facilities, port, airport, factories, distribution centres, hospitals, shops and recreation opportunities determines trip origins and destinations. Imbalances between the location of household and employment growth will increase pressure on the transport system.

50. Integrating land use and transport is necessary to:
    - Fully realise the economic benefits from population and employment growth
    - Ensure the transport network can continue to operate effectively as Auckland grows
    - Ensure value for money and good utilisation of new infrastructure and services

51. We can improve transport network efficiency through land use decisions. These decisions should aim to:
    - Encourage housing growth in areas with better access to employment and more transport options, such as around the strategic public transport network and on the isthmus.
    - Encourage employment growth where transport connections and options are strongest and where additional jobs would reduce reliance on long commutes across major transport bottlenecks, such as in the west and south.
    - Enable the consolidation of freight movements, minimise amenity impacts and ensure efficient connections to the strategic network

52. The Auckland Unitary Plan, adopted in August 2016, provides the legal planning framework for enabling growth, including future changes in land use. The Unitary Plan provides sufficient development capacity to meet Auckland's growth requirements for the next 30 years, enabling around 65% of future growth to be accommodated within the existing urban area, with greater intensification in and around centres, transport nodes and corridors. It also provides significant capacity for employment growth, particularly in major centres.

53. The balance of growth that the Unitary Plan enables between existing and future parts of Auckland matches the land-use assumptions that we have used in the project reasonably well. The main difference relates to the potential acceleration of some greenfield development in the north, but we have reflected this difference in our indicative early investment priorities.

54. Realising the Unitary Plan's capacity in a way that supports our desired land use and transport outcomes is an ongoing task that requires:

    - A more flexible and responsive approach to the planning, funding and staging of infrastructure and services to better integrate with the location and timing of development. (This includes supporting the market attractiveness of residential development and successful centres through early investment in enabling infrastructure).
    - Making sure that transport funding processes take account of the broader social and economic benefits of enabling growth.

Actively encourage increases in vehicle occupancy

55. Increasing private vehicle occupancy rates through ridesharing, carpooling and other emerging shared mobility opportunities such as shared taxis and taxi buses can help improve the transport system's performance.

56. Past efforts to increase private vehicle occupancy levels have had limited success. However, emerging technologies, particularly based around smartphone applications, provide new opportunities to overcome these challenges, by instantly connecting users with similar travel demands. When combined with the introduction of autonomous vehicles, shared mobility has the potential to fundamentally reshape the way transport is provided and consumed.

57. The private sector has led most recent advances in this area, and we would expect this to continue in future. However, public sector agencies will need to continue to encourage these initiatives by better understanding and reducing barriers, ensuring regulation enables innovation in this area, promoting pilot schemes, ensuring open access to data, and exploring opportunities to allocate road space to encourage ridesharing where it will result in greater overall throughput.

Progressively move to smarter transport pricing

58. The use of our roads is not free. The current system of charging for motor vehicle use (through petrol taxes, road user charges and vehicle registration fees) is based on the cost of providing and maintaining roads, but does not reflect differences in the true cost of travel for the individual user by time, location and mode. This "flat-rate" approach under-prices some trips, resulting in congestion, while over-pricing others. A progressive move to a pricing system that reflects the actual costs of each trip has the potential to result in much more efficient use of our existing road network, and provide better information on where investment in new capacity is required.

59. Developing technologies enable more sophisticated pricing systems than currently exist. This includes whole of network dynamic systems (the focus of our analysis) that can vary the price of travel by time and location. A system that applies across Auckland's entire road network offers the greatest potential to influence demand in a way that delivers step-change improvements in accessibility, congestion and public transport mode share. Applying charges across the whole network also reduces the likelihood of unintended consequences resulting from diverting traffic, as prices can be fine-tuned across the network to support desired outcomes.

60. A shift to smarter transport pricing would increase the cost of travel for some and reduce it for others, depending on the time and location of travel. In further work to develop smarter pricing, it will be important to fully understand where travel cost increases occur so that equity impacts can be assessed. This will require consideration of the affordability of travel, the impact of pricing on access to jobs, education and services, and any necessary mitigation, particularly for lower income residents who face long commutes.

61. Our focus has been on smarter pricing as a means of influencing demand, rather than as a revenue-raising tool. Full implementation of such a system will take some time due to its complexities, the developing nature of its supporting technology, and the need to gain community awareness and support. However, as smarter pricing is key to delivering a step-change in Auckland's transport performance, we should start laying the groundwork now, with a view to implementation within the next decade.

HB1-027

Delivering the Strategic Approach

62. The strategic approach will need to be progressively delivered through infrastructure investment, policies and services over the next 30 years. To give an indication of how the approach could be applied, we have developed an indicative package of the types of interventions likely to be required, as well as the overall scale and sequencing of investment.

63. We have focused on identifying early priorities, which roughly correspond to the 10 years from 2018 onwards when new transport and Auckland Council funding plans need to be in place; and medium to longer term priorities, which would be delivered beyond the first decade. The broad approach of the package, showing earlier and medium/later interventions is outlined below:

	Early focus	Medium and longer term focus
Make better use of existing networks	Increase productivity through enhanced network planning and management, and emerging technology	Accelerate uptake of new transport technologies to maximise productivity
Target investment to the most significant challenges	Complete committed investments, progress additional early priorities and support acceleration of growth	Address emerging capacity constraints, progressively implement strategic networks and continue to support growth
Maximise new opportunities to influence travel demand	Lay groundwork for a shift to influencing demand through smarter pricing, and encourage higher uptake of ridesharing	Progressively implement smarter transport pricing, integrating with other technology developments

Key focus areas

64. The indicative package includes a significant amount of investment in maintaining and operating the existing transport system, and in continuing to make improvements in safety and active modes through ongoing investments in these areas. In addition to these investments, we have identified six key areas where major interventions will be required to deliver the strategic approach. These are:
    - Supporting greenfield growth.
    - Addressing motorway capacity constraints.
    - Strengthening central area access.
    - Improving Airport access.
    - Enabling rail passenger and freight growth.
    - Shifting to a greater focus on influencing travel demand.
65. The following sections briefly outline the key drivers and potential timing of these major interventions. Early priorities (for the first decade) and medium to longer term priorities (beyond the first decade) are highlighted.

Supporting greenfield growth

66. Investment is needed to open up land for development and to address the impact of increased travel demands to and from new urban areas.
67. The Unitary Plan identifies over 12,000 hectares of "future urban" zoned land, as well as a number of locations where land currently used for rural activities has been "live zoned" to enable urbanisation in the near future. In total, the Unitary Plan enables around 150,000 dwellings of feasible capacity outside the existing urban area.

Early priorities	Medium and longer term priorities
• Early investment to enable growth in areas that have been 'live zoned' in the Unitary Plan, as well as in Special Housing Areas. • Route protection, land purchase and early works to ensure future opportunities are not built out and to minimise land costs. • Progress the Northwestern Busway to increase access to and from the northwest greenfield area and increase throughput along the congested Northwestern Motorway corridor.	• Progressive implementation of future transport networks in greenfield areas, depending on the timing and rate of development. ◦ Some investments may be needed 'up front' to unlock growth capacity, help shape land use and support the establishment of successful town centres. ◦ Other investments can be provided later, once growth has occurred, in response to capacity constraints. • Ongoing monitoring of the impacts of greenfield growth on travel patterns and refinement of when interventions are required.

Addressing motorway capacity constraints

68. Parts of Auckland's motorway network experience substantial congestion, both at peak times and increasingly throughout the day. Completion of the Western Ring Route, through the Waterview Connection and other committed motorway upgrades, will ease pressure on State Highway 1 and improve network resilience by providing an alternative north-south route. However, projected growth in travel means the motorway network will remain under significant pressure.

69. The inner part of Auckland's motorway network has the highest traffic volumes in the country, but is physically constrained – particularly along State Highway 1 between Takapuna and Mt Wellington where the motorway pushes up against high intensity and high value development, coastlines and other major infrastructure (such as railway lines). Limited capacity additions on this part of the network can provide some local benefits, but appear to shift bottlenecks and congestion points, rather than address them. Conversely, increasing capacity along entire corridors involves significant land acquisition, extremely high costs and potentially major amenity impacts.

70. A major new eastern strategic corridor would provide significant access and congestion benefits, but its extremely high costs suggest this will not be cost-effective in the next 30 years. However, given Auckland's ongoing growth it is prudent to retain existing route protection.

71. The Auckland Harbour Bridge forms a critical part of the motorway network as the main connection between the North Shore, the city centre and locations further south. Growth in freight, private vehicle and public transport use of the bridge will create a number of future challenges, particularly as providing an additional harbour crossing will involve very high costs. It is important to continue the work currently underway to protect the route for a new harbour crossing in a way that integrates potential future road and public transport requirements.

Early priorities	Medium and longer term priorities
• Ensure maximum network-wide benefits from completion of the Western Ring Route by providing for capacity upgrades at each end to address bottlenecks, optimising its performance and ensuring it integrates with the East-West Link. • Public transport investments, including the City Rail Link, extending the Northern Busway and accelerating the Northwestern Busway, to assist in taking pressure off the motorway network at peak times, especially for trips heading to the city centre. • Upgrades to outer parts of the motorway network, particularly to the northwest and the south, to enable and support growth.	• Ongoing targeted widening in outer parts of the network to enable and support growth. • Support developing vehicle technologies, increasing vehicle occupancy rates and smarter transport pricing to enable existing motorways to be used far more efficiently. • Progress cross-harbour improvements in a way that provides enduring benefits along the broader north-south corridor, integrates with public transport, and provides value for money. • Maintain existing route protection for an additional north-south corridor which may be needed beyond the 30-year timeframe.

Strengthening central area access

72. The city centre and its surrounds (including Newmarket) is New Zealand's largest employment hub and is projected to grow strongly over the next 30 years to reach nearly a quarter of a million jobs. This growth, expected to be largely driven by highly productive service-sector jobs, will be accompanied by a substantial projected increase in tertiary student numbers and continued household growth.

73. Access to this area is physically constrained, and there is competition for limited street-space between vehicles, pedestrians, cyclists and public amenity. This means it is imperative over time to move more people in fewer vehicles. This requires a continued modal shift towards public transport, walking and cycling.

74. Although bus efficiency improvements can help cope with increased demand in the short term, there are limits to the extent to which such improvements can continue to provide sufficient capacity. A mass transit solution will be required in the medium term. Key criteria for determining the best long-term solution should be the ability to meet projected demand in a way that integrates with the broader strategic network, provides for and stimulates ongoing growth along these corridors and in the city centre, and delivers value for money.

75. The Port of Auckland is located on the edge of the central area and is a significant freight origin and destination including for high-value imports that travel by both road and rail to and from other parts of Auckland and New Zealand. Consistent with the conclusions from Auckland Council's recent Port Future Study, we have assumed the Port will remain in its current location within the 30-year period of this project. In the meantime, strong growth in freight demand which is competing with general traffic congestion, needs to be addressed. Connections between the Port and the strategic road network could be improved, and growth in demand for rail passenger and freight services will progressively impact on the efficient operation of the Port.

Early priorities	Medium and longer term priorities
• City Rail Link and associated further rail improvements will cater for a substantial proportion of increased trip demand into the central area over the next decade and beyond. • Bus efficiency improvements on city centre corridors serving the north, northwest and central isthmus will provide additional capacity to address growth demands over the next decade. • Port access improvements focused on improved efficiency between the Port and the motorway network. • Improvements to the core rail network to enable passenger and freight to operate reliably together.	• Invest in additional mass transit capacity to relieve demand pressures on bus corridors serving the isthmus; followed by those serving the North Shore. • Improvements to Port access from the motorway network.

HB1-031

Improving Airport access

76. The Airport area is nationally significant. It is New Zealand's primary international gateway, the country's third largest port by value of goods and a major and growing employment centre. Substantial employment growth in the broader Airport area, combined with growing passenger and freight flows, is projected to result in an increase in daily trips to and from the area from 63,000 currently to around 140,000 over the next 30 years.

77. Providing for this growth in travel demand is challenging due to the Airport's location in the southwest corner of Auckland's urban area, the limited number of access points, the dispersed nature of trip origins and destinations within the broader Airport area, and the long average length of inbound and outbound trips.

78. Substantial access improvements are currently underway to extend the motorway from the north to the Airport's edge and future-proof the route for a higher capacity public transport mode. This is expected to ease congestion on the northern access corridor for some time. Capacity improvements are also required on the eastern access route, to address congestion and improve access from the east and south. These initiatives need to be supplemented with ongoing improvements in public transport services.

79. Over time, space constraints within the Airport area and capacity challenges on the broader road network make it increasingly difficult to serve the Airport area's transport demands through road and bus service improvements alone. This will require investment in mass transit, and route protection to enable this needs to be an early priority.

Early priorities	Medium and longer term priorities

• Complete access improvements from the north to extend the motorway to the Airport's edge.
• Increase capacity of the strategic road network from the east (including provision for public transport), which will also improve access from the south.
• Increase bus services and frequencies (especially for employees in the area), and extend bus lanes to improve reliability.
• Protect the routes for future mass transit corridors linking the Airport with the north and the east.
	• Implement mass transit following consideration of:
	  ◦ Required capacity to meet demand generated by Airport passenger and employee growth
	  ◦ Integration with the strategic public transport network (especially isthmus mass transit to the north)
	  ◦ Timing of major improvements to the Airport's internal road network.

Enabling rail passenger and freight growth

80. Auckland's rail network, combined with the Northern Busway, forms the core of the city's strategic public transport network. Investment over the past 15 years has resulted in impressive growth in passenger numbers, with rail accounting for a growing proportion of public transport trips. The network also plays a key role in the movement of freight, particularly to and from the Ports of Auckland and Tauranga. Continued strong growth in passenger trips and freight carried by rail is forecast over the next 30 years.

81. Ongoing investment will be needed to provide an integrated and resilient rail network that can effectively provide for projected growth in passenger and freight demand and Auckland's planned passenger service patterns. Auckland Transport and KiwiRail have developed a 30-year indicative Rail Development Plan that identifies the investments needed to deliver this.

Early priorities	Medium and longer term priorities

• The City Rail Link will provide benefits for rail passengers through significant reductions in travel times, particularly from the west, improved access to the city centre and increased capacity by removing the current Britomart bottleneck.
• Other key short term improvements likely to be required include:
  ◦ Additional infrastructure including a third track to address key capacity constraints and enable passenger and freight services to operate reliably
  ◦ Additional trains to cater for growing passenger numbers
  ◦ Removal of some road/rail level crossings to better manage safety risks and address road congestion
  ◦ Extension of electrification to Pukekohe to serve growth in the south.
	• Depending on demand, longer term improvements are likely to include:
	  ◦ Providing a fourth track between Wiri and Westfield
	  ◦ Further extension of triple-tracking to Papakura and potentially Pukekohe
	  ◦ Potential extension of the fourth main to Papakura
	  ◦ Further tranches of additional trains and a second depot
	  ◦ Ongoing level crossing removal programme.

Shift to a greater focus on influencing travel demand

82. Shifting to a greater focus on influencing travel demand should commence with early work to develop a pathway for moving to smarter pricing. This includes developing a basis for assessing the potential impacts on different users of the transport system, including affordability and equity considerations, and how access to jobs, education and services could best be met under such a system.

83. Work will also be needed to address the implications for the current national system of charging for transport use, the case for legislative change to enable charging for use of existing roads, the technology options, and ultimately the development of a work programme for implementation.

Early priorities	Medium and longer term priorities
• More detailed assessment of the benefits and impacts of smarter pricing, particularly net user effects, affordability, equity and any necessary mitigation. • Develop an implementation pathway that includes consideration of technology, national implications, legislative requirements, staging and trials; and progress priority actions. • Investment in intelligent transport systems to enable increased productivity, and smarter pricing. • Increased use of non-pricing demand management measures, such as high-occupancy lanes.	• Full implementation of smarter transport pricing. • Increased capacity of the public transport system where necessary to accommodate shifts in demand as a result of smarter pricing.

Indicative investment package

84. The indicative package illustrates how the strategic approach could be implemented over time. It is not an 'investment programme', as neither the Government nor Auckland Council are able to commit to funding over 30 years and all transport investments need to go through business case approval and statutory processes to proceed. We have placed greater emphasis on the first 10 years (2018 to 2028) because of considerable uncertainty about the rate and location of housing and employment growth, and the timing and impacts of technological change beyond this period.

85. Committed infrastructure investments form a key part of the indicative package in the first decade. The largest committed investments are listed below, with estimated expenditure incurred during the first decade, 2018-2028[5]:

    - City Rail Link ($2 billion).
    - Puhoi to Warkworth extension of the Northern Motorway ($500 million).
    - East-West Link ($1,500 million).
    - Accelerated motorway package ($500 million), which includes:
        - Northern corridor improvements and Northern Busway extension
        - Southern Motorway improvements.
        - Airport access (northern) improvements.
    - Mill Road northern section (partly committed, $290 million).
    - Panmure-Botany Busway and roading improvements (AMETI) (partly committed, $700 million).

86. We used the prioritisation framework in paragraph 37 to assess potential new investments beyond these current commitments (including the uncommitted elements of Mill Road and AMETI). This included an assessment of the extent to which they address the most significant early transport challenges, and may provide value for money in the next decade. The indicative sequencing of major new investments is outlined in the following map and table.

87. The large scale of most of these investments means that they have long lead times (seven years or more for planning, design, procurement and construction). This highlights the need to commence work on these projects at an early stage. To reflect this, we have allocated 10% of the capital cost of projects listed as medium priorities for the first decade.

88. In addition to these major investments, the indicative package also includes a significant amount of expenditure on safety programmes, walking and cycling, and minor road and public transport improvements. It also includes provision for maintaining and operating the transport system and asset renewals, and an allowance for additional expenditure as a consequence of growth in the asset base and user demand.

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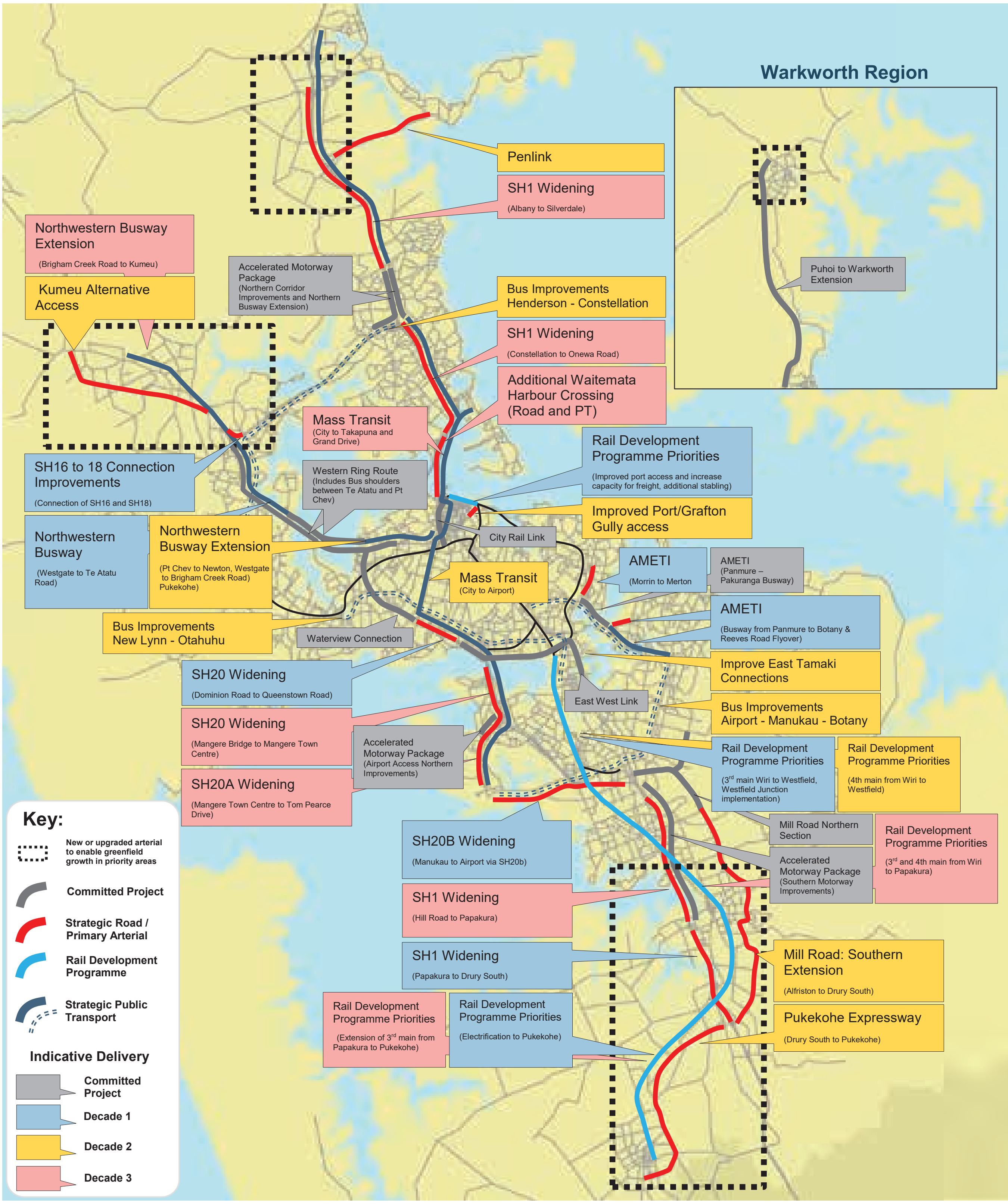
[5] Does not include costs incurred up to 2018. Puhoi to Warkworth reflects estimated Public-Private Partnership costs during 2018-28.

Indicative priorities for major new investments		
Early priorities (completion in decade 1)	**Medium term priorities (completion in decade 2)**	**Longer term priorities (completion in decade 3)**
• Northwestern Busway (Westgate to Te Atatu section). • Address bottlenecks on Western Ring Route (SH20 Dominion Rd to Queenstown Rd) and Southern Motorway (Papakura to Drury). • New or upgraded arterial roads to enable greenfield growth in priority areas. • Protect routes and acquire land for greenfield networks. • Complete SH16 to SH18 connection. • Early Rail Development Plan priorities (see paragraph 81). • Upgraded eastern Airport access (SH20B). • Investments to enable smarter pricing. • Increased investment in Intelligent Network Management. • Progress advance works on medium-term priorities.	• Continued investment to enable greenfield growth. • New strategic roads to Kumeu and Pukekohe. • Implementation of mass transit on isthmus and then to the Airport. • Bus improvements Airport – Manukau – Botany. • Improved access to Port/ Grafton Gully. • Northwestern Busway extensions. • Improve connection between East-West link and East Tamaki. • Penlink. • Medium-term Rail Development Plan priorities.	• Continued investment to enable greenfield growth. • Southern Motorway improvements south tof Manukau. • Southwest Motorway (SH20) improvements and improved northern Airport access. • Northern Motorway widening. • Waitematā Harbour crossing improvements, including mass transit upgrade of Northern Busway. • Longer term Rail Development Plan priorities.

ATAP Indicative Package: Major Interventions, all decades



Expected outcomes

89. The indicative package is projected to deliver substantially better outcomes against the key project objectives of access to employment, congestion and public transport mode share, when compared to the current plan[6]. In combination, this will make a positive contribution to regional and national economic growth and productivity. The graphs below outline the projected performance of both the indicative package and the current plan, using strategic transport modelling outputs for 2013, 2026, 2036 and 2046.

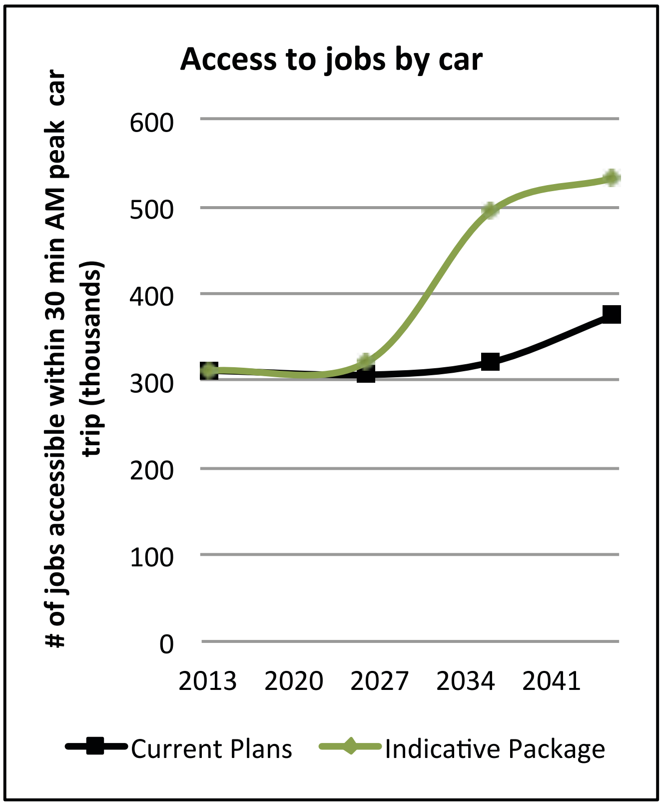
90. The use of a 2013 base year means that the model results need to be treated with some caution. Monitoring shows a significant recent increase in traffic volumes, and a decrease in average peak motorway speeds of 9% between 2013 and 2016. This suggests that the congestion and accessibility results in 2016 will already be significantly worse than indicated in the graphs below.

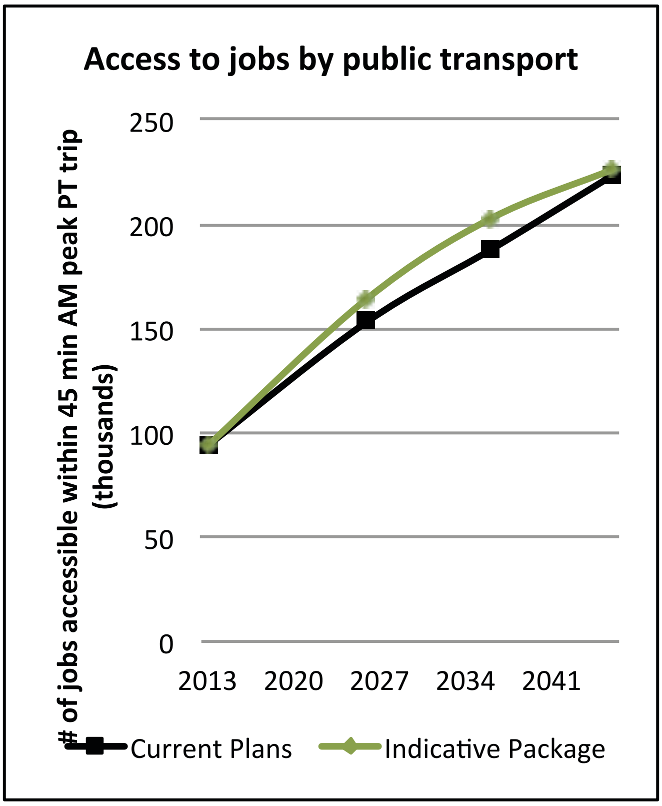
91. Our analysis shows that implementing this approach will provide better returns than the current plan. The most significant gains are increases to accessibility by car and reductions in peak congestion levels. It is important to emphasise that the 'step-change' in performance against these objectives is largely driven by the introduction of smarter transport pricing, which is assumed to be fully implemented in the second decade[7].

[6] For the "current plan", we used the 30-year investment proposals that were developed for the 2015-25 Auckland Regional Land Transport Plan and Long-term Plan. This is referred to as the "Auckland Plan Transport Network", or APTN.

[7] For modelling purposes, we tested prices ranging from 2.25 cents to 30 cents per kilometre, depending on time period, location and road type. We assumed that these charges would replace existing fuel taxes and road user charges for light vehicles (approximately 6 cents per kilometre).

92. **Access to employment[8]:** The average number of jobs accessible within 30 minutes by car in the morning peak increases sharply between 2026 and 2036, reflecting the less congested network as a result of smarter pricing. Public transport accessibility improves under both the current plan and the indicative package, so that the number of jobs accessible within 45 minutes doubles by 2036. This reflects the stronger focus on the strategic public transport network under both the current plan and, more particularly, the indicative package.



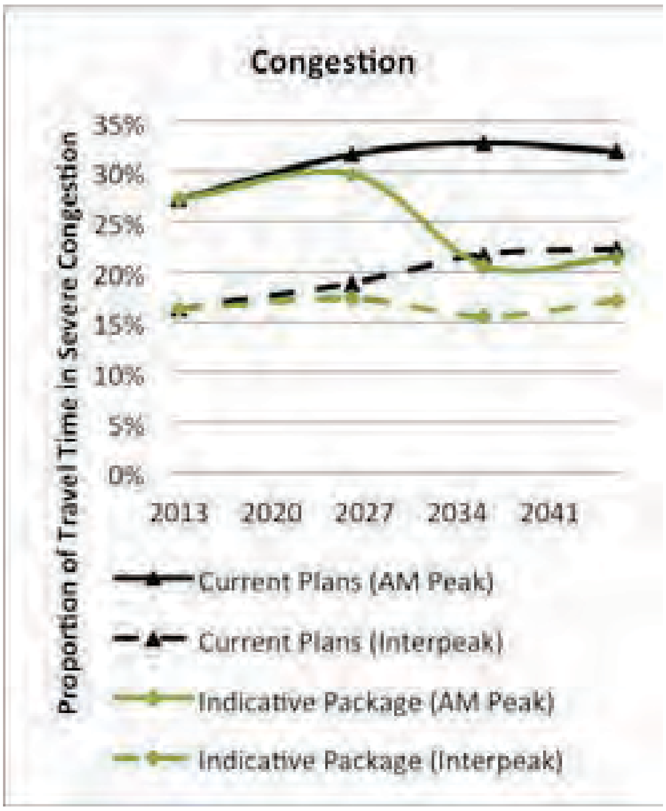


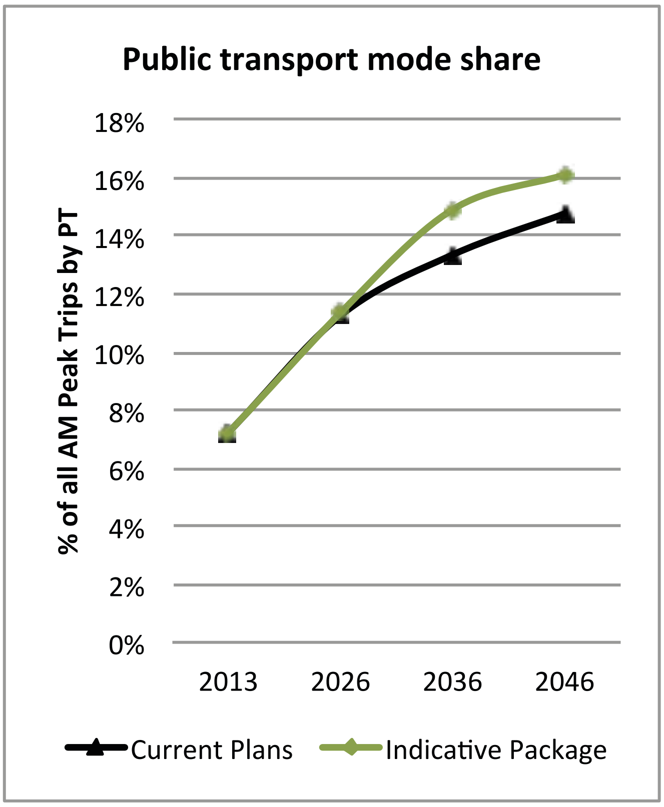
[8] Accessibility is measured as travel time rather than travel costs and therefore for this purpose does not assess the additional financial costs users face from pricing. A 30-minute car trip roughly corresponds to average journey to work time in Auckland. A 45-minute public transport trip includes walk and wait times.

HB1-039

93. **Congestion:** The proportion of travel time spent in severe congestion during the morning peak period is projected to increase from 27% in 2013 under the current plan to 32% by 2026. The indicative package performs slightly better than the current plan over this period (30%), but congestion remains higher than 2013 levels until the introduction of smarter pricing, assumed to be in the second decade. By 2036, the time spent in peak congestion falls to 21%, which is significantly better than 2013. Inter-peak congestion also shows improvement.

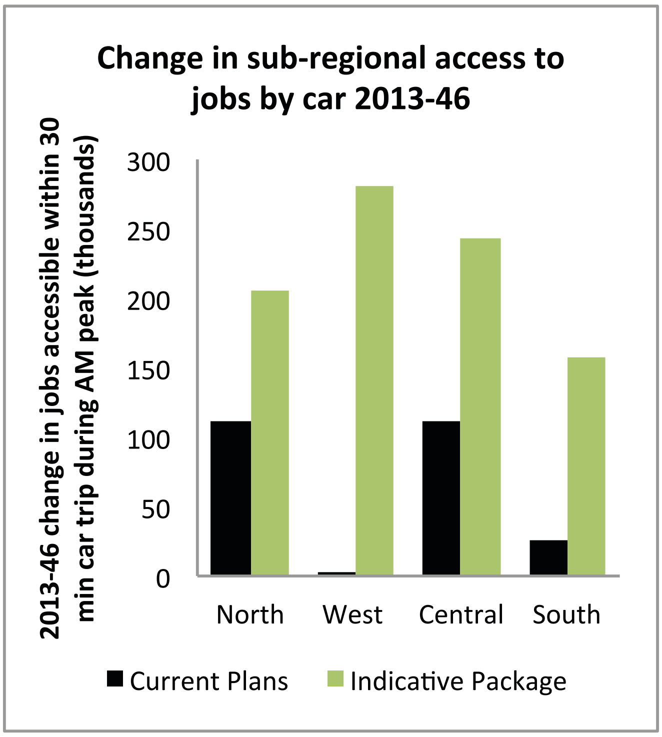
94. **Public transport mode share:** Both the current plan and the indicative package project a strong increase in public transport mode share, from 7% in 2013 to 11% by 2026. This equates to a doubling in total annual public transport tripsover that period, to around 146 million by 2026. Further improvements are projected under the indicative package, with mode share increasing to 16% by 2046 (276 million passengers).





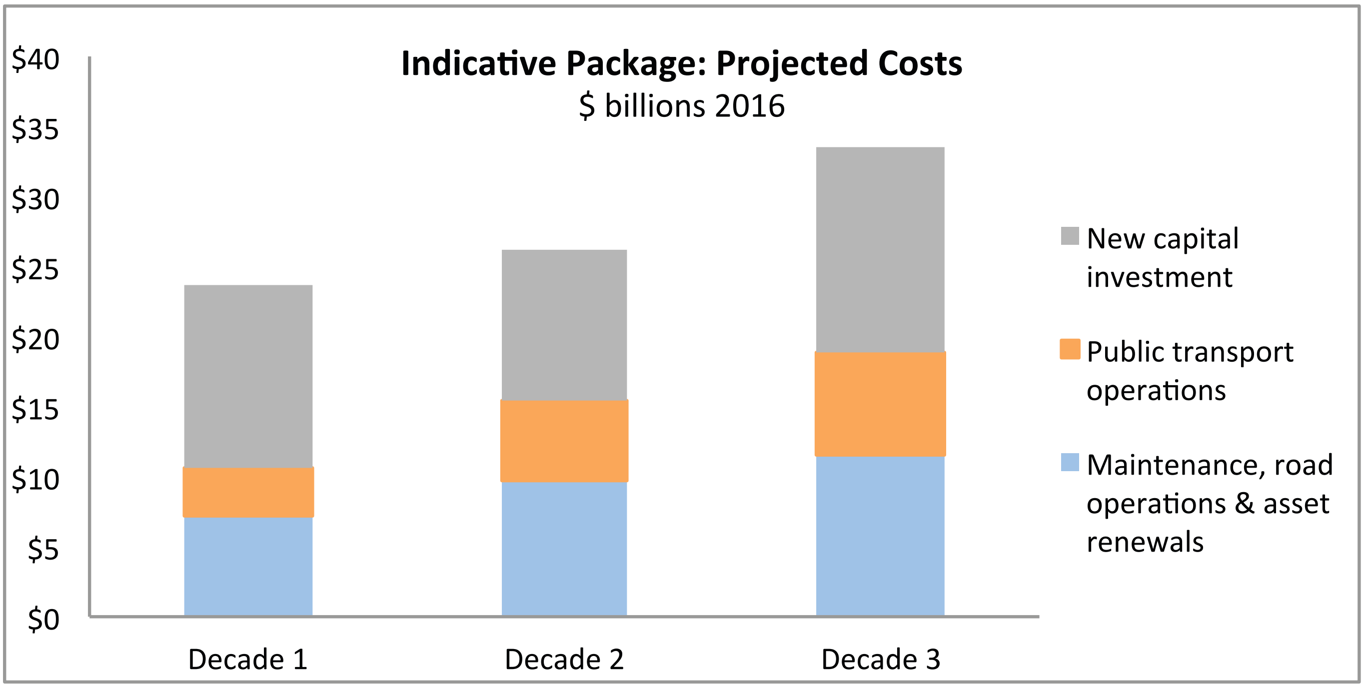
95. The indicative package also addresses some of the key sub-regional challenges facing Auckland.

96. Under the current plan, access to employment from West Auckland by a 30-minute car trip is projected to barely change over the next 30 years, despite Auckland's employment growth. However, under the indicative package the west achieves the greatest improvement in employment access, with around 280,000 more jobs being accessible compared to the current plan in 2046. In the south, the indicative package provides access to around 130,000 more jobs within a 30-minute peak trip by car than the current plan.



Cost estimates

97. The estimated expenditure to implement the indicative package in the first decade (2018 to 2028) is $23.7 billion (at 2016 prices). This includes $7.2 billion on maintenance, road operations and asset renewals, $3.4 billion on public transport operations (net of fare revenue), and $13.0 billion on new capital investment. The graph below summarises the cost estimates for these three components of the indicative package over the next three decades. A total of $84 billion of investment would be required over the 30-year period, of which $38.6 billion, or 46%, represents new capital expenditure.



98. The cost estimates show significant projected growth in expenditure on maintenance, operations and asset renewals. This reflects:
    - the increased demands of a rapidly growing asset base
    - a strong increase in projected expenditure on local road renewals in the first decade, targeted at achieving a consistent and appropriate level of service across the network[9]
    - increased public transport operating costs as a result of additional services and projected growth in passenger volumes.
99. Given the strategic nature of the project, there has been limited opportunity to fully scrutinise these cost estimates, and they should be therefore treated with some caution. In some cases, there will be opportunities to make savings, but conversely, some investments may cost more than has been estimated.

[9] Subject to review and agreement on appropriate levels of service and required funding.

Value for money

100. The project's terms of reference require consideration of the costs and benefits of alternative combinations of interventions and whether better returns can be achieved from transport investment than current plans. Value for money is normally assessed through cost benefit analysis, which measures society's willingness to pay for the various benefits that arise from an investment.

101. Before funding is committed all transport investments require a rigorous investment process to demonstrate value for money, based on robust value for money estimates as part of individual business cases.

102. We used Auckland's existing regional transport models to understand the differences in performance against our key objectives, reported above. Our analysis has shown that the recommended strategic approach will deliver better region-wide outcomes than current plans. Furthermore, our analysis showed that the indicative package would deliver significantly better results than a larger investment package that did not include smarter pricing. This suggests that the inclusion of smarter pricing is key to achieving value for money.

103. The existing modelling tools have limitations in providing detailed information on all the economic benefits that would be expected from a mix of large and complex interventions, such as those tested as part of the indicative package. For this reason, we have not relied on a package-wide benefit cost assessment based on modelling outputs.

104. Instead, we have focused on ensuring that the identified 'early priorities' are likely to provide value for money if they are implemented over the next decade. A number of these priorities have existing value for money assessments, which indicate they deliver benefits that exceed their costs.

105. Beyond these early priorities, it becomes more challenging to assess value for money, as uncertainties relating to project costs and the impacts of smarter pricing and new technologies become increasingly significant. Our most substantial uncertainty relates to large, longer-term infrastructure investments. The timing and scope of these investments should be monitored over time, particularly with regard to whether they provide value for money as we shift to a greater focus on influencing demand.

106. These caveats emphasise the need to consider the package and the implied funding gap as 'indicative'.

Funding Implications

107. A key task for the project is to provide advice on "the nature, scale and timing of any funding gap for the recommended strategic approach and its alternatives".

108. Funding for transport in Auckland comes from a variety of sources, most collected by either the Government or Auckland Council. These include fuel excise duty, road user charges, motor vehicle licensing, rates, taxes, public transport fares, parking charges, development contributions, and tolling. Under current funding policies, different types of projects have different funding sources. These are broadly outlined below:

- State highways are fully funded by the Government through the National Land Transport Fund (NLTF)
- rail network infrastructure (tracks, signals, electrification etc.) is fully funded by the Government from general taxation (except the City Rail Link, which is subject to separate negotiations)
- local roads, public transport operations (net of fares) and public transport infrastructure are jointly funded by Auckland Council and the Government, through the NLTF
- some local roads and public transport infrastructure is solely funded by Auckland Council, either because it is not eligible for NLTF funding (e.g. street cleaning or footpath renewals) or is not prioritised for co-funding from the NLTF.

109. The current funding plans (Auckland Transport's 2015-25 Regional Land Transport Plan informed by Auckland's Council's 2015-25 Long-term Plan and the NZ Transport Agency's 2015-18 National Land Transport Programme provided us with a seven-year funding estimate for 2018 to 2025. We extrapolated this out to 2028 to provide an estimate of funding from Auckland Council and the NLTF for the first decade (2018-2028).

110. The estimate of total funding available also needs to include rail network funding. Our estimate is based on the expectation that the Government will fund half the City Rail Link, and that it will also continue to fund the network infrastructure component of future rail development in Auckland, subject to business cases. The indicative package includes an estimated cost of $470 million for rail network infrastructure in the first decade, which we assume is able to be funded by the Government and is therefore not included in funding gap calculations.

111. Based on these assumptions, we estimate that the total transport funding available to Auckland is likely to be around $19.8 billion in the first decade.

112. The difference between the $23.7 billion estimated cost of the indicative package and the funding available from current plans indicates a first decade funding gap in the order of $4 billion. The actual size of the gap, and the shares that can be attributed to the Council and the NLTF will vary depending on the assumptions made, especially in relation to:

- The total size of the investment programme, including the amount spent on maintenance, operations and asset renewals.
- Whether the share of investment between Auckland Council and the NLTF follows recent trends, or changes over time.

113. Further work will be needed to understand the implications of these different assumptions on the quantum of additional funding that will be needed from the Council and the NLTF, and to determine the options that are available for the Council and the Government to address the funding gap.

114. We have not calculated a funding gap beyond the first decade, due to greater uncertainty about the timing of longer-term interventions and the lack of any current funding plans against which to compare the package.

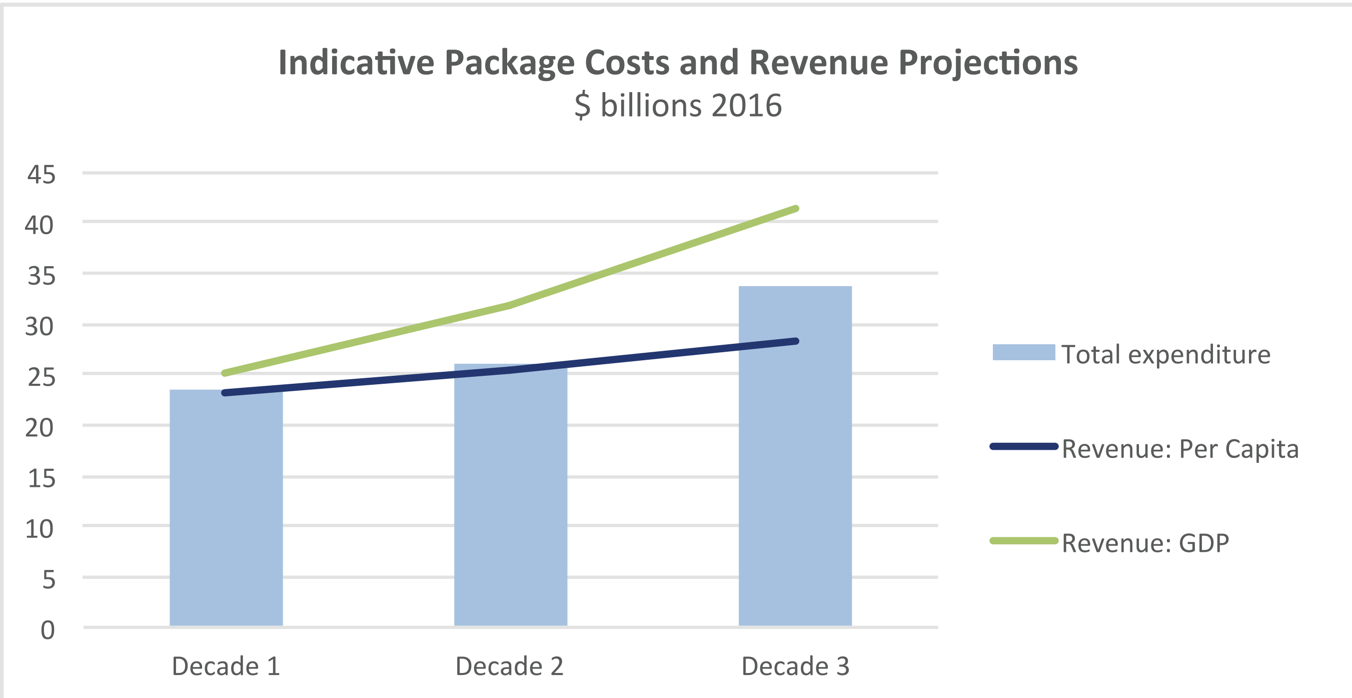
115. However, we developed two scenarios to understand the potential funding that could be available in the longer term to help understand the potential affordability of the indicative package.

116. Taking 2012-2015 expenditure levels as a baseline, our scenarios were:

- A "Per Capita" scenario, where future transport expenditure increases in line with Auckland's population (i.e. the amount invested per Aucklander remains the same, but the total continues to increase in line with Auckland's population growth).
- A "GDP" scenario, where future transport expenditure increases in line with Auckland's economic growth (i.e. transport investment as a proportion of the Auckland region's Gross Domestic Product, or GDP, is maintained over time by increasing investment in line with economic growth)

117. Under the "Per Capita" scenario approximately $75 billion would be available for transport investment over the next 30 years compared with approximately $96 billion under the "GDP" scenario. However, in the first decade the difference between the two scenarios is only approximately $2 billion.

118. The graph below compares total expenditure estimates for the indicative package across the three decades with the revenue available under the "Per Capita" and "GDP" scenarios. In each decade, total expenditure would be higher than the "Per Capita" revenue, but less than the share of "GDP" revenue.



Recommendations

119. Putting the strategic approach into practice will require a number of key decisions in the next few months.

We recommend that the Government and Auckland Council:

- **Adopt the recommended strategic approach, which contains the following key components:**
  a. **Make better use of existing networks**
  b. **Target investment to the most significant challenges**
  c. **Maximise opportunities to influence travel demand**
- **Implement the recommended strategic approach by:**
  a. **Reflecting the strategic approach in statutory documents**
  b. **Considering options for addressing the funding gap**
  c. **Laying the groundwork for smarter transport pricing**
  d. **Ensuring supportive investment processes**
  e. **Taking steps to maintain ongoing alignment**
  f. **Completing work on priority actions as soon as possible**

120. Reflecting the strategic approach in statutory strategic documents (the next Government Policy Statement for land transport and the forthcoming refresh of the Auckland Plan) will ensure future policy and investment decisions are aligned with this approach. These documents give guidance to statutory funding and planning documents prepared by Auckland Transport, Auckland Council and the NZ Transport Agency.[10]

We recommend the Government, Auckland Council, Auckland Transport and the NZ Transport Agency incorporate the strategic approach into their statutory strategic documents.

121. Our estimates suggest an indicative funding gap of around $4 billion in the first decade. To implement the strategic approach, this gap needs to be bridged. A number of options are available.

122. Additional funding could be provided, by either increasing funding available for transport from current funding sources or through introducing new funding tools. The merits of these options need to be jointly considered in a timely manner, so that clarity is provided to the 2018 funding plans.

123. Both the Council and Government will need to consider what this means for their current funding arrangements, and to identify future options for joint consideration.

We recommend the Government and Auckland Council work together to consider options and agree on an approach to address the funding gap by mid-2017, to inform statutory funding documents.

[10] Auckland Transport's Regional Land Transport Plan and Regional Public Transport Plan, NZ Transport Agency's National Land Transport Programme and Auckland Council's Long-term Plan.

124. Progressively shifting to smarter transport pricing is crucial to achieve a step-change in the performance of Auckland's transport system. We believe that preparatory work on smarter pricing should be progressed with urgency, to develop an ambitious but feasible programme for implementation. The first key step along this pathway is to establish a dedicated smarter pricing project that leads to:

- more detailed assessment of the benefits and impacts of smarter pricing, particularly net user effects, equity and any necessary mitigation
- development of an implementation pathway that includes consideration of national implications, legislative requirements, technology, staging and trials.

We recommend the early establishment of a dedicated project to progress smarter transport pricing with a view to implementation within the next 10 years.

125. Transport investment processes need to ensure the best performing interventions are prioritised for funding, regardless of type. Funding arrangements would benefit from greater consistency, particularly across the strategic networks. This includes moving to consistent and integrated decision-making for rail.

We recommend investment processes are reviewed to ensure they align with the strategic approach.

126. Achieving an aligned strategic approach through this project has demonstrated the value of establishing an agreed set of objectives, measures, problem definitions and assumptions. A continuation of this collaborative approach is recommended as ongoing review will be important as land use and population growth projections are adjusted.

127. The requirement for six-yearly reviews of the Auckland Plan provides a possible opportunity to incorporate a review of the strategic approach. The Government and Auckland Council should further consider how we review the strategic approach over time, including whether statutory changes are required.

We recommend the Government and Auckland Council consider whether statutory changes are required to support ongoing joint strategic transport planning.

128. We have identified a number of high priority actions that should progress over the next 12 months to support the strategic approach. These are set out in the following schedule.

We recommend that the identified priority actions be completed as soon as possible.

Action	Responsibility
• Agree the location of key routes where through-movement should be prioritised, as well as a target for improved productivity on these routes. • Complete and implement a framework for managing competing uses on these routes, through traffic management actions and investment priorities.	Auckland Transport and NZ Transport Agency (with Auckland Council).
• Agree appropriate asset management levels of service, associated funding requirements and provide improved visibility of the trade-offs from different levels of asset management investment.	Auckland Transport and NZ Transport Agency.
• Develop a shared work programme to facilitate the uptake of new transport technologies, including intelligent network management, connected and autonomous vehicles, and shared mobility; with a focus on enabling regulation, supporting infrastructure and trials.	Ministry of Transport, NZ Transport Agency and Auckland Transport.
• Consider how government transport funding processes should reflect the benefits of enabling growth.	Ministry of Transport and NZ Transport Agency (with Auckland Council and Auckland Transport).
• Complete business cases for each of the high priority interventions identified in this report, to enable early decisions on funding, timing and route protection to proceed as soon as possible.	Auckland Transport and NZ Transport Agency.

Find out more:
transport.govt.nz/atap
aucklandcouncil.govt.nz/atap

Auckland Transport Alignment Project (ATAP) 2020 Update

Terms of Reference

1 Parties

1.1 The Minister of Transport, the Hon Phil Twyford

1.2 The Minister of Finance, the Hon Grant Robertson

1.3 The Mayor of Auckland, Phil Goff

1.4 The Deputy Mayor of Auckland, Bill Cashmore

1.5 The Planning Committee Chair, Auckland Council, Chris Darby

1.6 Chair of the Independent Maori Statutory Board, David Taipari

2 Background

2.1 The Auckland Transport Alignment Project (ATAP) commenced in 2015 and aligned the priorities of both central government and Auckland Council. Initial work developed a long-term strategic approach for the development of Auckland's transport system to deliver the best possible outcomes for Auckland and New Zealand.

2.2 Since 2015, various projects have been undertaken collaboratively by the ATAP partners including developing indicative investment packages.

2.3 The most recent investment package for 2018 to 2028 was agreed by Cabinet and Auckland Council in April 2018.

3 Purpose of the project

3.1 There is a need to update the 2018-28 ATAP package in light of a number of emerging considerations. These include:

- The impacts of Covid-19, including the impacts on Government and Auckland Council revenue streams
- Any decisions taken on the economic stimulus package announced by the Government within the timeframes of the ATAP 2020 update
- The New Zealand Upgrade Programme (NZUP) transport investment in Auckland
- Climate change and mode shift as increasingly significant policy considerations for both the Government and Auckland Council
- The need to provide direction for the upcoming round of statutory planning processes including the Regional Land Transport Programme (RLTP), Auckland

Council's Long-term Plan (LTP), the Government Policy Statement on Land Transport, and the National Land Transport Programme

- Emerging spatial priorities.

3.2 The ATAP 2020 Update will use the agreed decade one (2018-28) package of projects as a base given the existing commitment to its delivery.

3.3 This project will not replace the statutory decision-making responsibilities of Auckland Transport regarding the activities within the Auckland Regional Land Transport Plan or the NZ Transport Agency regarding the National Land Transport Programme or KiwiRail regarding the Rail Network Investment Plan . It will also not replace the statutory decision-making responsibilities of Auckland Council regarding the development of its Long-term Plan and/or associated with the application of its Regional Fuel Tax.

4 Government and Auckland Council Priorities

4.1 The shared Government and Auckland Council objectives for transport in Auckland are:

- Enabling Auckland's growth through a focus on intensification in brownfield areas and with some managed expansion into emerging greenfield areas
- Accelerating better travel choices for Auckland (modeshift)
- Better connecting people, places, goods and services
- Improving resilience and sustainability of the transport system and significantly reducing the greenhouse emmissions it generates
- Making Auckland's transport system safe by eliminating harm to people
- Ensuring value for money across Auckland's transport system through well targeted investment choices.

4.2 In addition to the objectives above, the ATAP 2020 Update will consider modeshift, climate change, emerging brownfield and greenfield spatial priorities and transport investments in light of the Covid-19 economic shock.

4.3 ATAP 2020 will also take into account broader priorities outlined in relevant statuary documents such as the draft Government Policy Statement on Land Transport (2021-2031) and Auckland Council's Auckland Plan.

5 Project Approach and Scope

5.1 The project will take a collaborative partnership approach aimed at agreeing an indicative prioritised investment package for Auckland. Phase one of the work will focus on the 2021-2031 period with the aim of providing advice to council and government prior to the government elections in September. Decisions on the recommended package are expected to be made post the elections. Work on decades two and three (2031-2051) at a more indicative level will commence once decisions are made on the 2021-2031 period.

5.2 Packages of investment will be developed and evaluated within funding envelopes based on logical assumptions of expected funding levels. The impacts of Covid-19 on revenue streams and on delivery of the ATAP programme will be assessed .

5.3 The 2021 to 2031 work includes six workstreams, all of which will incorporate advice on the impacts of Covid-19:

- *Prioritisation and evaluation.* This workstream brings together all of the work to develop indicative package(s) of investment that meet the objectives and considerations outlined in section 4. It will determine a prioritisation and evaluation methodology. Packages of priority projects will be developed and funding envelopes applied . The extent to which packages achieve modeshift will be a key part of the evaluation framework.

- *Climate change.* This will determine how a climate change lens can be applied to assessing ATAP projects.

- *Operating expenditure.* This will focus on the operating expenditure component of the package, particularly in terms of maintaining service levels and identifying consequential operational expenditure arising from capital investments.

- *Operationalising ATAP.* This will identify and review any operational rules that may impede the implementation of ATAP and seek agreement on ways to resolve these.

- *Funding.* This will determine the funding envelope for 2021-31, covering funding from Government, Auckland Council and other sources. Initially assumptions based on Covid19 recovery scenarios will guide this work.

- *Urban Development.* This will ensure urban development and land-use considerations underpin the ATAP investment package.

6 Governance of the Project

6.1 The project will be led by the ATAP Governance Group, co-chaired by the Secretary for Transport and the Chief Executive of Auckland Council. The ATAP Governance Group consists of the Secretary for Transport, Deputy Secretary Treasury, the State Services Commission Deputy Commissioner Auckland , and the Chief Executives of Auckland Council, the NZ Transport Agency, Auckland Transport and KiwiRail.

6.2 The ATAP Steering Group consisting of officials from the Ministry of Transport, the Treasury, Auckland Council, the NZ Transport Agency, Auckland Transport and KiwiRail, will provide detailed direction and oversight to the project teams.

6.3 The ATAP Governance Group will:

- Approve funding assumptions
- Approve the investment options to be developed
- Approve the assessment and prioritisation framework
- Provide advice to the Parties as required
- Recommend a package to the parties with clearly defined funding sources from central and local government
- Ensure the project is delivered to the agreed scope and timeframes
- Ensure that the project is aligned and integrated with other government and Auckland Council related work as appropriate.

6.4 The ATAP Parties will:

- Provide direction to the ATAP 2020 Update through the objectives, considerations and approach set out in this Terms of Reference
- Receive updates on the work and provide feedback at appropriate points/milestones
- Build consensus on the indicative package(s) as they are developed
- Receive advice from the Governance Group on the recommended package
- Make final decisions on the recommended package.

7 Project Timing

7.1 The first phase of the ATAP 2020 Update (focused on 2021 to 2031) will provide advice to the political sponsors mid-late August, prior to government elections in September

7.2 This enables the consideration of advice prior to the elections and decision making early in the new term of government.

7.3 The work on the 2031-2051 period will commence once the work on the first decade is complete

Hon Phil Twyford
Minister of Transport

Phil Goff
Mayor of Auckland

Date: Date:

21.9.20

The Regional Land Transport Plan

Developing the 2021-31 RLTP

Auckland Transport

An Auckland Council Organisation

Purpose

- To outline the background and process for the ATAP Refresh and development of the 2021 RLTP

- To provide an opportunity for conversation on the context and key issues facing the development of 2021-31 RLTP

Auckland Transport
An Auckland Council Organisation

The ATAP Refresh Scope and Governance

What is ATAP?

- Non-statutory process to improve alignment between Council and Government about how Auckland's transport system should develop
- ATAP does not replace existing statutory processes but seeks to inform them
- ATAP takes a long-term policy approach and also provides guidance to 10 year investment priorities
- Underpins government support for funding (recognised in GPS)

Terms of Reference were signed off by the Minister and Governing Body on 14 May 2020

What is the 2020 ATAP Update?

ATAP had its genesis in 2015, and followed two council-led processes that focused on transport funding. Those processes failed to gain traction with central government, due in large part to the lack of agreement about the strategic priorities for transport in Auckland.

To date, there has been three ATAP processes with the fourth process, the 2020 ATAP Update, underway.

Original ATAP

Undertaken in 2015/16 to agree an aligned 30 year strategic approach to transport.

Extensive technical and modelling work undertaken as part of its development. Included an 'indicative package' of key investments on a decade by decade basis.

This had a $4 billion funding gap, which was not resolved.

As it was not fully funded and 'out-of-cycle', it was not adopted in an RLTP

2017 ATAP Update

10 year indicative package updated to reflect faster than expected growth.

This updated the original ATAP package, and recommended bringing forward investments to the first decade,

This increased the funding gap to $5.9 billion (in 2015 dollars).

As it was not fully funded and 'out-of-cycle', it was not adopted in an RLTP

2018 ATAP Update

Decade 1 package updated to ensure alignment with the priorities of the new government and Council's refreshed Auckland Plan.

Within planned funding levels of $28 billion.

The RLTP 2018 reflects the very close inter-relationship between the RLTP, ATAP and the Regional Fuel Tax. As they were developed almost simultaneously, they are closely aligned.

2020 ATAP Update

Update to reflect emerging issues, e.g. implications of Covid-19 and NZUP; climate change and mode shift outcomes; spatial priorities; need to provide strategic direction for LTP and RLTP.

Includes Phase 1 (2021-31) and Phase 2 (2031-51).

Project rationale and drivers

- Mode shift
- Light Rail deferred
- Climate Change
- NZ Upgrade Programme
- COVID-19
- Responding to Growth
- NLTF funding not accessed

The purpose of the 2020 ATAP Update is to:

- Establish new funding baseline
- Ensure transport package reflects council's and government's priorities on climate change and mode shift, and transport needs on emerging spatial priorities
- Help inform upcoming statutory plans i.e. RLTP 2021-31 and LTP 2021-31
- Ensure that ATAP informs and reflects recent and pending transport investment decisions, e.g. NZUP and the economic stimulus package

ATAP does not replace any statutory processes or decision-making but seeks to inform these processes.

2020 ATAP Update - Scope

Phase 1 intended to focus on the 2021-31 period, to provide advice to Council and Government prior to the government elections in September. Decisions on the recommended package are expected to be made post elections. Work on decades two and three at a more indicative level will commence once decisions are made on the 2021-31 period.

The work will involve six workstreams:

- **Prioritisation and evaluation** – bringing together the work to develop packages that meet the project's objectives and considerations
- **Climate change** – how a climate change lens can be applied when assessing projects
- **Operating Expenditure** – focussed on the maintenance of service levels and consequential operating expenditure from capital investments
- **Operationalising ATAP** – reviewing any operational rules that may impede ATAP's implementation and resolving them
- **Funding** – determining the funding envelope
- **Urban development** – ensuring urban development and land-use considerations underpin the investment package

Project Objectives

The shared council and crown objectives for transport (per Terms of Reference) are:

a. Enabling and supporting Auckland's **growth** and the **quality compact urban approach**

b. Accelerating better **travel choices** for Auckland

c. Better **connecting** people, places, goods and services

d. Improving the **resilience and sustainability** of the transport system, and significantly reducing the greenhouse gas emissions it generates

e. Making Auckland's transport system safe by **eliminating harm** to people

f. Ensuring **value for money** across Auckland's transport system through well targeted investment choices

In addition, ATAP 2020 will consider **climate change** and **mode shift** outcomes, **emerging brownfield and greenfield priorities** and the broader priorities outlined in statutory documents such as the **Auckland Plan** and **GPS**

Project Governance

ATAP Parties (Political Oversight)

- Ministers of Finance and Transport
- Mayor, Deputy Mayor and Planning Committee Chair
- Chair IMSB
- Governing Body and cabinet approve recommended investment package

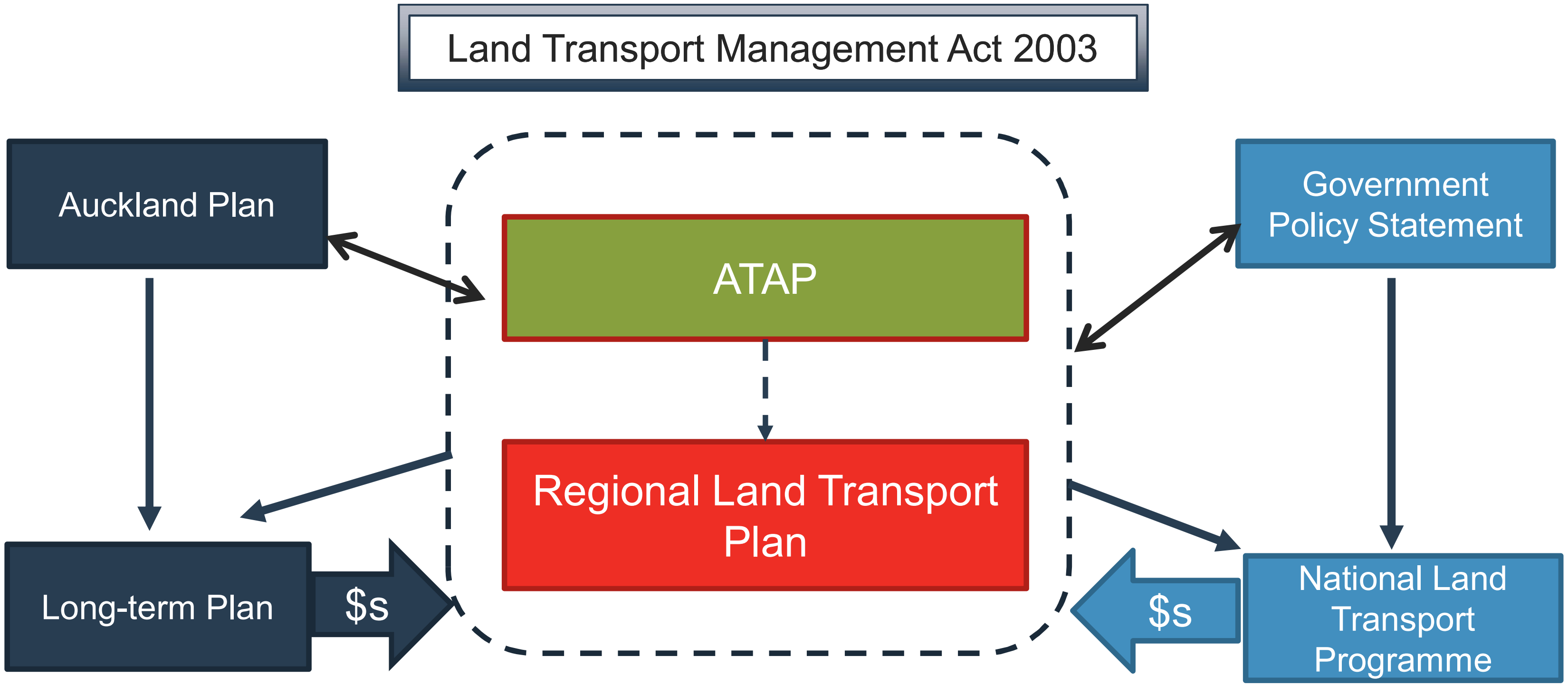
Governance Group

- Chief Executives of MoT, AT, KiwiRail, NZTA
- Deputy Secretaries of Treasury and State Services Commission
- Recognition that ATAP needs to better reflect the role of Maori as Treaty partners

Project Team

- Senior officials from participating organisations

Strategic Context for 2021-31 RLTP



Expectation that 2020 ATAP Refresh will inform the statutory processes of each agency, including 2021 RLTP

Tensions between ATAP and statutory documents such as the RLTP

Issues

- The Regional Transport Committee is not a party to ATAP
- ATAP has become progressively more prescriptive and detailed
- RLTP development needs to precede ATAP development
- ATAP historically focussed on transport investments

Response

- Seek to engage with ATAP throughout the development phase, and prior to final sign-off
- Encourage ATAP's focus to remain at strategic level
- Have a clear process to amend ATAP as RLTP and other statutory processes evolve
- Encourage ATAP to take a whole system approach

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Auckland Transport system objectives

Draft GPS and Auckland Plan Alignment with RLTP Objectives

Draft GPS 2021-31 *Strategic Priorities*	Safety	Climate Change	Better Travel Options	Improving Freight Connections
RLTP 2021-31 *Objectives*	Making Auckland's transport system safe by eliminating harm to people	Improving resilience and sustainability of the transport system	Accelerating better travel choices for Aucklanders	Better connecting people, places, goods and services
			Enabling & supporting Auckland's growth and the quality compact urban approach	
Auckland Plan 2050 *Directions*	Maximise safety and environmental protection	Including: Council climate change targets • 50% reduction in net carbon emissions by 2030 + 100% by 2050	Increase genuine travel choices for a healthy, vibrant and equitable Auckland	Better connect people, places, goods and services

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2018-2028 RLTP Recapp

RLTP 2018-28

New GPS & Auckland Plan – stronger direction to PT and active modes, and safety

ATAP –aligned central and local government on strategic direction, priorities and funding

RFT – provided substantial increase in capital funding

2018/103

Land Transport Management (Regional Fuel Tax Scheme—Auckland) Order 2018

Rt Hon Dame Sian Elias, Administrator of the Government

Order in Council

At Wellington this 27th day of June 2018

Present
Her Excellency the Administrator of the Government in Council

This order is made under section 65K(1) of the Land Transport Management Act 2003—

(a) on the advice and with the consent of the Executive Council; and
(b) on the recommendation of the Minister of Finance and the Minister of Transport

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2018 RLTP Development

Development of the 2018 RLTP began with a comprehensive multi-criteria assessment and prioritisation of all projects against ATAP objectives using the 'Integrated Transport Programme (ITP) Calculator'.

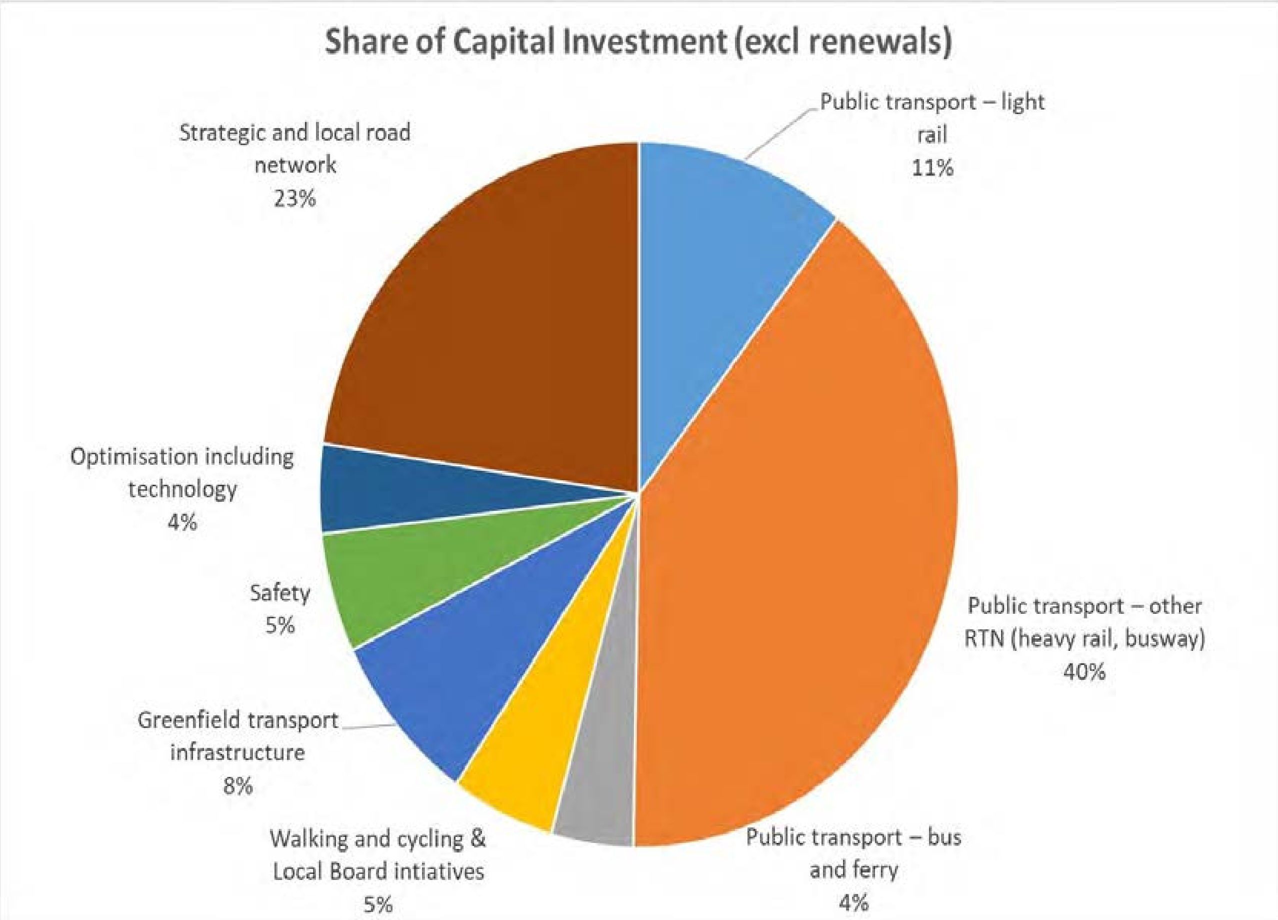
The RLTP/ATAP evaluation took into account the extensive modelling undertaken in the early ATAP processes.

This process was supported by the concurrent development of the RLTP and ATAP

A shortlist of the best projects emerging from the 'Calculator' was then further assessed by the ATAP officials group process, before final ATAP programme decisions were made by the Minister and Mayor.

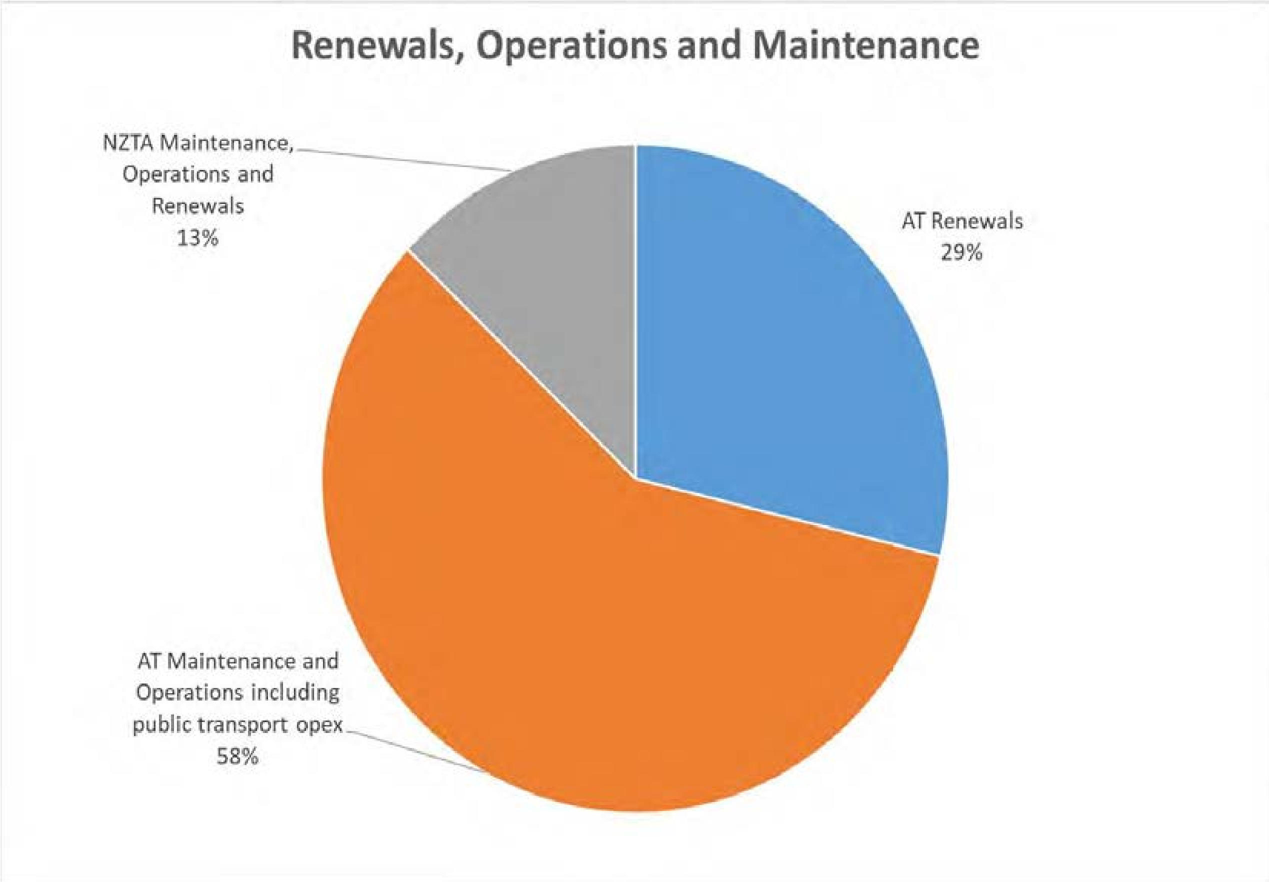
The agreed ATAP programme was adopted as part of the 2018 RLTP, albeit with the addition of a very small number of projects to reflect Council local board preferences.

Investment Package



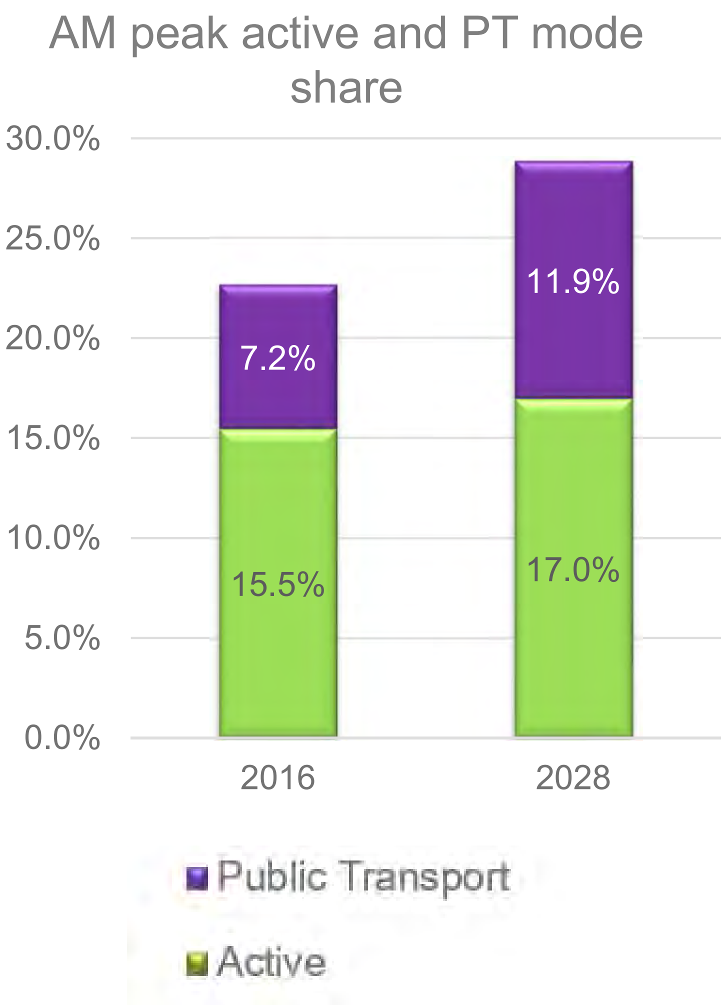
Investment Area	2018-28 Investment (inflated to year of spend)
Rapid Transit (rail, light rail, busway)	$8.4 billion
Strategic & local roads	$3.8 billion
Supporting greenfield growth	$1.3 billion
Safety programmes	$0.9 billion
Walking, cycling and local board priorities	$0.9 billion
Bus & ferry	$0.7 billion
Optimisation & technology	$0.7 billion
Asset renewals	$3.3 billion
Operations (net of revenue)	$8.1 billion
Total	$28.0 billion

2018-28 RLTP Investment Package



Package also covers renewals, maintenance and operating costs such as public transport subsidies

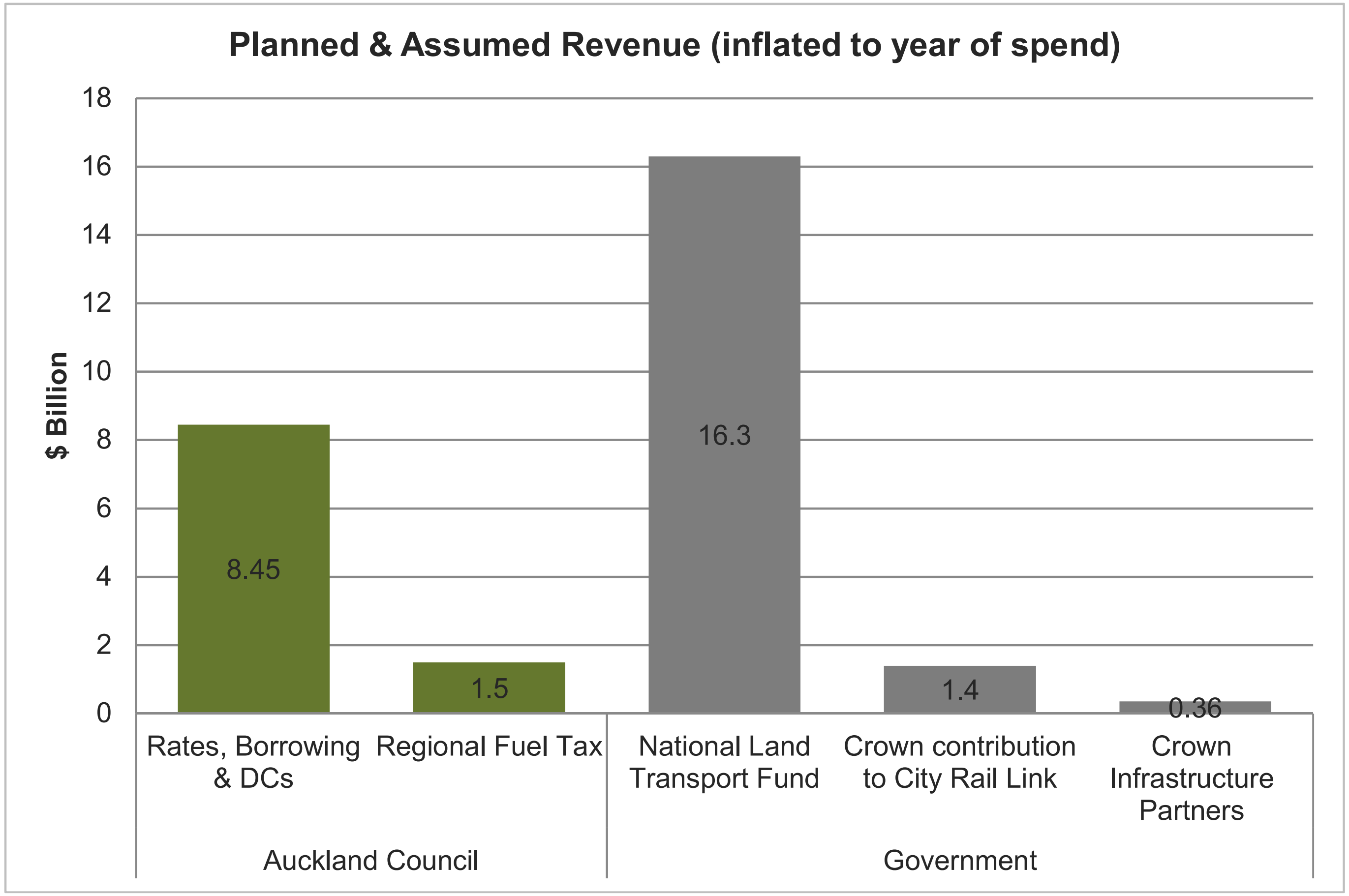
2018 RLTP Results Summary



Modelling results for the 2018-28 RLTP show:

- strong performance in morning peak mode change to PT and active modes, but less impact on daily travel
- Congestion and average travel speeds hold steady for private vehicle travel, despite population growth (although note this includes the impact of Waterview and Western Ring Route)
- Congestion reduces and average travel speeds improve significantly for PT
- Strong improvement in access to labour / employment by PT and solid improvement for access by private vehicles – although still problems in some areas
- Limited impact on greenhouse gas emissions due to population growth

Assumed Revenue 2018-28



Funding totals (excluding fees & charges):

- Auckland Council: $10 billion
- Government: $18 billion

Funding increase from previous plans:

- $1.5 billion from Regional Fuel Tax (slightly offset by lower Council borrowing)
- $364m from Crown Infrastructure Partners
- $2.8 billion more from National Land Transport Fund

Total: $4.6 billion extra funding

Auckland Regional Fuel Tax Scheme

The RFT Scheme

- Came into effect from 1 July 2018
- RFT is 10 cents per litre (+GST) for ten years

RFT is critical to funding AT's transport programme

- forecast to generate $150 million p.a. ($1.5 billion over ten years)
- enables $4.5 billion of expenditure when NLTF co-funding and Development Contributions are added
- covers 14 projects for AT - groups of projects & programmes.
- Mill Road and Penlink now funded by Government through NZ Upgrade Programme

2018/103

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NZ Upgrade Programme

Investment package of $3.5 billion for Auckland, (part of $6.8b national programme), announced by Government in January 2020

Although some projects already in RLTP, it departs from 2018 RLTP and ATAP

- Brings forward investment in Drury (Mill Rd Stage 2, Drury Stations) from second decade
- Transfers responsibility for delivery

Creates issues with alignment around Drury and Seapath/Skypath

Mill Rd & Penlink (now earlier in 2018-28 period

Full Govn Package v RLTP	Agency	Govn package	Govn proposed profile	RLTP Profile	RLTP 2018 Total
Third Rail-Wiri to Quay Park Rail Corridor Improvements	KiwiRail	**315**	starting late 2020	2018/19 - 2022/23	**173**
Papakura to Pukekohe electrification	KiwiRail	**371**	starting late 2020	2018/19 - 2022/23	**232**
Seapath	NZTA	**360**	starting 2021	2018/19 - 2019/20	**31**
Skypath	NZTA			2018/19 - 2022/23	**67**
Drury rail station and park'n'rides	AT	**247**	starting 2023		**0**
Penlink	AT	**411**	late 2021	later in 2018-28 period	**200**
Mill Road	AT	**1354**	late 2022	later in 2018-28 period for stage 1	**507**
Papakura to Bombay stage 1 (Papakura to Drury including interchange)	NZTA	**423**	starting late 2020	2018/19 - 2024/25	**412**
Total		**3481**			**1622**

Impact of the Future of Rail Review and Land Transport (Rail) Legislation Act

The Future of Rail Review introduces:

- A *New Zealand Rail Plan* that articulates the Government's priorities emerging from the Review. These will need to be considered when determining Auckland Transport's rail investment programme
- A Rail Network Investment Plan that shows KiwiRail's proposed investments. KiwiRail's proposed investments would be included in the RLTP, but for co-ordination purposes only. The Plan would be approved for funding by the Minister of Transport rather than through NZTA's processes.
- KiwiRail would appoint a non-voting member to Regional Transport Committees (RTC), including Auckland's RTC

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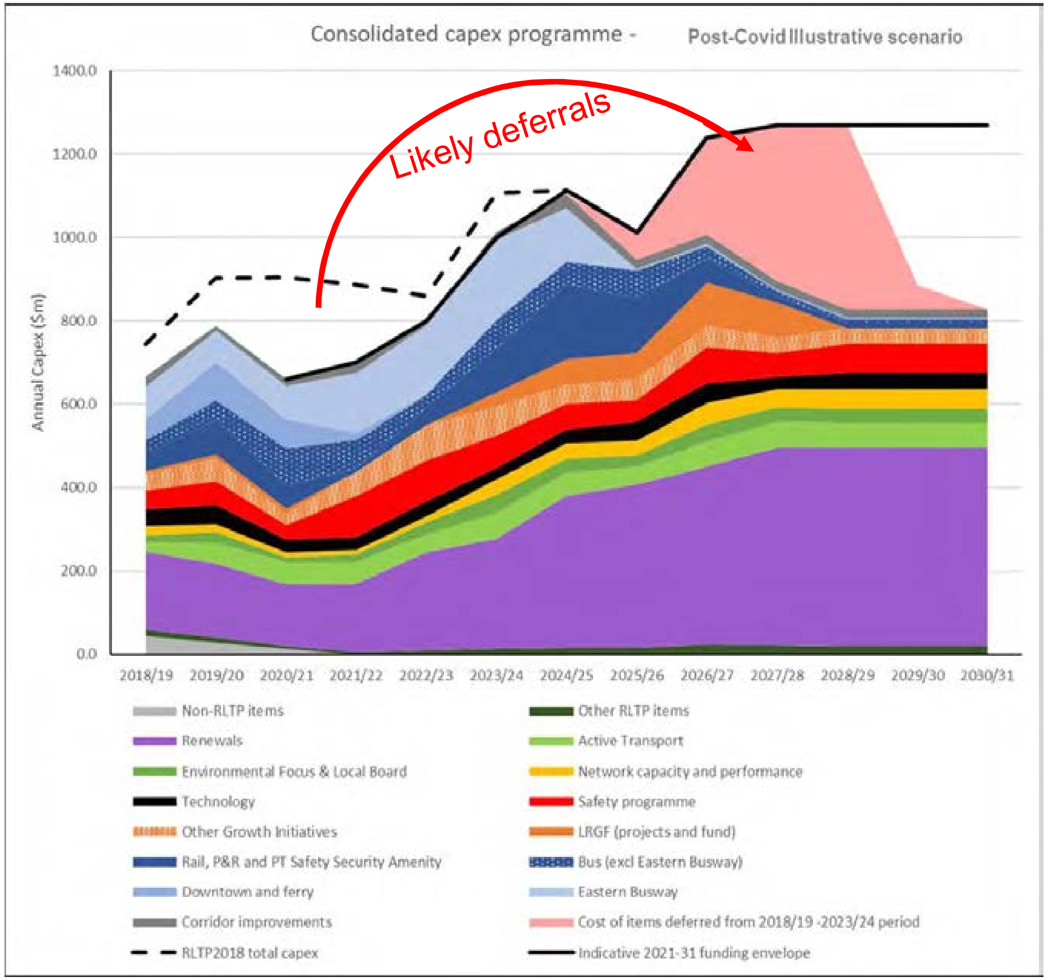
Funding context

Funding Context for ATs programme

- Council has advised estimated capex contribution of $5.1 bn for AT's programme 2021-31, including reductions for first three years
- This suggests ten year capex 2021-31 of around:
  - $10.2 bn under 50/50 NZTA scenario
  - $8.5 bn under likely NZTA funding scenario
- **Likely need to defer items from FY21-24 into period post FY26**, consuming headroom provided by transfer of Penlink and Mill Rd to NZUP
- Inflation costs and cost increases to existing projects (potentially a total of $0.5bn) will put further cost increases on the programme
- ***Likely that there will be relatively little unallocated funding available for new projects or increases to existing programmes, leading to a shift in emphasis to reprioritising the 2018-28 programme***



Other funding assumptions

ATAP estimates for National Land Transport Fund (NLTF)

- funding envelope for ATAP 2020 update estimated at between **$16.1 - $16.9 billion.**
- Estimate is based on population share.
- Similar to estimate used in 2018 ATAP, which included $1.8 billion for light rail and $0.8 billion for East-West link

Government funding for CRL and NZ Upgrade Programme is additional to this.

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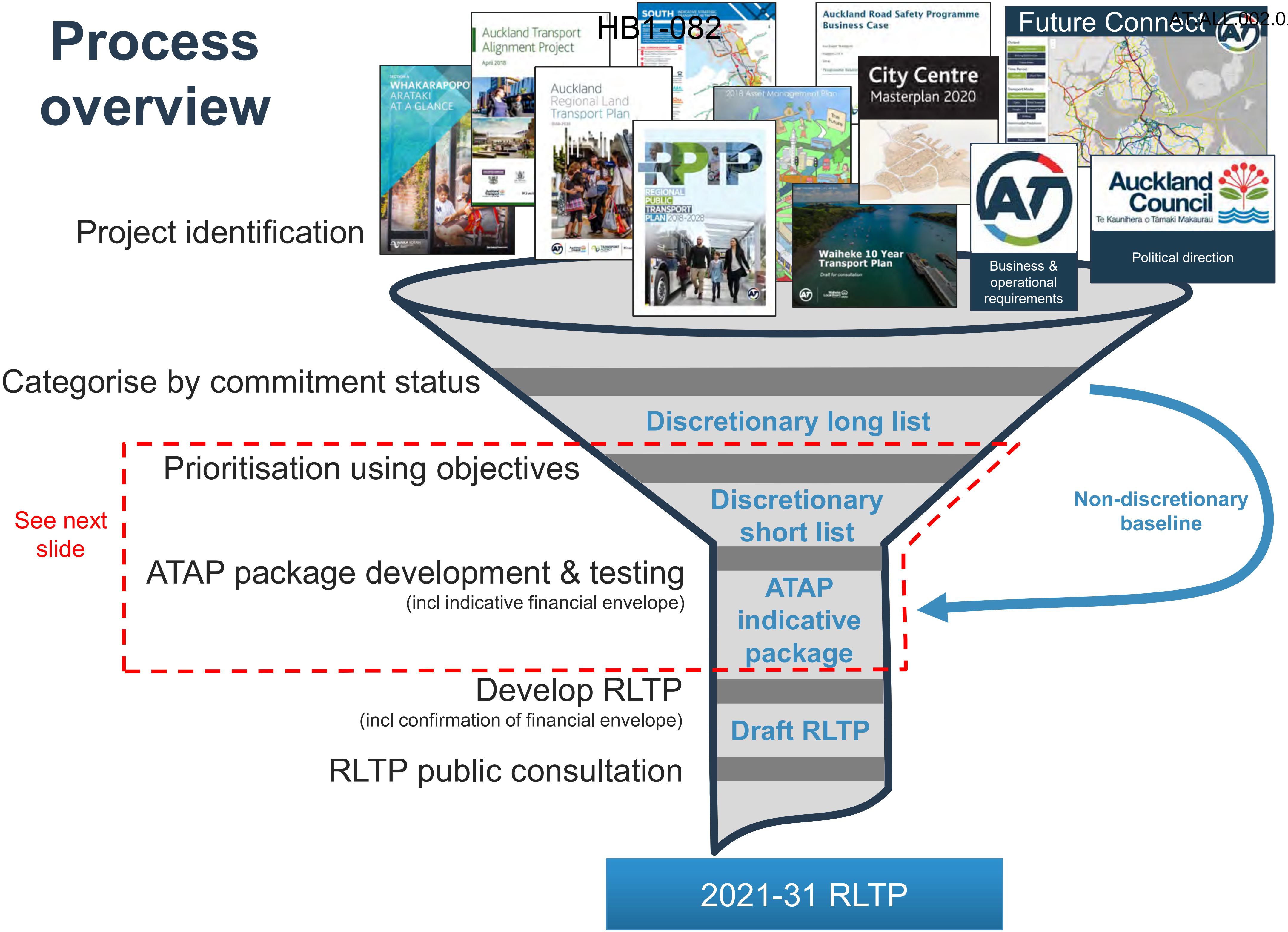
2021-31 RLTP and ATAP Methodology

HB1-082

AT.ALL.002.0129

Process overview



ATAP prioritisation

Prioritisation against objectives, by joint officials, taking a whole of system view

- Accelerating better travel choices for Aucklanders
- Enabling & supporting Auckland's growth and the quality compact urban approach
- Improving resilience and sustainability of the transport system
- Making Auckland's transport system safe by eliminating harm to people
- Better connect people, places, goods and services

↓

Package development to test weighting of key objectives within available funding

- Package 1 eg: Emphasis on better transport choices and climate change
- Package 2 eg: Emphasis on supporting brownfields growth
- Package 3 eg: Emphasis on mix of transport choices and growth
- Package 4 eg: Emphasis on greenfields growth (Drury)

Committed existing projects form baseline for future programme and all package options

↓

Final ATAP programme development based on feedback from ATAP Parties

Building the next RLTP – identifying proposals

Initial step was to seek longlist of internal CAPEX proposals from across AT, including:

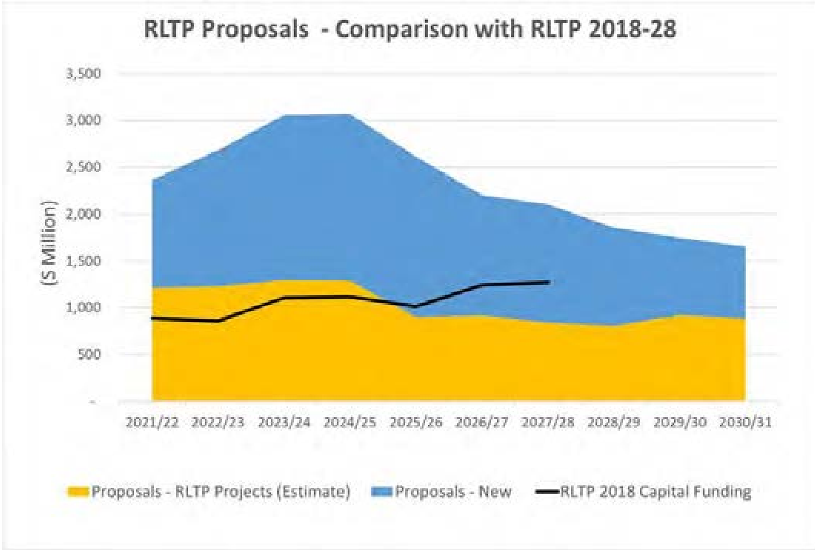
- Updates to costs / timing for existing projects & programmes
- Proposals for increased funding for existing programmes – eg Renewals $3b to $5.5b
- New projects or proposals (ie not funded in 2018 RLTP)

We received 220 proposals, including 56 existing projects / programmes

Total of $23.3 billion of proposals received

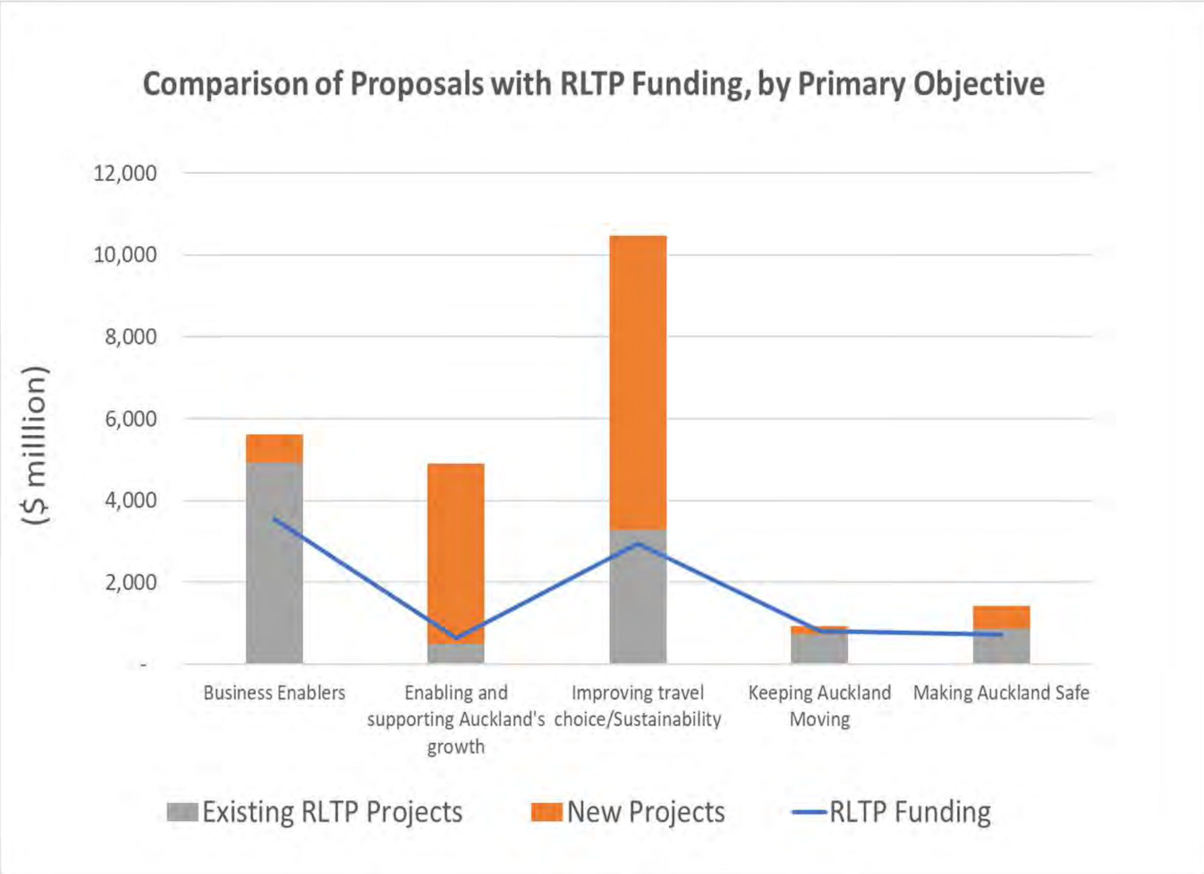
- $10.3 bn existing projects / programmes
- $13.0 bn of new items

Proposed timing for new and existing projects



- New proposals are heavily weighted towards front-end of the programme
- Significant number of existing projects also keen to accelerate delivery

Building the next RLTP – identifying proposals



AT proposals for new / additional funding heavily weighted towards the 'growth' and 'improving travel choice/ sustainability' objectives

- Key growth items
  - Supporting growth, incl. Drury
  - Responding to Kainga Ora growth areas
- Key Improving travel choice/ sustainability items
  - RTN extensions
  - Connected Communities
  - A4E initiatives
- Business Enablers items
  - Increase in renewals

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Key Emerging Issues

Asset Maintenance and Renewals

2018 RLTP funded renewals at around $3 billion albeit loaded to the latter part of the RLTP.

Asset Management team has signalled an increase in funding is required to renew assets.

Drivers are the continuous deterioration of road pavements in areas subject to growth and heavy vehicles, the need to address backlog, and the historical under-funding in areas such as stormwater assets.

The team is developing scenarios that balance Cost vs Risk vs Levels of Service. Issues for the 2021 RLTP are:

- Responding to continuous deterioration of the asset network
- Responding to a number of mitigation measures required to address climate change adaptation
- Adequate funding of consequential opex for Roading and PT Metro

Accelerating Better Travel Choices – Public Transport

Improve travel choices for Auckland through the provision of effective public transport network and services

- Current RLTP includes significant commitment to expanding the Rapid Transit Network (RTN) eg via City Rail Link, Eastern Busway etc and improving the Frequent Transport Network eg via Connected Communities
- This is an area of success - modelling indicates significant improvement in AM peak PT mode share as a result of investment

Key emerging issues

- Way forward on Northwestern RTN and City Centre to Mangere is uncertain (see next slide)
- Clarity is needed on RTN development going forward – eg complete one or two big projects, or stage across multiple projects?
- Cost increases for existing projects are providing challenging (eg Connected Communities)
- We will struggle to afford high quality across all of the rail network, frequent bus network and ferry network

Accelerating Better Travel Choices - Light Rail

- The future of planned Light Rail is uncertain, and work by MoT is largely on hold until after the September election.
- The Northwest and City Centre to Māngere corridors remain essential parts of the planned Rapid Transit Network.
- Growth depending on these corridors is still progressing, so need for the corridors will only become more urgent.
- $1.8 billion is still allocated to these corridors in the NLTF.
- Officals agreement that ATAP will consider how best to invest this allocation. Issues for investigation include:
    - What are the priorities within the two corridors?
    - What can delivered for $1.8b? This could include sections of the corridors, or interim improvements.
    - Identifying how much additional funding would be required to fully deliver both corridors.

Accelerating Better Travel Choices – active modes

Improve travel choices for Auckland through the expansion and enhanced safety of the active modes networks, particularly cycling

- Current RLTP includes significant commitment to expanding the cycling network via the Urban Cycleway Programme, Cycling Programme investment and Local Board projects
- RLTP was expected to achieve moderate mode-change to cycling, of around 2-4%

Key emerging issues

- Cycling projects costing almost double what was estimated in 2017
    - Cycle Programme investment will deliver much less than anticipated
- Coordination with out of sequence NZUP investments in Skypath, Seapath and Northern Corridor is a challenge
- Little funding to support development of the walking network or progress minor cycling projects

Enabling & supporting Auckland's growth and the quality compact urban approach

- Provision of transport infrastructure to support growth areas is a major ongoing challenge
- 2018 RLTP supports urban growth via investment in RTN, but:
  - very limited investment in greenfields growth areas ($300m)
  - no provision for projects to address immediate impacts of brownfields development

Key emerging issues

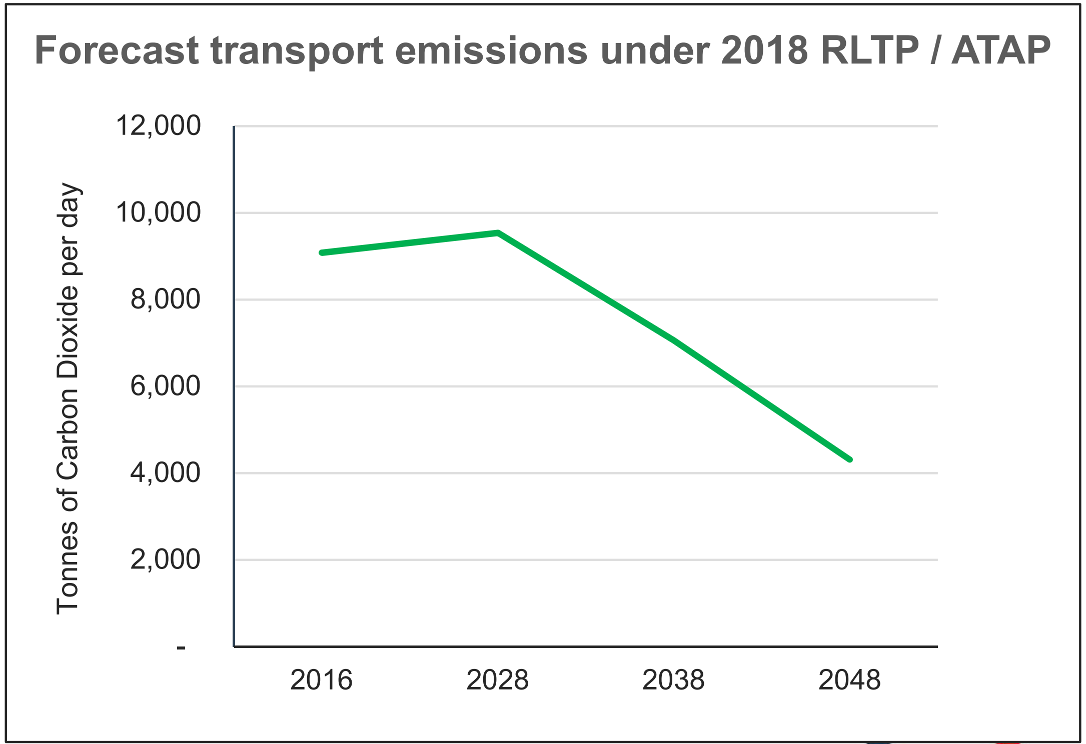
- Infrastructure requirements far exceed available funding
- No clear agreement between central and local government on land use and spatial development priorities
- Coordination with NZUP investment and Government priorities around Drury
- Providing for large scale brownfields developments, especially Kainga Ora
- The Local Residential Growth Fund has been defunded.

Improving resilience & sustainability, and significantly reducing carbon emissions

- Current RLTP mainly supports this outcome via ‘Accelerating Better Travel Choices’ objective (mode shift to PT and Active modes)
- Emissions expected to increase slightly to 2028 under current RLTP due to population growth, but decrease from 2028-48 due to electric vehicles

Key Emerging Issues

- ATAP will look at whole programme with ‘climate lens’
  - But, extensive modelling shows transport investment and land use only have marginal impact on transport emissions
- Regulatory & pricing support for electric vehicles and / or very aggressive pricing for demand management is needed
- Constraints on opex will impact on our delivery to achieve Accelerated Bus Roadmap

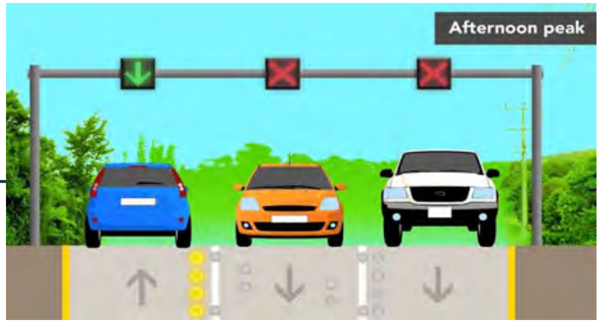


Better connect people, places, goods and services

- This objective tends to focus on connection and access via the road network
- 2018 RLTP included a number of initiatives, including:
  - State highways improvements
  - Optimisation and Intelligent Transport Systems (ITS)
  - A smaller number of corridor improvements, often supporting housing growth
- Modelling indicates good performance from 2018 RLTP, with congestion and road travel speeds holding steady, and a significant improvement in access to employment

Key emerging issues

- Based on modelling performance, this objective is seen as an area for continuity rather than a priority for increased investment
- The exception is support for freight movement, (highlighted in the draft 2021 GPS) but receives limited attention in AT's capital programme

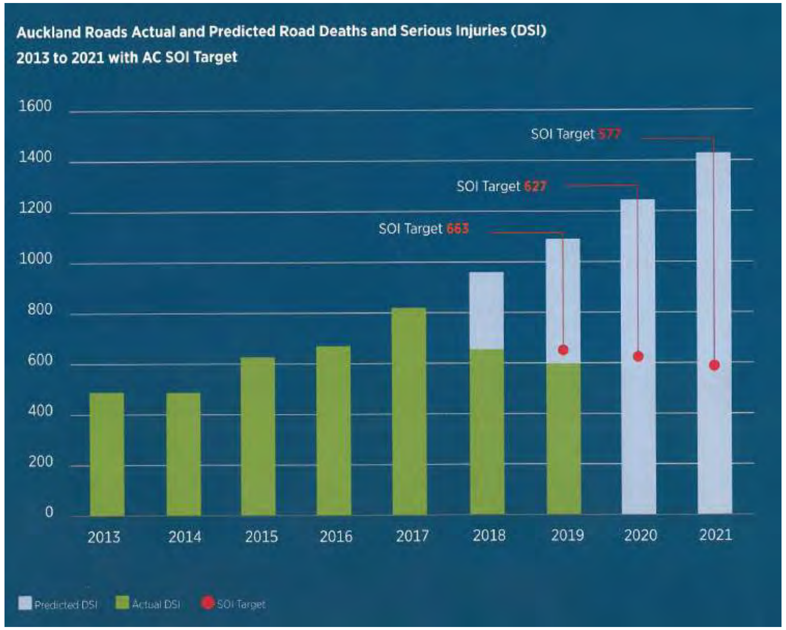


Making Auckland's transport system safe by eliminating harm to people

Safety was a major new theme in the 2018 RLTP, leading to:

- Safety Budget doubled to $700 million
- Vision Zero for Tamaki Makaurau
- A Safety Business Case (PBC) to determine the most effective response
- Safety-focussed initiatives e.g. Speed Limit Bylaw

RLTP safety investment expected to achieve 60% DSI reduction target



Key Emerging Issues:

- Maintaining momentum on reducing DSIs
- Funding for minor improvements (previously Minor Safety)
- Allowing local board to decide elements of the programme

AT Opex

The RLTP included $10.1 billion opex funding for AT, including PT fares, parking and other charges, principally for road maintenance and PT services.

Pressures on opex include:

- Expanding PT services levels
- Contracting for electric buses (Low Emissions Road Map)
- Increasing costs signalled for road maintenance

Funding

The 2018 RLTP presented a $28 billion investment programme across all agencies.

Auckland Council and NZTA have both signalled similar levels of funding for 2021-31 as was in the 2018 ATAP. However,

- Auckland Transport has been unable to access the expected level of NLTF funding – actual share averages closer to 60:40 Council-NLTF, compared to the 50:50 split that underpins the 2018 ATAP.
  - This means the difference between a $10 billion capital programme and an $8.5 billion programme.
- AT needs to deal with the flow-on effects of underfunding and delayed delivery from 2018-21
- The deferral of light rail and NZUP projects in Drury all place additional pressure on Auckland Transport's capital programme

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Next Steps

Approach to ATAP

- Looking to move ahead of ATAP, so RLTP development shapes ATAP
- Seek to broaden out ATAP from investment focus to wider systems approach
  - Eg. regulatory interventions, greater governance oversight of delivery, coordinated approach to climate change, coordination with Congestion Question
- Resolution of NZTA co-funding issue needs to be a key priority
- Need greater certainty around NZTA Board engagement
- Design process to allow AT Board (subcommittee) involvement before key decisions are made

Next steps

- Seeking approval of a Board subcommittee, to meet weekly
- Input to:
  - ‘Testing’ of ATs existing 2018 capital programme
  - Shortlisting prioritisation
  - Package development
  - Advice to ATAP Parties
- Oversight of ATAP progress

Final RLTP Project list: final RLTP costs, ATAP categorisation

Agency	RLTP project name	RLTP 10-year total ($m)	ATAP Status	ATAP Commitment	In base ATAP package	ATAP category	RCAT assessment
AT	Seismic Strengthening Programme	25.0	Committed	In construction	Yes	Maintenance, Operations and Renewals	7
AT	Street Lighting Improvements	17.0	Committed	In construction	Yes	Maintenance, Operations and Renewals	4
AT	AT Operating Expenditure (Maintenance and Public Transport Services, Net)	7490.0	Committed	Opex and renewals	Yes	Maintenance, Operations and Renewals	3
AT	Renewals	3931.0	Committed	Opex and renewals	Yes	Maintenance, Operations and Renewals	7
WK	State Highway Maintenance, Operations & Renewals	1862.0	Committed	Opex and renewals	Yes	Maintenance, Operations and Renewals	7
KR	Additional Rail Maintenance and Renewals	73.0	Committed	Opex and renewals	Yes	Maintenance, Operations and Renewals	4
AT	Projects Funded by Rodney Transport Targeted Rate	22.0	Essential	Not contracted	Yes	Maintenance, Operations and Renewals	6
WK	Northwest Bus Improvements	85.0	Committed	Covid Response and Recovery Fund	Yes	Rapid Transit	
CRLL	City Rail Link	2600.0	Committed	In construction	Yes	Rapid Transit	1
KR	Rail Network Resilience and Performance Programme - Catch-up Renewals	137.0	Committed	In construction	Yes	Rapid Transit	4
AT	Rosedale and Constellation Bus Stations	59.0	Committed	In construction	Yes	Rapid Transit	2
AT	Eastern Busway Stage 1	7.5	Committed	In construction	Yes	Rapid Transit	1
AT	EMU Rolling Stock Current Tranche	5.0	Committed	In construction	Yes	Rapid Transit	3
AT	Eastern Busway Stages 2 to 4	866.4	Committed	In contract	Yes	Rapid Transit	2
AT	Interest and Principal Repayment for EMUs	362.0	Committed	In contract	Yes	Rapid Transit	
WK	CC2M & Northwest Rapid Transit	1800.0	Committed	Not contracted	Yes	Rapid Transit	1
KR	Drury Stations	495.0	Committed	NZUP	Yes	Rapid Transit	4
KR	Papakura to Pukekohe Electrification	375.0	Committed	NZUP	Yes	Rapid Transit	1
KR	Wiri to Quay Park	318.0	Committed	NZUP	Yes	Rapid Transit	1
AT	EMU Rolling Stock and Stabling Tranche for CRL	412.5	Essential	CRL Day-1 requirement	Yes	Rapid Transit	1
AT	CRL Day One - Level Crossing Removal	220.0	Essential	CRL Day-1 requirement	Yes	Rapid Transit	1
KR	CRL Day One - Infrastructure Package	61.0	Essential	CRL Day-1 requirement	Yes	Rapid Transit	1
KR	CRL Day One - Resilience and Asset Maintenance Programme	50.7	Essential	CRL Day-1 requirement	Yes	Rapid Transit	1
KR	Additional MO&R for CRL Components	9.0	Essential	CRL Day-1 requirement	Yes	Rapid Transit	1
AT	Papakura Rail Station Park and Ride	9.9	Essential	Local Board initiative	Yes	Rapid Transit	4
AT	Level Crossings Removal - Group 2	100.0	Discretionary[1]	Not contracted	Yes	Rapid Transit	2
AT	Airport to Botany Rapid Transit Route Protection	49.5	Discretionary[1]	Not contracted	Yes	Rapid Transit	3
KR	Progressive Fencing and Security	20.0	Discretionary[1]	Not contracted	Yes	Rapid Transit	7
AT	Northern Busway Enhancements	62.0	Discretionary	Not contracted		Rapid Transit	1
AT	Airport to Botany Stage 2 Bus Improvements	30.1	Discretionary	Not contracted		Rapid Transit	2
WK	Puhoi-Warkworth	874.3	Committed	In construction	Yes	Strategic & Local Roads	8
WK	Southern Corridor Improvements (Manukau-Papakura) (Debt Repayment)	241.3	Committed	In construction	Yes	Strategic & Local Roads	8
WK	Northern Corridor (includes busway extension)	151.8	Committed	In construction	Yes	Strategic & Local Roads	8
WK	SH16 Brigham Creek-Waimauku	137.4	Committed	In construction	Yes	Strategic & Local Roads	7
AT	Parking Programme	49.0	Committed	In construction	Yes	Strategic & Local Roads	4
WK	SH20A to Airport (Debt Repayment)	47.7	Committed	In construction	Yes	Strategic & Local Roads	8
AT	Resolution of Encroachments and Legacy Land Purchase Arrangements	17.0	Committed	In construction	Yes	Strategic & Local Roads	7
AT	Ormiston Town Centre Link	16.8	Committed	In construction	Yes	Strategic & Local Roads	6
WK	State Highway Low Cost Low Risk Programme	12.6	Committed	In construction	Yes	Strategic & Local Roads	7
AT	Improvements Complementing Developments	12.0	Committed	In construction	Yes	Strategic & Local Roads	7
AT	Medallion Drive Link	12.0	Committed	In construction	Yes	Strategic & Local Roads	8
WK	Weigh Right	8.8	Committed	In construction	Yes	Strategic & Local Roads	7
WK	Preventing Wrong Way Drivers	8.6	Committed	In construction	Yes	Strategic & Local Roads	7
AT	Wolverton Culverts	10.0	Committed	In contract	Yes	Strategic & Local Roads	7
WK	Mill Road safety improvements and local infrastructure investment in Drury network	874.0	Committed	NZUP	Yes	Strategic & Local Roads	8
WK	Penlink	830.0	Committed	NZUP	Yes	Strategic & Local Roads	7
WK	State Highway 1 Papakura to Drury South Stage One	655.0	Committed	NZUP	Yes	Strategic & Local Roads	8
AT	CRL Road Side Projects	7.3	Essential	CRL Day-1 requirement	Yes	Strategic & Local Roads	1
AT	Lake Road/Esmonde Road Improvements	48.4	Essential	Local Board initiative	Yes	Strategic & Local Roads	4
AT	Regional Improvement Projects	62.0	Essential	Not contracted	Yes	Strategic & Local Roads	7
AT	Unsealed Road Improvements	40.0	Essential	Not contracted	Yes	Strategic & Local Roads	7
AT	Environmental Sustainability Infrastructure	20.2	Essential	Not contracted	Yes	Strategic & Local Roads	4
WK	Noise wall upgrade programme	15.0	Essential	Not contracted	Yes	Strategic & Local Roads	7
AT	Lincoln Road Corridor Improvements	106.2	Discretionary	Not contracted		Strategic & Local Roads	7
WK	SH18 Squadron Drive interchange upgrade	68.0	Discretionary	Not contracted		Strategic & Local Roads	7
AT	Glenvar Road/East Coast Road intersection and corridor improvements	57.3	Discretionary	Not contracted		Strategic & Local Roads	7
AT	Smales Allens Road Widening and Intersection Upgrade	23.4	Discretionary	Not contracted		Strategic & Local Roads	8

Final RLTP Project list: final RLTP costs, ATAP categorisation

Agency	RLTP project name	RLTP 10-year total ($m)	Status	Committed status	In base ATAP package	ATAP category	RCAT assessment
AT	**Hill Street Intersection Improvement**	**18.8**	Discretionary	Not contracted		Strategic & Local Roads	
AT	**Rosedale Road Corridor**	**8.0**	Discretionary	Not contracted		Strategic & Local Roads	**4**
AC	**Te Whau Pathway**	**30.3**	Committed	Covid Response and Recovery Fund	Yes	Walking & Cycling & Local Board Initiatives	**4**
WK	**Glen Innes to Tāmaki cycleway**	**19.4**	Committed	In construction	Yes	Walking & Cycling & Local Board Initiatives	**2**
WK	**Old Mangere Bridge Pedestrian & Cycling Link**	**16.9**	Committed	In construction	Yes	Walking & Cycling & Local Board Initiatives	**4**
AT	**Urban Cycleways Programme**	**139.2**	Committed	In contract	Yes	Walking & Cycling & Local Board Initiatives	**2**
WK	**Northern Pathway**	**785.0**	Committed	NZUP	Yes	Walking & Cycling & Local Board Initiatives	**2**
AT	**Local Board Initiatives**	**200.0**	Essential	Local Board initiative	Yes	Walking & Cycling & Local Board Initiatives	**4**
AT	**Meadowbank Kohimarama Connectivity Project**	**22.1**	Essential	Local Board initiative	Yes	Walking & Cycling & Local Board Initiatives	**4**
AT	**On-going Cycling Programme**[2]	**306.0**	Essential	Not contracted	Yes	Walking & Cycling & Local Board Initiatives	**2**
AT	**New Footpaths Regional Programme**	**49.0**	Essential	Not contracted	Yes	Walking & Cycling & Local Board Initiatives	**2**
WK	**Walking and Cycling Low Cost Low Risk**	**6.0**	Essential	Not contracted	Yes	Walking & Cycling & Local Board Initiatives	**4**
AT	**Accessibility Improvement Project**	**40.0**	Discretionary	Not contracted		Walking & Cycling & Local Board Initiatives	**4**
AT	**Access for Everyone Introductory Works**	**30.0**	Discretionary	Not contracted		Walking & Cycling & Local Board Initiatives	**2**
AT	**Minor Cycling and Micromobility (Pop-Up Cycleways)**	**30.0**	Discretionary	Not contracted		Walking & Cycling & Local Board Initiatives	**2**
AT	**Waiheke Ten-Year Transport Plan**	**10.0**	Discretionary	Not contracted		Walking & Cycling & Local Board Initiatives	
AT	**Mangere Cycleways (Airport Access)**	**11.6**	Committed	In construction	Yes	Bus & Ferry	**4**
AT	**Downtown Ferry Basin Redevelopment**	**2.0**	Committed	In construction	Yes	Bus & Ferry	
AT	**Matiatia Park and Ride**	**25.6**	Essential	Local Board initiative	Yes	Bus & Ferry	**7**
AT	**Connected Communities**	**583.0**	Essential	Not contracted	Yes	Bus & Ferry	**2**
AT	**Public Transport Safety, Security and Amenity**	**154.0**	Essential	Not contracted	Yes	Bus & Ferry	**4**
AT	**Midtown Bus Improvements**	**131.7**	Essential	Not contracted	Yes	Bus & Ferry	**1**
AT	**Core Technology**	**57.0**	Essential	Not contracted	Yes	Bus & Ferry	**4**
AT	**Double Decker Mitigation**[2]	**29.0**	Essential	Not contracted	Yes	Bus & Ferry	**4**
AT	**Downtown Crossover Bus Facilities**	**220.0**	Discretionary	Not contracted		Bus & Ferry	**1**
AT	**Carrington Road Improvements**	**54.6**	Discretionary	Not contracted		Bus & Ferry	**4**
AT	**Park and Ride Programme**	**51.0**	Discretionary	Not contracted		Bus & Ferry	**4**
AT	**Decarbonisation of the Ferry Fleet Stage 1**	**30.0**	Discretionary	Not contracted		Bus & Ferry	**3**
AT	**Sylvia Park Bus Improvements**	**19.9**	Discretionary	Not contracted		Bus & Ferry	**4**
AT	**Albert and Vincent Street Bus Priority Improvements**	**8.1**	Discretionary	Not contracted		Bus & Ferry	**4**
AT	**Neighbourhood Interchanges**	**6.1**	Discretionary	Not contracted		Bus & Ferry	**4**
WK	**Supporting Growth Route Protection Programme**	**44.4**	Committed	In construction	Yes	Spatial Priorities	**7**
AT	**Matakana Link Road**	**26.0**	Committed	In construction	Yes	Spatial Priorities	**8**
AT	**Greenfield transport infrastructure - Northwest**	**142.0**	Committed	In contract	Yes	Spatial Priorities	**7**
AT	**Wynyard Quarter Integrated Road Programme**	**46.1**	Committed	In contract	Yes	Spatial Priorities	**6**
AT	**Tāmaki Regeneration**	**40.9**	Committed	In contract	Yes	Spatial Priorities	**6**
AT	**Supporting Growth - Investigation for Growth Projects**	**28.0**	Committed	In contract	Yes	Spatial Priorities	**7**
AT	**Wainui Improvements**	**23.1**	Committed	In contract	Yes	Spatial Priorities	**7**
AT	**Huapai Improvements**	**17.5**	Committed	In contract	Yes	Spatial Priorities	**8**
AT	**Scott Point Repayment**	**5.0**	Committed	In contract	Yes	Spatial Priorities	**7**
AT	**Supporting Growth - Post Lodgement and Property**	**64.5**	Essential	Not contracted	Yes	Spatial Priorities	**7**
AT	**Western Link Road Route Protection**	**6.0**	Discretionary[1]	Not contracted	Yes	Spatial Priorities	**7**
AT	**Projects Supporting Auckland Housing Programme**	**401.0**	Discretionary	Not contracted		Spatial Priorities	**4**
AT	**Drury Local Road Improvements**	**242.8**	Discretionary	Not contracted		Spatial Priorities	**7**
AT	**Northwest Growth Improvements**	**185.5**	Discretionary	Not contracted		Spatial Priorities	**7**

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Final RLTP Project list: final RLTP costs, ATAP categorisation

Agency	RLTP project name	RLTP 10-year total ($m)	Status	Committed status	In base ATAP package	ATAP category	RCAT assessment
WK	**Dome Valley Safety Improvements**	**31.6**	Committed	In construction	Yes	Safety	**7**
AT	**Tāmaki Drive/ Ngapipi Road safety improvements**	**6.8**	Committed	In construction	Yes	Safety	**7**
AT	**Safety Programme**	**657.0**	Essential	Not contracted	Yes	Safety	**7**
WK	**Safer Networks Programme**	**154.0**	Essential	Not contracted	Yes	Safety	**7**
AT	**School Speed Management**	**75.0**	Essential	Not contracted	Yes	Safety	**4**
AT	**Marae and Papakainga (Turnouts) safety programme**	**13.2**	Essential	Not contracted	Yes	Safety	**7**
AT	**Minor Improvements**	**100.0**	Discretionary	Not contracted		Safety	**4**
AT	**Community Safety Fund**	**10.0**	Discretionary	Not contracted		Safety	**7**
AT	**Customer and Business Technology**	**353.0**	Committed	In construction	Yes	Optimisation & Technology	**7**
AT	**Transport Demand Forecasting Models Update**	**6.0**	Committed	In construction	Yes	Optimisation & Technology	**7**
AT	**Network Performance**	**138.0**	Essential	Not contracted	Yes	Optimisation & Technology	**7**
WK	**ITS Programme & State Highway Optimisation Programme**	**124.4**	Essential	Not contracted	Yes	Optimisation & Technology	**7**
AT	**Intelligent Transport Systems**	**52.0**	Essential	Not contracted	Yes	Optimisation & Technology	**7**
AT	**Core Operational Capital Programme**[2]	**14.0**	Discretionary[1]	Not contracted	Yes	Optimisation & Technology	**7**
AT	**Supporting Electric Vehicles**	**34.0**	Discretionary	Not contracted		Optimisation & Technology	**5**
AT	**Freight Network Improvements**	**30.0**	Discretionary	Not contracted		Optimisation & Technology	**7**
WK	**Warkworth to Wellsford (Designation)**	**21.0**	Committed	In construction	Yes	Planning for the future	**7**
WK	**SH1 Additional Waitemata Harbour Connections (Business Case, Designations and Property)**	**60.0**	Essential	Not contracted	Yes	Planning for the future	**7**
KR	**KiwiRail Strategic Future Planning**	**47.0**	Essential	Not contracted	Yes	Planning for the future	**3**
WK	**East West Link (Property)**	**30.7**	Essential	Not contracted	Yes	Planning for the future	**7**
AT	**Strategic Business Cases**	**22.0**	Essential	Not contracted	Yes	Planning for the future	**7**
WK	**SH1 Drury South to Bombay (Route Protection)**	**18.3**	Essential	Not contracted	Yes	Planning for the future	**7**
WK	**Grafton Gully Improvement Business Case**	**15.0**	Essential	Not contracted	Yes	Planning for the future	**7**
WK	**20Connect (SH20B) Route Protection**	**14.6**	Essential	Not contracted	Yes	Planning for the future	**7**
AT	**Electric Bus Trial Roadmap**[2]	**9.0**	Essential	Not contracted	Yes	Planning for the future	
WK	**SH18 Rapid Transit**	**3.0**	Essential	Not contracted	Yes	Planning for the future	**7**
KR	**Maintenance, Operations, and Renewals**	**74.0**	Not in ATAP	Not in ATAP		Not in ATAP	
AT	**Community Connect (PT Concession Card Trial)**	**4.0**	Not in ATAP	Not in ATAP		Not in ATAP	
DoC	**Local Road Maintenance (DoC)**	**0.4**	Not in ATAP	Not in ATAP		Not in ATAP	
DoC	**Local Road Improvements (DoC)**	**0.4**	Not in ATAP	Not in ATAP		Not in ATAP	

[1] There were several discretionary projects that were considered to be baseline for ATAP. These have been noted here to reflect their treatment in ATAP.

[2] These projects do not match up exactly with ATAP projects. They reflect combinations of ATAP projects into one RLTP programme or vice versa.

Entered by Board Secretary

Development of the Regional Land Plan Transport Plan 2021-31

For decision: ☐

For noting: ☒

Ngā tūtohunga / Recommendations

That the committee:

a) Notes the requirements and timelines for the 2021-31 Regional Land Transport Plan.

b) Notes the decision points in the RLTP process, including those of Auckland Council.

Te whakarāpopototanga matua / Executive summary

1) The Auckland Regional Transport Committee (RTC) is responsible for preparing and consulting on the 2021-31 Regional Land Transport Plan (RLTP). This report introduces the requirements for the RLTP and related processes, to inform the RTC as it initiates the process of developing this RLTP.

Ngā tuhinga ō mua / Previous deliberations

2) A report on the Development of RLTP was provided to the Finance, Capital and Risk Committee (FCRC) in February 2020, although not to the Auckland Transport (AT) board or RTC. FCRC noted the need to align the outcomes in the RLTP with those sought by Auckland Council (Council).

Entered by Board Secretary

Te horopaki me te tīaroaro rautaki / Context and strategic alignment

3) The RLTP is the primary document guiding land transport planning and investment for the Auckland region. It includes the activities of AT, Waka Kotahi New Zealand Transport Agency (Waka Kotahi) and KiwiRail. Two key strategic drivers for the programme are the Auckland Plan 2050 (Auckland Plan) and the Government Policy Statement on land transport (GPS).
4) The vision in the Auckland Plan is that Aucklanders will be able to get where they want to go, more easily, safely and sustainably. It sets out three directions: (i) better connecting people, places, goods and services; (ii) increase genuine travel choices for a healthy, vibrant and equitable Auckland; and (iii) maximise safety and environmental protection.
5) The GPS sets out the strategic direction for land transport. Under the Land Transport Management Act 2003 (the LTMA), the RLTP must be consistent with the GPS. A draft GPS was issued in May 2020, and includes the four strategic priorities of Safety, Better Travel Options, Improving Freight Connectivity, and Climate Change. The final GPS will be released imminently.

Ngā matapakinga me ngā tātaritanga / Discussion and analysis

6) The Auckland RTC is responsible for completing a review of the existing RLTP, consulting on the draft RLTP, and lodging the draft RLTP with the AT board. The AT board is responsible for approving the final RLTP. The requirements of an RLTP are set out in attachment one.
7) Under recent changes to the LTMA arising from the Future of Rail Review, a KiwiRail representative has been added as a non-voting member of the RTC. The KiwiRail representative has been invited to talk about the Rail Network Investment Programme at the RTC meeting.
8) The current RLTP covers the 2018-28 period. It was published soon after the GPS 2018, and the Auckland Plan, and reflects the strong emphasis on public transport, active modes and safety in those strategies. It also reflects the $28 billion investment package agreed between the Government and Auckland Council in the 2018 Auckland Transport Alignment Project (ATAP).
9) A new RLTP is proposed for the period from 2021 to 2031 to incorporate any shifts in priorities, such as climate change, mode shift and spatial priorities, as well as Government decisions on the NZ Upgrade Programme and stimulus package, as well as the impacts of the COVID-19 pandemic.
10) This RLTP would be informed by the ATAP update process that has been initiated by Government and Council. Both processes are aimed at optimising the transport programme for Auckland for the next 10 years against the objectives of growth, climate change, safety, mode shift and better connecting people, goods and services. The ATAP process is intended to produce a report by the end of October on different transport 'packages' that reflect different weightings of the above objectives. The Governing Body and Cabinet are expected to approve the final ATAP package in December 2020.

11) This ATAP is an opportunity to move beyond the transport capital programme and address strategic issues that underpin this RLTP, such as:

   a. Policy changes to achieve the radical shifts to meet Auckland Council's targets for a low carbon economy and management of travel demand.

   b. Spatial growth priorities, such as Drury, Redhills and Whenuapai areas, and Kainga Ora's development programme.

   c. Funding levels, including AT's ability to access funding from the National Land Transport Fund (NLTF) at the levels signalled in the 2018 ATAP. NLTF funding at ATAP levels is critical if AT is to be able to deliver on its current RLTP.

12) With these issues addressed through ATAP, the AT Board is able to focus on the specifics of the investment programme, such as public transport services, safety, and asset renewal and maintenance. These services and programmes go to the heart of AT's ability to respond to the CCO Governance Review's recommendation that it improves its engagement with local communities.

13) Although the RLTP will be informed by ATAP, ATAP does not replace the RLTP statutory process, nor the processes for Council's Long Term Plan (LTP) and Regional Fuel Tax (RFT) and Waka Kotahi's National Land Transport Programme (NLTP). However, ATAP is one of Government Commitments in the draft GPS, which states that the Government expects forthcoming NLTPs to meet the expectations in ATAP. NZTA has also signalled that ATAP work can act as a strategic case for projects within the ATAP package. Both of these may have NLTF funding implications for projects that are outside of ATAP.

Auckland Council and the RLTP

14) The Council has a crucial role in the development of the RLTP for a number of reasons:

   a. Council's LTP sets out the activities and community outcomes it expects to achieve. Importantly, it sets Council's funding and targets for AT. As a substantive council-controlled organisation, AT must give effect to the relevant aspects of the LTP (s.92(1) of the Local Government (Auckland Council) Act 2009). The process for the 2021 LTP includes workshops with councillors in October 2020, the Mayoral Proposal in late November 2020, consultation on the draft LTP in the first quarter of 2021, and finalisation of the LTP in June 2021.

   b. The Covid-19 pandemic and associated lockdowns has had a significant impact on transport revenues, particularly PT revenue, which has led to considerable uncertainty for the overall Council budget. This will constrain the ability fund new transport initiatives.

   c. Council is responsible for preparing and consulting on the RFT Proposal. The RFT Proposal specifies the projects that can be funded from the fuel tax and effectively defines most of the discretionary projects in AT's capital programme. In the 2018 RLTP, the RFT enabled $4.4 billion of AT's $10 billion capital programme, including the next phases of the Eastern Busway, the next tranche of Electrical Multiple Units and stabling, and the enhanced safety programme. Council will consider any changes needed to the RFT programme now that Mill Road and Penlink are funded from the NZ Upgrade Programme. The RFT process is expected to follow similar timelines to the LTP.

d. The recently released CCO Governance Review recommended that "AT and the council jointly prepare the RLTP, the draft of which the council endorses before going to the AT board for approval". The Governing Body has requested the chief executives of Auckland Council and AT work to implement this.

15) For these reasons, it will be important that Councillors are involved as the RLTP is developed. The LTP workshop in October will be a critical opportunity to canvas issues with the Council. Council's participation in the ATAP process and a review by the Governing Body of the proposed ATAP package, provide additional opportunities for Council to be informed of and provide input to the RLTP. The formal decision points in the RLTP process are shown in attachment two, including those for Auckland Council.

Inclusion of transport programmes for Waka Kotahi and KiwiRail

16) The programmes for Waka Kotahi, KiwiRail and Department of Conservation need to be included in the draft RLTP and should be formally submitted to the RTC, once they are approved by their respective agencies. Draft programmes for Waka Kotahi and KiwiRail are being considered as part of the ATAP Update.

17) The process for inclusion of KiwiRail's programme in this RLTP is new compared with 2018. With recent changes to the Land Transport Management Act arising from the Future of Rail Review, the RTC is no longer responsible for prioritising KiwiRail's programme in the RLTP. The RLTP must include any significant rail activities proposed by KiwiRail, and their inclusion is for co-ordinated planning only and does not affect whether they are included in a rail network investment programme or their funding.

Submission of final RLTP to Waka Kotahi.

18) We are feeding into Waka Kotahi's NLTP process from now to December, to secure funding for the continuous programmes and improvement programme over the next three years. Waka Kotahi has specified that regional councils must submit their RLTPs by 30 June 2021, to allow it to prepare the NLTP by August 2021.

Ngā tūraru matua / Key risks and mitigation

19) Delays in the finalisation of ATAP will pressurise the preparation of, and final decisions on, the RLTP. However, we are closely involved in the ATAP process, and will be able to provide advice to the RTC and prepare the main content of the RLTP in parallel with the ATAP process.

Entered by Board Secretary

Ngā ritenga-ā-pūtea me ngā rauemi / Financial and resource impacts

20) No financial and resource impacts are expected in the preparation of the RLTP.

Ngā whaiwhakaaro ō te taiao me te panonitanga o te āhuarangi / Environment and climate change considerations

21) Environment and climate change are being considered as part of the development of the transport strategy and investment programme.

Ngā reo o mana whenua rātou ko ngā mema pooti, ko ngā roopu kei raro i te maru o te Kaunihera, ko ngā hāpori katoa / Voice of mana whenua, elected members, Council Controlled Organisations, customer and community

22) Discussions will occur with elected members as part of the process of developing the LTP, the RLTP and ATAP.

23) Stakeholder, community and public perspectives will be sought as part of the review of the 2018 RLTP and consultation on the draft RLTP. Mana whenua will also be consulted and their views and perspectives considered as part of the consultation process for the draft RLTP. The Chair of the Independent Maori Statutory Board is a party to ATAP.

Ngā whaiwhakaaro haumaru me ngā whaiwhakaaro hauora / Health, safety and wellbeing considerations

24) No key health, safety and wellbeing considerations are associated with the development of the RLTP.

Ā muri ake nei / Next steps

25) The next steps are developing the strategic priorities and investment programme for the RLTP, as well as involvement in the LTP and ATAP processes. The broad timelines for the RLTP and these related processes are in attachment three.

Entered by Board Secretary

Ngā whakapiringa / Attachments

Attachment number	Description
Attachment One	Requirements of a RLTP
Attachment Two	RLTP Formal Decision Points
Attachment Three	Timeline for the RLTP

Te pou whenua tuhinga / Document ownership

Submitted by	Mark Fleming, **Principal Policy Advisor**	
Recommended by	Jenny Chetwynd **Exec GM Planning and Investment**	
Approved for submission	Shane Ellison **Chief Executive**	

Entered by Board Secretary

Attachment One Requirements of a Regional Land Transport Plan

1. The requirements of an RLTP are set out in the LTMA. AT is required to prepare the RLTP at least every six years, but may do so more frequently. Given shifts in some priorities and current pressures, it is proposed to prepare a new RLTP covering the period from 1 July 2021 to 30 June 2031. Responsibility for preparing and approving the RLTP lies with AT.
2. The RLTP must contain:
   (a) Auckland region's transport objectives, policies and measures;
   (b) A statement of transport priorities for the region;
   (c) A forecast of revenue and expenditure on activities;
   (d) All regionally significant expenditure on transport to be funded from sources other than the National Land Transport Fund;
   (e) Identification of activities of inter-regional significance.
3. The RLTP covers the activities of AT, Waka Kotahi, KiwiRail and other agencies for example the Department of Conservation. It must contain a list of any significant rail activities or combinations of rail activities proposed by KiwiRail for Auckland.
4. The Auckland RTC is responsible for completing a review of the existing RLTP during the six month period immediately before the expiry of the third year of the plan i.e. within the period January to June 2021, consulting on the draft RLTP, and lodging the draft RLTP with the regional council – in Auckland's case, the AT Board.
5. When considering the draft RLTP, the RTC must be satisfied that it contributes to the purpose of the LTMA 'to contribute to an effective, efficient, and safe land transport system in the public interest', and that it is consistent with the GPS. The RTC must take into account any national energy efficiency and conservation strategy, relevant national policy statements and regional policy statements or plans in force under the Resource Management Act 1991, and likely funding from any source.
6. When consulting on the draft RLTP, the RTC must follow consult in accordance with the consultation principles specified in the Local Government Act 2002, including receiving views presented to it with an open mind and give those views due consideration when making decisions.
7. Once lodged by the RTC, the AT Board may then decide either to approve the draft RLTP without modification, or to refer it back to the RTC for reconsideration.

Entered by Board Secretary

Attachment Two RLTP Formal Decision Points

Note: dates are based on current knowledge and may change

	RLTP Development	Decisions affecting draft RLTP		
		Who	**What**	**Decision and relationship**
October	RLTP strategic framework and investment programme developed	Minister of Transport	Final GPS 2021 and NZ Rail Plan released	Influences strategic direction for land transport and rail
October/ November		Waka Kotahi KiwiRail	WK investment programme KR investment programme	For consideration in draft RLTP For inclusion in the draft RLTP
November		Mayor	Mayoral Proposal	Sets priorities and planned Auckland Council funding, which sets AT's capex and opex funding envelopes
December		Governing Body and Cabinet	Approval of final ATAP package	Informs draft RLTP
January-February	Draft RLTP prepared RTC consulted by Auckland Council on draft RFT Proposal RTC approves draft RLTP for public consultation	Auckland Council	Draft LTP Draft RFT Proposal	Confirms planned Auckland Council funding Sets RFT-enabled projects in the draft RLTP
February-March	Consultation on draft RLTP (timing aligned with LTP and RFT)			
April-May	RTC considers results of consultation on draft RLTP			

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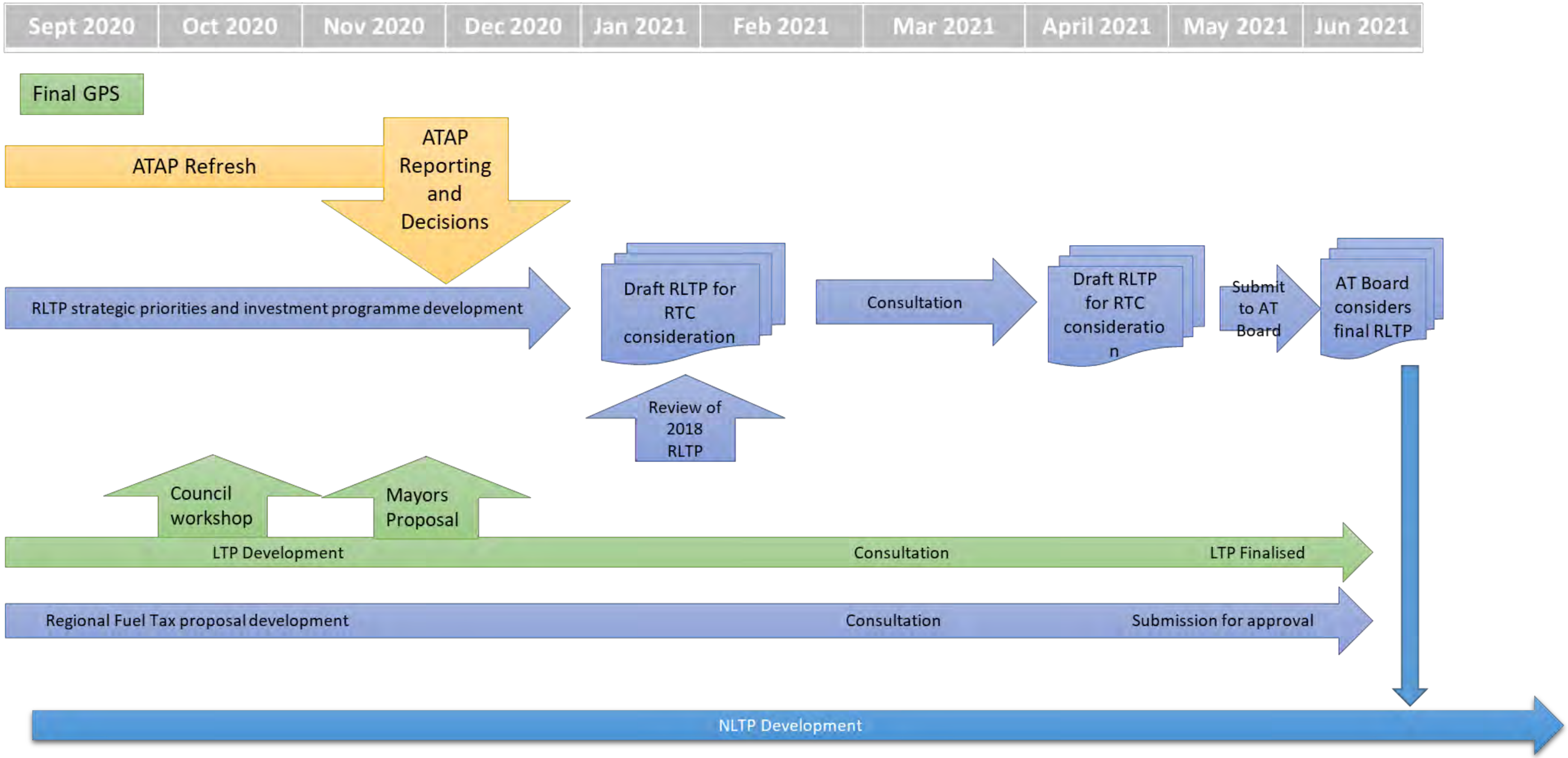
May-June	RTC recommends revised draft RLTP to AT Board AT Board approves final RLTP	Auckland Council Waka Kotahi	Final LTP and RFT Proposal Advice on continuous programmes	Confirms funding envelopes for transport and RFT-enabled projects in the final RLTP Sets funding for continuous programmes such as PT services and Maintenance, Operations and Renewals
August		Waka Kotahi	Publishes NLTP	Confirms the priority projects to be funded for next three years from the NLTF

Entered by Board Secretary

Attachment Three Timeline for the RLTP



In confidence

Minister of Transport

Cabinet Development Committee

Auckland Transport Alignment Project (ATAP) 2021-31 Investment Package

Proposal

1. This paper seeks agreement from Cabinet on an indicative package of investment for transport in Auckland for the 2021-31 period, developed by the Auckland Transport Alignment Project (ATAP). The package gives effect to the priorities of the Government and Auckland Council (the Council).

Relation to Government priorities

2. The ATAP 2021-31 investment package contributes to the Government's objectives of building a productive, sustainable and inclusive economy by enabling greater transport choice in Auckland and moving people and goods faster through investment in public transport, walking and cycling and roads. Safety is also a key component of the package.

3. The package also enables more connected communities through increased investment in public and active transport and network connectivity through urban areas.

4. Transition to a clean, green and carbon-neutral New Zealand is also supported by this investment, with significant investment in public transport and active modes encouraging people to move away from the private car.

Executive Summary

5. ATAP is a strategic exercise to align transport priorities, funding and investment of the Government and the Council. It develops an indicative package of transport investments for Auckland (the ATAP package) to inform statutory processes and individual project and programme business cases.

6. The Minister of Finance, the Mayor and Deputy Mayor of Auckland, Auckland Council Planning Committee Chair, Chair of the Independent Māori Statutory Board and I (the parties) asked for advice on an investment package for Auckland for 2021-31.

7. A large part of the ATAP 2021-31 package is a continuation of ATAP 2018-28 with an on-going commitment to projects now in construction, renewing existing assets and supporting public transport operational expenditure.

8. The ATAP 2021-31 package invests in public transport, walking and cycling, safety and integrating modes of transport through key region-wide programmes. Developing Auckland's rapid transit is key to the public transport network.

9. The work has prioritised investment to produce an indicative package of investments that can be funded from current Government and Council plans.

10. Around $31 billion of transport funding is available for investment in Auckland over the next decade. Funding is provided by:

10.1. the National Land Transport Fund (NLTF) - $16.3 billion

10.2. Crown funding for the City Rail Link ($1.3 billion) and for the New Zealand Upgrade Programme ($3.4 billion)

10.3. Auckland Council - $10.0 billion including $1.3 billion for City Rail Link

10.4. Covid Response Recovery Fund (CRRF) - $85 million for sections of the Te Whau Pathway and State Highway 16 Interim Bus Improvements.

11. The Government Policy Statement on Land Transport 2018-28 (GPS) includes an expectation that Auckland will receive $16.3 billion from the NLTF over the period 2021-31. [redacted]

Withheld under section 9(2)(g)(i) of the Official Information Act 1982

12. The ATAP 2021-31 package will deliver significant benefits to Auckland. These include improvements to the public transport system in Auckland, delivery of large scale projects including the City Rail Link (CRL), investment in rail electrification and continued investment in walking and cycling. The ATAP 2021-31 package is expected to result in the following outcomes:

12.1. acceleration of the shift from cars to public transport, walking and cycling with these modes expected to absorb approximately 64 per cent of increased trip demand. Public transport mode share increases from 7 per cent to 11 per cent in the morning peak

12.2. a reduction in greenhouse gas emissions per capita but a small increase in total emissions with the forecast Auckland population increase outweighing any positive overall change

12.3. an increase in accessibility to jobs by a 30 minute car journey by 14 per cent and an increase in accessibility to jobs by a 45 minute public transport journey by 60 per cent (noting employment growth of 19 per cent across the Auckland region)

12.4. improved safety outcomes with an expected reduction in deaths and serious injury of 60 per cent by 2030

12.5. a reduction in congestion for bus passengers and on arterial routes, but significant increases in congestion on the motorway network and a 10 per cent increase in congestion overall. Officials' work on congestion pricing in Auckland indicates that the introduction of a modest congestion charge across the strategic corridors would result in an 8-12 per cent decrease in congestion across the region.

13. Delivering these investments is a collective responsibility for the Government and Auckland Council. I support the recommendation of the ATAP agencies that further work continue to look at the most efficient and effective way of funding transport in Auckland through the NLTF, alongside new funding and financing options as enabled through the Infrastructure Funding and Financing Act.

14. To help address transport equity in Auckland, there is an allocation of funding to enable a public transport concession for Community Service Card holders pilot for Auckland included in this package. This is expected to be implemented through the AT Hop Card. If the pilot is successful I would look to a wider rollout nationwide.

15. The ATAP 2021-31 investment package reduces per capita emissions through encouraging people to shift away from private motor vehicle travel to public transport, walking and cycling options. However, if the package is viewed in isolation, total transport emissions in Auckland will rise over the period in question due to population growth. This makes it clear that additional measures are required to reduce overall emissions in line with the Government's ambitions and the indicative direction taken by the Independent Climate Change Commission. While the Transport Emissions Action Plan remains under development, it is clear to me that further levers across infrastructure, behaviour and technology will need to be applied.

Background

16. ATAP aims to align the transport priorities of the Government and the Council through officials, including a Chief Executive's Governance Group, working together to provide advice to the parties. The strategic approach encompasses prioritising investment, making best use of existing networks and maximising opportunities to influence travel demand. Every three years ATAP develops an indicative package of transport investments for Auckland (the ATAP package) to inform statutory processes and individual project and programme business cases. Commencing in 2016, this process has enabled a step change in investment planning for Auckland.

17. We (the parties) asked for this work to be completed in time to provide direction to the Regional Land Transport Plan (RLTP) and National Land Transport Programme processes. As an alignment and consensus-building exercise between the Government and the Council, ATAP provides strong direction to these processes.

Agreed objectives

18. The Terms of Reference, developed by the parties, sets out the following agreed Government and Auckland Council objectives:

    18.1. enabling Auckland's growth through a focus on intensification in brownfield areas and with some managed expansion into emerging greenfield areas

    18.2. accelerating better travel choices for Auckland (modeshift)

    18.3. better connecting people, places, goods and services

    18.4. improving resilience and sustainability of the transport system and significantly reducing the greenhouse emissions it generates

    18.5. making Auckland's transport system safe by eliminating harm to people

    18.6. ensuring value for money across Auckland's transport system through well targeted investment choices.

19. Officials have developed the ATAP package by assessing project-specific information, transport network modelling and utilising existing business case recommendations. They have followed the direction of the Terms of Reference in

considering how transport can improve outcomes in access, health, safety and the environment as well as support Auckland's growth.

The primary focus is continuing our record investment through NZ Upgrade and ATAP 2018

20. The ATAP 2021-31 package largely progresses the ATAP 2018-2028 programme agreed early in the last term. This reflects the continuation of overall direction through the Terms of Reference and, given we are three years on, a significant portion of funding is allocated to projects that are in construction or under contract.

21. The ATAP 2021-31 package includes already committed projects in construction such as the CRL and the Eastern Busway and funding for specific projects under the New Zealand Upgrade Programme, the Covid Response Recovery Fund and Auckland Light Rail.

22. The Government is investing $4.15 billion more into Auckland's transport than in the 2018-28 ATAP, primarily resulting from funding made available for large scale projects in Auckland through the New Zealand Upgrade Programme (NZUP). It was assumed previously that funding for these projects would be shared between central and local Government.

23. Major projects that the ATAP agencies recommend as high priorities for investment over the next decade within funding expected from current plans are listed below.

ATAP 2021-31 Key Projects
• City Rail Link • State Highway 1 Ara Tūhono Puhoi to Warkworth • State Highway 1 Northern Corridor (includes busway extension to Albany) • Penlink (includes land for future public transport priority lanes) • Light Rail (City centre to Mangere corridor as a priority) • Eastern busway (Panmure-Botany) • Northern Pathway (Westhaven to Akoranga) • Rail electrification to Pukekohe and extension of third main rail line (Wiri to Quay Park) • City Centre Bus Improvements • Mill Road • Walking and cycling programme • Significant programme of safety improvements • Integrated bus, cycle and safety programme • Network optimisation and technology programme • Additional electric trains • Public transport concession card for Community Services Card holders

The proposed package balances a number of constraints

24. Auckland Council's funding contribution remains the same as it was in 2018-28 with approximately $10 billion of funding which includes $1.5 billion of Auckland Regional Fuel Tax with the remainder ($8.5 billion) sourced through rates. Auckland Council argue it is limited because Covid-19 has had an impact on Auckland Council's revenue.

25. This has caused some ATAP projects have been deferred to future years, but still within the 2021-31 period. To avoid future deferral of projects, the draft Auckland Council ten year budget (Long-term Plan) includes a proposal to raise rates and increase debt. Central Government does not think it is sufficient and expect further investment to be required.

26. The contribution from the National Land Transport Fund remains the same in ATAP 2021-2031 as in ATAP 2018-2028 at $16.3 billion due to the Government's decision not to increase fuel excise duty or road user charges this term. At the same time, forecast revenue has reduced over the period as a result of COVID-19.

27. In the last three years the funding required for operational costs and asset renewals have increased by over $2 billion and there have also been some cost escalations in committed projects. As Auckland Council's contribution has also remained the same this means that the funding environment is much more constrained now than for previous iterations of ATAP.

28. Significant investment required to renew Auckland's asset base, both in rail and roading has become increasingly apparent in the 2021-31 work and this package of investment commits significant funding to ensuring current assets are renewed and maintained to a safe level. There are a number of contributing factors to increases in renewals expenditure. As one example, the introduction of double decker buses has seen a significant uptake of bus ridership but also requires more road maintenance to support the new fleet.

29. This leaves $1.8b discretionary spend. This means we cannot do it all. Given these constraints, I have prioritised investment in housing and reducing emissions.

Housing

30. Transport spending across the ATAP programme enables intensification. In addition I propose one third of the $1.8b discretionary spend for infrastructure to support new housing, focussed on:

    30.1. The Auckland Housing Programme (AHP) including Tāmaki, Mt Roskill, Oranga and Mangere

    30.2. Some private sector developments such as those in the north west

    30.3. Investment in Drury which builds on our NZUP investments, which were targeted to support new housing, and already committed investment in greenfield transport infrastructure.

31. Rapid transit continues to form the backbone of Auckland's transport system. This is critical for access improvements and to supporting and shaping Auckland's growth as noted in the Government's recent National Policy Statement on Urban Development. It reflects the Government's priority that private and public housing and urban development at scale should be located around public transport at scale. The ATAP 2021-31 package includes rail network upgrades and significant investment in busway improvements.

32. The package allocates $1.8 billion seed funding for Auckland Light Rail with priority being the City Centre to Mangere corridor. ATAP 2021-31 also includes an allocation

for the business case work (and for property acquisition) on an additional Waitemata Harbour Crossing. I have asked officials to progress this work.

33. The package also includes supports housing development in the Drury area with $1.6 billion in total including:

33.1. Mill Road $1.354 billion

33.2. Electrification from Papakura to Pukekohe $371 million

33.3. Third main line $315 million

33.4. Drury Rail stations $247 million

33.5. SH1 improvements Papakura to Drury South $423 million

33.6. Drury and Paerata Growth Area $243 million.

The Government will need to cover Auckland Council's share to better meet our housing objectives

34. [redacted].

The programme is not sufficient for housing objectives or our climate change objectives

35. The programme has been developed on the basis of Auckland Council's growth strategy and the Unitary Plan. Auckland Council is undertaking further work to understand and meet the requirements of the NPS-UD. The ATAP programme does not necessarily enable Auckland Council to meet the requirements of the National Policy Statement on Urban Development (NPS-UD) and we expect Auckland Council to make further investment decisions to meet the requirements of the NPS-UD.

36. Furthermore the Ministry of Housing and Urban Development have identified crucial developments that it considers is essential to reducing Auckland's housing shortfall and meeting existing need. ATAP invests in these projects but not at a sufficient level to achieve scale and pace. The Ministry of Housing and Urban Development has identified the following investment is required:

36.1. [redacted]

36.2. [redacted]

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36.3. [redacted]

[redacted]

37. [redacted] the total discretionary spend within ATAP is $1.844 billion meaning it is not possible to fully fund this requirement within ATAP without additional funding either from the Crown or Auckland Council. [redacted]

38. The ATAP work has acknowledged there is limited discretionary funding in the programme. Challenging choices have been made to balance investment across objectives. The highest priority development for the Government is the Auckland Housing Programme followed by development in Drury. [redacted]. To accommodate the additional spend ($321 million) indicated as needed by the Ministry of Housing and Urban Development, the following trade offs would be needed:

    38.1. Funding for the Northwest Growth Area would be reduced by $132 million from $186 million to $54 million or funding to support Connected Communities (an integrated public transport and cycling programme in the isthmus) would be reduced by $132 million from $628 million to $496 million

    38.2. Stage and sequence some of the Regional Fuel Tax programme (previously consulted on) including Glenvar, Lake and Lincoln Roads to release $81 million

    38.3. Funding for regional improvement projects, network performance and technology would be reduced by $90 million from $269 million to $179 million

    38.4. Smales Allens Road Widening and Intersection Upgrade would not be included in the ATAP programme ($18 million).

39. The additional investment in the Auckland Housing Programme would fund a number of projects through Mt Roskill, Mangere, Tamaki, and Oranga including: a number of intersection upgrades, arterial road upgrades to implement bus priority measures, walking and cycling bridges over SH20, collector road upgrades, additional bud lanes in Mangere, upgrading the Middlemore Rail Station, and local neighbourhood roading asset renewals and upgrades in Oranga. Further detailed work on the prioritisation of the projects within this package would be needed if this funding is agreed.

40. In relation to accommodating housing in Drury, in the second quarter I will be considering the current scope and costings of projects within the New Zealand Upgrade Programme with the Minister of Finance. [redacted]

Climate

41. Overall, the focus of the investment in the ATAP 2021-31 package is on achieving mode shift from the private vehicle towards public and active transport, continued investment in renewal of transport assets in Auckland and ensuring sufficient operating expenditure to run the network.

42. The independent Climate Change Commission's draft advice on the first three emission budgets forecasts to meet the emission budgets the distance travelled by walking needs to be increased by 25%, cycling 95% and public transport 120% by 2030. This package goes some way to achieving that in Auckland with a 43% increase in walking and cycling trips and 91% increase in public transport trips forecast by 2031 as a result of the investments made in this package.

43. Given the challenge set by the Independent Climate Change Commission the emission budgets will not be achieved on present plans.

44. An allocation of $1.1 billion in the ATAP 2021-31 investment package to cycling sees cycleways completed through the isthmus. An additional $360 million (funded through the New Zealand Upgrade Programme) will see the Northern Pathway completed between Westhaven and Akoranga and $50 million is provided for a Glen Innes to Tāmaki cycleway. Other cycling investment includes the Te Whau Pathway, provision of a cycleway as part of the Eastern Busway, a pedestrian and cycling link on the old Mangere Bridge and cycling investment in the west and south of Auckland as part of the Auckland Transport cycling and walking programme.

45. This ATAP work has highlighted the need for significant investment in Auckland's rail network from 2030 onwards. ATAP 2021-31 has prioritised investment that is needed to support the opening of the City Rail Link but there is insufficient funding to progress the wider rail network development that Auckland requires. I will be working with officials over coming months to gain a better understanding of the rail investment required and this will form part of the Rail Plan and rail network investment conversations. The ATAP agencies will advise on investment for decades 2031-51 later this year and I will advise as appropriate.

Public Transport Concession Scheme

46. Funding for running a pilot of a public transport concession for Community Service Card holders for Auckland has been included as a new initiative. This will reduce the costs of public transport for those on lower incomes. I have requested that officials look at options for an ongoing scheme for Auckland and a national rollout. This will require Government funding.

47. The introduction of a public transport concession for Community Service Card holders Pilot in Auckland would see approximately an additional 2.7 million public transport trips in Auckland in the first 12 months of implementation. This represents approximately 3% of total public transport trips in Auckland.

Reduction in greenhouse gas emissions per capita

48. In the short term, the 2021-31 ATAP investment package sees an increase of 6 per cent in carbon dioxide emissions from transport in Auckland. Increased investment in public transport projects and walking and cycling are designed to encourage the move from private car to public transport supporting emissions reduction but population increase works against this. If the Auckland population remained stable, the ATAP 2021-31 package would result in a 13 per cent decrease in emissions when compared with the previous package.

49. Without the ATAP 2021-31 investment package, carbon emissions increase by just over 9 per cent.

50. The total CO2 emissions reduction resulting from the ATAP 2021-31 investment package is 133,988 (annual CO2 tonnes equivalent). The reduction in emissions moves from approximately 4,648,960 annual CO2 tonnes equivalent without this investment package to 4,514,972 annual CO2 tonnes equivalent with this investment

Further investment and regulation will be required

51. To achieve meaningful reductions, changes are required in the private car fleet which generates most transport emissions in Auckland and nationally. Government policy levers including regulation and financial incentives need to be implemented to reduce car use, and drive a rapid transition to an electrified private vehicle fleet.

52. To drive further transport emission reductions, further investment and regulation will be required, as a large proportion of current expenditure is on non-discretionary network maintenance and investment in public transport. As in other areas of the economy, there is a need to front-load investment with the aim of reducing emissions quickly and laying the groundwork for reduced emissions in future. In Auckland, future investment in other projects to drive mode shift will be required. Key projects that have been identified in discussion with officials are:

- Auckland Light Rail
- Extension of the Northern Busway
- Additional investment in rail infrastructure
- A wider cycleways programme
- Progressing to construction of Puhinui to Botany rapid transit.

53. As Government, we are developing multiple policies to reduce vehicle emissions in order to achieve forthcoming 2022-2035 emission budgets and the long term goal of net zero CO_2 emissions by 2050, as required under the Climate Change Response Act 2002. You have recently agreed to a CO_2 emissions standard for light vehicles imports by 2025 (the Clean Car Standard), to introduce a biofuel mandate in principle, to decarbonise the public transport bus fleet by 2035 and to reduce the fleet size and emissions of the Government's own vehicles by 2025. Further initiatives, including an incentive for low emission vehicles, as signalled publicly in January, will be needed to increase supply and demand.

54. Auckland could contribute around 35-40% of the national estimated emissions reduction from implementing a biofuels mandate, the Clean Car Standard and decarbonising the public transport bus fleet. With these measures, Auckland could reduce carbon emissions by 1-2 mega tonnes between 2022 and 2031. This will increase to a 4-8 mega tonne reduction between 2022 and 2050.

Funding the ATAP 2021-31 Package

55. The proposed ATAP 2021-31 package assumes that all eligible Auckland Transport projects will receive a Funding Assistance Rate (FAR) of 51 per cent from the NLTF and it [redacted]

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56. To enable the cost of Auckland renewals to be met from 2024 onwards it is expected that there will need to be an increase to the Local Road Maintenance Activity Class in the GPS. I am aware that this will require broader trade-offs to be made within the GPS and overall affordability will need to be considered.

57. I have directed officials at the Ministry of Transport and Waka Kotahi, the New Zealand Transport Agency to progress this work to enable the funding allocated to Auckland as indicated in the GPS to be accessed for the best Auckland projects.

Limitation of ATAP process

58. The ATAP process has been useful to align transport priorities and investment across central and local government in Auckland. However, the size and scale of Auckland means that larger scale intergenerational investment is required across multiple infrastructure types including transport, housing, water and social.

59. The Government (we) need to clarify our priorities for Auckland and how best to manage the infrastructure deficit. Taking an integrated approach across portfolios to address investment is needed. T[redacted] on housing and urban growth policy, we need to also address those questions in order to make the best transport investment decisions.

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Consultation

60. Auckland Council, Waka Kotahi, Auckland Transport, the Treasury, KiwiRail and the Ministry of Transport have worked in partnership on the ATAP 2021-31 investment package. In addition, consultation has occurred with the Ministry for the Environment, the Ministry of Business, Innovation and Employment. The Ministry of Housing and Urban Development has been involved in the working group. The Department of Prime Minister and Cabinet has been informed.

61. A broad range of stakeholders were consulted during the ATAP process, representing business, freight, property, health, public and active transport advocates (refer to Appendix B for a full list of stakeholders).

62. The Auckland Business Forum noted they would like to see a greater emphasis placed on investment in freight and are supportive of the introduction of congestion pricing as part of ATAP. Infrastructure New Zealand support the recommended package noting that in the longer term, a combination of funding sources including value capture, road pricing and increased Crown investment are needed.

63. Emissions were discussed including broader policy levers that will be needed.

64. Stakeholders were supportive of the direction of the ATAP work recognising that it is largely a continuation of the previous investment package (2018-28) and signalled a strong desire to see continued momentum towards delivering this transformative programme of transport investments for Auckland. They have also requested greater communication on progress as we move forward and I will be working with officials on this.

Financial Implications

65. There are no direct fiscal implications arising from this paper, however, there is an expectation that spending through the NLTF will be required for ATAP.

Impact Analysis

Climate Implications of Policy Assessment

66. In The Climate Implications of Policy Assessment (CIPA) team has been consulted and confirm that the CIPA requirements apply to this proposal as one of the explicit policy objectives is to reduce emissions.

67. MFE support the proposed increased investment in public transport projects and walking and cycling are designed to encourage transport modes shift and will lead to likely significant long term emissions reductions. We are also supportive of the introduction of a public transport concession for Community Service Card holders Pilot in Auckland and expect this to have an impact on emissions while also having wider benefits for low income households. These measures and investment will work in conjunction with wider transport initiatives to reduce emissions such as the Clean Car Standard and decarbonisation of the public transport bus fleet.

68. A CIPA quantification sheet could not be completed for this proposal as all the necessary information is not currently available.

69. The CIPA team will work with the Ministry of Transport to assess emissions impacts as part of a future Cabinet paper proposal for the longer term investment (2031-2050).

Population Implications

70. The introduction of a public transport concession for Community Service Card holders pilot in Auckland will see positive benefits for card holders including improved access to social and economic opportunities, direct financial savings by lower public transport costs and lower costs as compared to operating a car. Māori, Pasifika, and New Zealanders with disabilities are disproportionally represented within the Community Service Card holders and will benefit from the pilot.

71. Regional improvements in accessibility and safety will result in positive impacts for population groups in Auckland, including Māori. New investment of $13 million in road safety improvements at marae and papakāinga housing will benefit Māori living in Auckland. Investment in neighbourhood safety improvements such as traffic calming and pedestrian safety improvements in low decile areas of south and west Auckland will also benefit Māori and Pacific populations.

72. However, journey times to services and employment in the south and west of Auckland is likely to lengthen due to increased congestion on the motorway network which is likely to have a detrimental effect on Māori and Pacific populations, given the concentration of these groups in these areas.

73. A package of accessibility, safety and security improvements on the public transport network will support users with access challenges such as people with disability.

74. Equity in accessing transport remains a challenge for Auckland and I have asked officials to identify appropriate actions to address this.

Communications

75. I will be announcing the ATAP 2021-31 package of investment jointly with the Mayor of Auckland.

76. The launch of the 2021-31 ATAP investment package is likely to be early March prior to the consultation period for the Auckland RLTP.

Proactive Release

77. I intend to release the Cabinet paper proactively in full within the 30 day timeframe.

Next steps

78. The parties are overseeing drafting of a report that explains the ATAP 2021-31 package.

79. We intend to release this report publicly once we have approved it.

80. I am planning a launch event with the Mayor of Auckland to announce the ATAP 2021-31 package.

Informing the Regional Land Transport Plan

81. For the ATAP process to inform consultation on the RLTP, Cabinet and the Council's Governing Body will need to agree to the ATAP package by March 2021.

82. Decisions by Cabinet will be communicated to the Council so the ATAP 2021-31 package informs the Auckland RLTP.

Recommendations

83. The Minister for Transport recommends that the Committee:

   1. **note** that the Auckland Transport Alignment Project (ATAP) has developed a package of transport investments (the ATAP package) for Auckland over the next decade (2021–2031) which reflects the following priorities:

      - enabling Auckland's growth through a focus on intensification in brownfield areas and with some managed expansion into emerging greenfield areas
      - accelerating better travel choices for Auckland (modeshift)
      - better connecting people, places, goods and services
      - improving resilience and sustainability of the transport system and significantly reducing the greenhouse emissions it generates
      - making Auckland's transport system safe by eliminating harm to people
      - ensuring value for money across Auckland's transport system through well targeted investment choices.

   2. **either** :

      a. **agree** the core ATAP 2021-31 package developed by officials. This emphasises mode shift from private vehicles towards public transport, walking and cycling as well as continued investment in renewal of transport assets in Auckland and that includes the following key elements:
         - Seed funding for light rail, with the priority being the city centre to Māngere corridor
         - Eastern busway (Panmure-Botany)
         - Airport-Puhinui state highway upgrade, bus/rail interchange and bus priority improvements
         - Pukekohe electrification and third main Wiri to Quay Park
         - Mill Road
         - Penlink

- Walking and cycling programme
- Significant programme of safety improvements
- Bus priority programme
- Network optimisation and technology programme
- Additional electric trains
- City Rail Link and complementary programme of day one work required
- Sufficient operating expenditure to run the Auckland network and cover a public transport concession for Community Service Card holders pilot for Auckland.

OR;

b. **agree** an amended ATAP 2021-31 package. This retains the core elements of the package developed by ATAP officials and enables more housing development by allocating $321 million to transport investments to support the Auckland Housing Programme. To enable this package, key trade-offs include:

- Funding for the Northwest Growth Area would be reduced by $132 from $186 to $54 million or funding to support Connected Communities (an integrated public transport and cycling programme in the isthmus) would be reduced by $132 million from $628 million to $496 million
- The Regional Fuel Tax (previously consulted on) programme would see the removal of funding for two roading projects on the North Shore of Auckland to the value of $81 million
- Funding for two regional improvement projects, network performance and technology would be reduced by $90 million from $269 million to $179 million
- Smales Allens Road Widening and Intersection Upgrade would not be included in the ATAP programme ($18 million).

3. **note** that rail network investment in Auckland requires funding beyond what ATAP 2021-31 can provide to increase the capacity required for future decades.

4. **note** that there is a small provision for investment in the Government spatial priority areas in the proposed ATAP 2021-31 programme.

5. **note** that the ATAP programme does not necessarily enable Auckland Council to meet the requirements of the National Policy Statement on Urban Development (NPS-UD) and we expect Auckland Council to make further investment decisions to meet the requirements of the NPS-UD.

6. **note** that the 2021-31 ATAP investment package sees an increase of 6 per cent in carbon dioxide emissions from transport in Auckland. On a per capita basis, carbon dioxide emissions reduce by 13% highlighting that continued population growth in Auckland works against the modeshift oriented investment.

7. **note** that further infrastructure investments, behavioural change and use of technology will be required to reduce Auckland's transport emissions to a degree that is consistent with the goals of the Government and the interim direction of the Independent Climate Commission.

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8. [redacted]

9. [redacted].

10. **note** that ATAP 2021-31 will inform statutory processes in the coming months including the Regional Land Transport Plan and National Land Transport Programme.

11. **note** that I am planning a launch event with the Mayor of Auckland to announce the ATAP 2021-31 package.

12. **agree** to the release of a public-facing report detailing the ATAP 2021-31 package.

13. **Invite** the Minister for Infrastructure to convene a meeting with the Minister of Housing, Minister of Transport and Minister of Local Government on a whole of government integrated approach to future Auckland development decisions including achieving alignment with Auckland Council on urban growth and finding planning and funding solutions for Drury and the Northwest.

Authorised for lodgement

Hon Michael Wood

Minister for Transport

Hon Michael Wood

Minister of Transport
Minister for Workplace Relations and Safety

22 February

Hon Phil Goff, Mayor of Auckland

Subject: Auckland Transport Alignment Project and regional transport emissions

Dear Phil,

The challenge of moving carbon emissions to net zero by 2050 is a significant one, and transport, which produces around 50% of New Zealand's C02 emissions needs to be at the forefront if we are to achieve the reductions proposed by the independent Climate Change Commission in its draft emissions budgets. I am pleased that you and your councillors are as committed to the task as myself and the Government.

Clearly the investments we make through ATAP need to be consistent with our shared ambition to decarbonise transport, and from this point of view it is pleasing that the modelling shows that the proposed programme would result in a 13 per cent decline in emissions per person over the next decade, achieved through a 91 per cent increase in public transport trips and a 43 per cent increase in walking and cycling trips. This shows that the proposed ATAP investments will offer Aucklanders better transport choices and that the package has a meaningful impact on emissions.

The point that you identify is that Auckland's strong population growth has the effect of overwhelming these gains, resulting in a gross modelled emissions increase of six per cent over the period in question. You and your councillors are correct that we need to take steps to ensure that gross emissions decline rather than increase.

Given the scale of the transport decarbonisation task and Auckland's strong growth we will have to use all of the levers at our disposal. ATAP, which mainly focusses on a large slice of infrastructure investment is one of those levers, but not the only one. As such, when we work together to reduce Auckland's transport emissions we will need to consider not only the impact of ATAP investments, but other tools, including but not limited to:

- Other transport investments (e.g. current significant crown funded rail investments like the upgrade of the line between Swanson and Whangarei to help more freight move by rail)
- Behavioural changes such as educational campaigns to encourage people to take up public transport or active modes, incentives to encourage public transport uptake, and early work to consider congestion charging
- Decarbonisation of the vehicle fleet, which the government is moving aggressively on with recent announcements to introduce a Clean Car Standard, mandate a biofuels blend, and to work with local government to phase out diesel buses
- Working to improve the delivery of safe cycling infrastructure in Auckland, which has been slower than any of us would think ideal.

Officials advise me that some of these measures, when combined with the ATAP investments will result in a greater per capita emissions decrease than achieved through ATAP alone, and an overall emissions decrease.

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The total CO_2 emissions reduction resulting from the ATAP 2021-31 investment package is 133,988 tonnes of CO_2 per year. Auckland could contribute around 35 to 40 per cent of the national estimated emissions reduction from implementing a biofuels mandate, the Clean Car Standard and decarbonising the public transport bus fleet. With these measures, Auckland could reduce carbon emissions by further 1 to 2 million tonnes between 2022 and 2031. This will increase to a 4-8 million tonne reduction between 2022 and 2050. Without these measures, Auckland would emit 4,648,960 annual CO_2 tonnes equivalent over the next ten years and this would continue to grow.

These decarbonisation measures are a positive start and for the first time, puts us on track to reduce transport sector emissions in Auckland. However, more clearly needs to be done. It is important that the proposed ATAP package proceeds in order for a range of important investments that will give Aucklanders greater transport choice to proceed. Once the package is in place I am keen to engage with Auckland Council and Auckland Transport further to consider initiatives that we can co-operate on to advance our shared ambition to decarbonise Auckland’s transport system. I would propose that we formally bring in the expertise of the Climate Change Commission to assist us with this work.

Thank you again for your engagement in the ATAP process and for the clear stance that you and your Council have taken in support of decarbonisation. I look forward to working with you and hope this letter provides some assurance to Auckland Council that central government will continue working with you to use all the necessary levers to meet this challenge.

Yours Sincerely,

M. Wood.

Hon Michael Wood
Minister of Transport

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HB1-130

Hīkina te Kohupara – Kia mauri ora ai te iwi

Transport Emissions: Pathways to Net Zero by 2050

Ministry of Transport
TE MANATŪ WAKA

Enabling New Zealanders to flourish

May 2021

GREEN PAPER

NOT GOVERNMENT POLICY

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Foreword
Kupu whakataki

Hon Michael Wood
Minister of Transport

The challenge is clear. If we are to mitigate the worst effects of climate change, we have less than 15 years left to halve greenhouse gas (GHG) emissions. That's why this Government declared a climate emergency, and it's why we are taking action to reduce emissions.

While Aotearoa's transport system is often seen as just about getting people or products from A to B, it is also a major contributor of emissions and has an enormous impact on our health, environment and quality of life. Transport accounts for 47 percent of our carbon dioxide emissions, and roughly a fifth of NZ's GHG emissions. Air pollution, accidents and congestion from traffic are bad for our health and productivity.

The challenge before us is without precedent. However, eliminating emissions across our economy and within the transport system is achievable and can help support our economic recovery. Reaching that goal will create a better future for us and our tamariki, support the creation of entirely new businesses in low carbon industries, and create sustainable jobs across the country. Reaching our aspirations will also help unclog our cities, move freight more sustainably, and improve our air quality.

The Government's actions to date have already begun to lay the groundwork to reduce transport emissions. We have the opportunity to build a cleaner, healthier, safer and more equitable transport future. New policies, which include the Clean Car Standard, decarbonisation of the public transport fleet and the biofuels mandate are a solid start. However, to effectively reduce emissions across the entire transport system, more action is needed.

The Ministry of Transport's *Hīkina te Kohupara Kia mauri ora ai te iwi* sets out a strategic and phased set of potential pathways and approaches to phase out emissions across our transport system. While the pathways outlined in *Hīkina te Kohupara* are not Government policy, we want to have a national conversation about the changes we all need to make.

Hīkina identifies opportunities to move Aotearoa towards a net zero carbon transport system by 2050. The plan considers the key relationships transport has with other sectors, such as energy and urban development; and considers the impacts not only on the transport sector, but generationally, by gender, socio-economically, and ethnically, with a focus on Māori and Pasifika.

A key challenge will be to incorporate the need to reduce emissions across transport projects and urban development. We will also require innovative approaches to decision-making and financing for infrastructure choices, and move away from ‘business as usual’ approaches.

As a nation, we need to accept that the journey to halve our transport emissions by 2035 will lead to some hard choices, not only within the sector but across the economy and our society. Any climate response, however innovative it might be, must be fair, equitable and inclusive. Therefore, a carefully considered approach with public input is vital to manage the impacts and opportunities that come with moving to a net zero carbon economy.

The Government’s priority is to build a zero carbon Aotearoa that better meets the needs of people, communities and the planet. *Hīkina* explores how this could be achieved.

Executive Summary

On 2 December 2020, Government declared a climate emergency for Aotearoa and committed to taking urgent action to reduce emissions.

Hīkina te Kohupara – Kia mauri ora ai te iwi: Transport Emissions: Pathways to Net Zero by 2050 (Hīkina te Kohupara) identifies what Aotearoa could do to shift the transport system onto a zero emissions pathway. It sets out a system-wide approach for reducing transport emissions.

This discussion paper will contribute to the Government's Emission Reduction Plan, which must be completed by December 2021. It will also be used to develop a 10-15 year time horizon action plan for how Aotearoa will continue to reduce its transport emissions.

Our transport system needs to shift to a low/zero carbon pathway as soon as possible to meet our emissions reductions commitments and targets. Transport is responsible for 47 percent of total domestic CO_2 emissions, and 19.7 percent of total greenhouse gas emissions. Without largely decarbonising transport, Aotearoa will not be able to achieve its net zero carbon target as mandated by the Climate Change Response Act 2002 (CCRA) by 2050.

Decarbonising our transport system will be challenging. However, this transition could make Aotearoa a healthier, safer, more vibrant, resilient, and prosperous place to live and work. There are many opportunities to reduce emissions while improving well-being and the liveability of our towns and cities. This will require difficult choices to be made by Central and Local Government about how to prioritise investment and other action to move different sectors to low-carbon pathways. This will include considering which policies are progressed, and assessing what regulatory, investment, economic and education tools will help deliver these choices. Alongside this will be the need to negotiate the choices, including understanding what trade offs within transport and across sectors are made to achieve or implement chosen policies.

Local and central government have been taking action to address transport emissions. This has included investment through the Government Policy Statement on land transport for public transport, walking and cycling, and rail. Government has agreed to implement the Clean Car Standard and there are road user charge exemptions for electric vehicles to encourage uptake. However, a lot more is required for our transport system to significantly reduce emissions at the pace required.

Hīkina te Kohupara identifies opportunities to reduce emissions across three themes, based on the 'Avoid, Shift, Improve' framework.

- ***Theme 1*** – *Changing the way we travel:* We need to shape our towns and cities to make it easier, safer, and more attractive for people to access work, schools, shops, and other opportunities by public transport, walking, and cycling. This will reduce dependence on private motorised vehicles, and avoid/reduce emissions. Transport needs to be integrated with land-use planning to encourage quality compact mixed-use urban development, while providing better transport options. Transport pricing, and other demand management tools, could also play an important role.

- ***Theme 2*** – *Improving our passenger vehicles:* 67 percent of Aotearoa's transport emissions currently come from light vehicles (including cars, small vans, and SUVs). Decarbonising the light vehicle fleet is crucial. We need to increase the supply of clean vehicles, increase demand for them, and provide supporting infrastructure. Biofuels could also play an important role in reducing emissions from the current fleet (and other modes). Public transport fleets, particularly buses, also need to shift to being cleaner vehicles. Cleaner aviation technologies are in the early stages of development, but there are opportunities to reduce emissions by using sustainable aviation fuel.

- ***Theme 3*** – *Supporting a more efficient freight system:* 23 percent of Aotearoa's transport emissions currently come from heavy vehicles (mostly trucks). While light vehicles currently produce the most emissions, trucks will produce the most emissions by 2055 without further interventions. Emissions could be reduced by improving the efficiency of supply chains, shifting freight to low emission modes, and improving the fuel efficiency, and carbon intensity of freight modes and fuel. Trucks will need to be decarbonised through the uptake of alternative fuels such as biofuels, electrification, and/or green hydrogen.

These changes will need to be co-ordinated, and staged, to maximise the opportunities for reducing emissions from now to 2050. Many decisions need to occur within the first emissions budget (2022 to 2025).

While everyone in Aotearoa will experience changes from the transition to zero emissions, and many people will benefit, the impacts of this shift will not be spread evenly. People who already experience social/economic disadvantages could be disproportionately affected if transport costs increase. This means that Government needs to carefully consider the impacts of policies and changes on different communities and regions to ensure a Just Transition.

Future work will need to ensure that policies are fair, equitable, and inclusive. Government must work with Iwi/Māori, communities, regions, and sectors to manage the impacts and maximise the opportunities of the changes ahead.

There are many pathways that Aotearoa could take to achieve a zero carbon transport system by 2050. Hīkina te Kohupara models four potential pathways. These pathways are not limited by current Government policies or commitments. The pathways aim to provoke thinking and illustrate the scale of the changes required. The modelling shows that it will be challenging to reach net zero by 2050, *but* it can be achieved if complementary policies are implemented across the transport system.

Aotearoa's pathway to a zero carbon transport system will be shaped by the actions of Government, civil society, business, and consumers over the next three decades. Substantial and sustained actions will be required to decarbonise our transport system. Actions taken or not taken within the next five years will significantly shape this future pathway, and determine how close we get to, or stray from a zero carbon target.

Hīkina te Kohupara is one step on our path to a zero carbon transport system. We do not underestimate the challenges ahead, but we recognise the imperative to change. We also see the opportunities to create a better transport system through this transition that is cleaner, healthier, safer, inclusive, and resilient, and enables the people and businesses of Aotearoa to flourish.

Guide to reading this document

This document has three main parts, as summarised below.

Part One: Context		
Chapter 1	**Introduction**	*Sets out the purpose of Hīkina te Kohupara and how it relates to advice from the Climate Change Commission, the Emissions Reduction Plan and a future transport strategy.*
Chapter 2	**Transport emissions – our current state and pathway**	*Outlines Aotearoa's rising transport emissions, and where they come from. It also includes the principles used to shape our analysis.*
Chapter 3	**Government's role in reducing emissions**	*Summarises the range of levers that Government can use to reduce transport emissions.*
Chapter 4	**The role of innovation in the transport system**	*Outlines the opportunity that innovative ideas, policies, and technologies provide to improve the way people and goods move around.*
Part Two: Opportunities to reduce emissions		
Chapter 5	**Avoid, Shift, Improve Framework**	*Explains the framework that underpins our strategic approach.*
Chapter 6	**Theme 1: Changing the way we travel**	*Identifies opportunities to avoid and shift emissions from people travelling, by developing better towns and cities that support transport mode shift.*
Chapter 7	**Theme 2: Improving our passenger vehicles**	*Identifies opportunities to reduce emissions by improving our vehicle fleets (including light vehicles, public transport, and domestic planes).*
Chapter 8	**Theme 3: Supporting a more efficient freight system**	*Identifies opportunities to reduce freight emissions.*
Part Three: Pathways		
Chapter 9	**Supporting a Just Transition**	*Outlines key considerations for supporting a Just Transition, and mitigating potential distributional impacts of transport emission reduction policies.*
Chapter 10	**Four potential pathways**	*Sets out four potential pathways for how we could reach a zero carbon transport system by 2050 and a breakdown of the potential investment required to achieve this outcome.*
Chapter 11	**What opportunities should the Government progress in the first three emissions budgets?**	*Sets out current policies that contribute to mitigating emissions and proposals for the first three emissions budgets.*
Chapter 12	**Where to next?**	*Sets out the next steps for Hīkina te Kohupara.*

Chapter 1: Introduction

On 2 December 2020, Government declared a climate emergency for Aotearoa and committed to taking urgent action to reduce emissions.[1] In declaring a climate emergency, Aotearoa commits to reducing emissions to avoid more than 1.5 degrees rise in global warming. This is one step towards tackling climate change. Much more is required from across a range of sectors including transport, energy, agriculture and communities. Hīkina te Kohupara seeks to identify opportunities to reduce emissions from the transport sector to assist Aotearoa to move towards net zero emissions and to respond to the climate emergency. Information on how Hīkina te Kohupara was developed is at Appendix A.

Purpose of Hīkina te Kohupara

This discussion paper identifies what Aotearoa could do to shift our transport system on to a zero emissions pathway and seeks feedback on options to achieve this

Aotearoa's transport system needs to decarbonise. Transport currently produces over 19.7 percent of our domestic greenhouse gas (GHG) emissions, and almost half of our carbon dioxide (CO_2) emissions.[2] Transport emissions are still increasing. Without major interventions, transport emissions will not fall quickly enough to deliver on our domestic and international climate commitments and targets.

Various government initiatives exist to reduce transport emissions, and more are underway. However, broader and deeper changes are needed to quickly shift our transport system to a zero emissions pathway.

Hīkina te Kohupara sets out a system-wide analysis of the opportunities for reducing transport emissions in Aotearoa. It highlights potential priority areas and areas that Government could focus on to make the biggest impacts on reducing transport emissions. This includes opportunities within the transport sector, as well as interdependent sectors and systems that have a significant impact on transport emissions.

While Government will play a leading role in making the shift, it needs to work closely with iwi, communities, businesses, and councils to reduce transport emissions

All New Zealanders have a stake in our transport system, as we all form part of this system every time we walk, bike, bus, drive, fly, or catch a train or ferry. Everything we make, grow, buy, or sell in Aotearoa also moves through complex road, rail, air, and sea networks.

The shift towards a zero emissions pathway will therefore be experienced by all people and businesses in Aotearoa. Although government can drive and influence many changes within the transport system, it needs to work with communities to grow the mandate for changes, and to make changes happen.

We are seeking feedback on this discussion paper, including views on policies that should be progressed and implemented.

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[1] Hon James Shaw. (2020). *Climate Emergency Declaration will be matched with long-term action.* Retrieved from: Climate emergency declaration will be matched with long-term action | Beehive.govt.nz

[2] Ministry for the Environment. (2020). *Our atmosphere and climate.* Retrieved from: https://www.mfe.govt.nz/sites/default/files/media/Environmental%20reporting/our-atmosphere-and-climate-2020-report.pdf. P15

Hīkina te Kohupara has dual purposes – to inform the Government's first Emissions Reduction Plan and support a 10-15 year transport emissions action plan

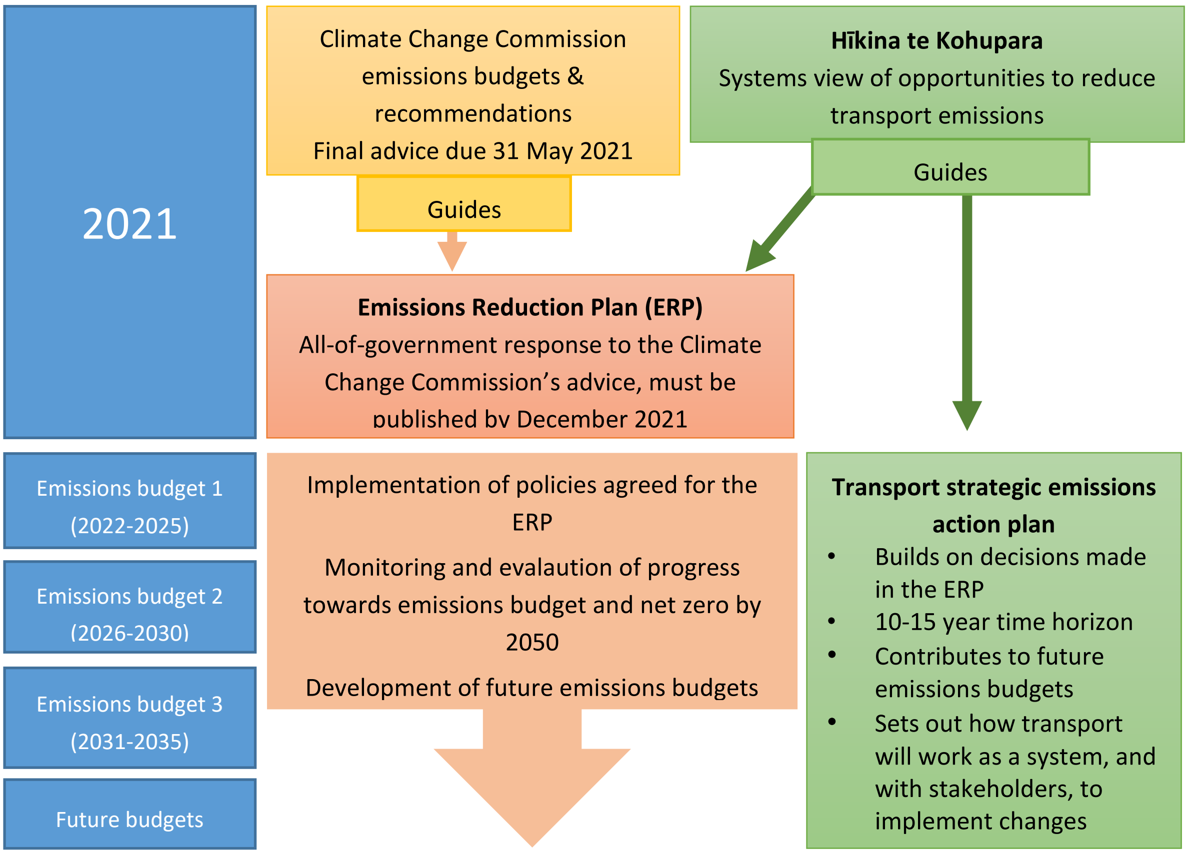
In 2016, Aotearoa committed to taking action against climate change when the Government signed and ratified the international Paris Agreement. The Government agreed to reduce GHG emissions to 30 percent below 2005 levels for the period 2021-2030.

New Zealand's Parliament subsequently passed the Climate Change Response (Zero Carbon) Act in 2019 (CCRA). This Act provides a framework for implementing climate change policies, and for preparing and adapting to the effects of climate change. The CCRA sets a domestic target for Aotearoa to reduce net emissions of all GHGs (except biogenic methane) to zero by 2050.

> Globally, reducing carbon dioxide (CO_2) emissions to net zero is the highest priority in the fight against climate change, because unlike other gases it stays in the atmosphere for hundreds of years.

Hīkina te Kohupara will also inform the development of a 10-15 year time horizon strategy that sets out **agreed** Government policies that extend beyond the first Emissions Reduction Plan. It will include their potential effect on mitigating transport emissions, resource and investment considerations, and the interdependent relationships with other government departments, business, Iwi/Māori that the Ministry will need to engage with to deliver a net zero carbon transport system.

The diagram below illustrates the relationship of Hīkina te Kohupara with the Climate Change Commission's advice, the development of an all-of-government Emissions Reduction Plan and a transport strategic action plan.

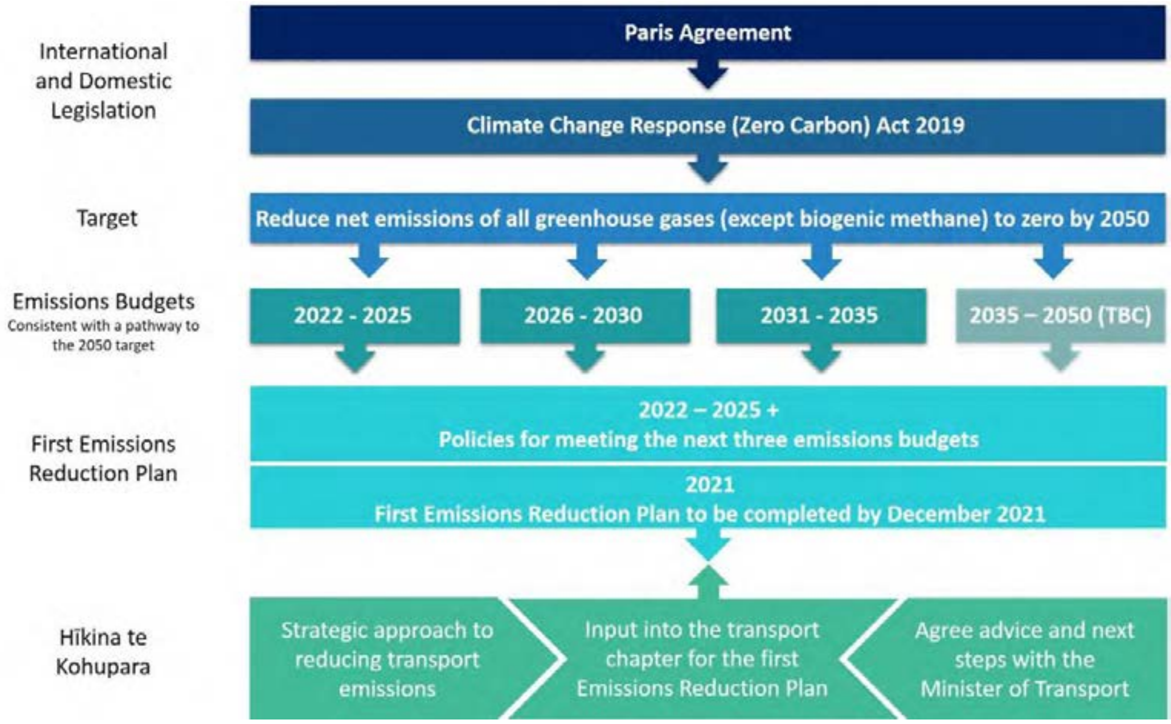


The Government must prepare an Emissions Reduction Plan under the CCRA

The CCRA sets emissions budgets for Aotearoa. These operate as stepping stones to keep us on track to meeting our long-term emissions reductions targets. The Climate Change Commission (the Commission) advises Government on each emissions budget, which cover five-year periods from 2022 onwards (except the first period, which is four years).

The Government needs to confirm and publish its first Emissions Reduction Plan for the period 2022-2025 by 31 December 2021. This will identify policies for meeting emissions budgets from 2022 to 2035. This plan also needs to demonstrate that we are on a pathway to meet our 2050 target.

Hīkina te Kohupara informs the Government's Emission Reduction Plan, by outlining strategic approaches and opportunities to reduce transport emissions. The diagram below illustrates the role of Hīkina te Kohupara in relation to the Government's first Emissions Reduction Plan.



The Climate Change Commission has issued draft advice on its first three emissions budgets

The Commission, He Pou a Rangi, released its draft advice and emissions budgets on 1 February 2021 for public consultation. The advice sets out the Commission's draft advice on the first three emissions budgets and the Government's first emissions reduction plan.[3] The Commission's final advice is due on 31 May 2021.

[3] Climate Change Commission (2020). *Our Advice and Evidence.* Retrieved from: Our advice and evidence » Climate Change Commission (climatecommission.govt.nz)

For transport, the Commission identified the following as key to Aotearoa transitioning along it’s pathway to decarbonise transport.

Climate Change Commission’s Table 3.1: Key transitions along their path.

<table>
<tr><th></th><th></th><th>Budget 1</th><th>Budget 2</th><th>Budget 3</th></tr>
<tr><td rowspan="3">Transport</td><td>Road transport</td><td colspan="2">Accelerate EV uptake

Improve average efficiency of new Internal Combustion Engine (ICE) vehicles</td><td>Phase out new light ICE vehicles

Electrify medium and heavy trucks</td></tr>
<tr><td>Reducing travel demand</td><td colspan="3">Encourage remote working for those who can

Encourage switching to walking, cycling and public transport</td></tr>
<tr><td>Non-road transport</td><td>Electrification of rail</td><td colspan="2">Biofuel blending

Start electrification of ferries and costal shipping</td></tr>
</table>

A number of recommendations are made by the Commission for transport. These include emphasis on:

- developing an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport
- a package of measures to accelerate light electric vehicle uptake, including consideration of EV battery refurbishment and waste; steps to mitigate impacts for low-income households and people with disabilities, regional and remote access, and with limited access to electricity; and evaluating the role of other pricing mechanisms beyond the NZ Emissions Trading Scheme.
- policies to increase the use of low carbon fuels for trains, ships, heavy trucks and planes.

Additionally, the Commission recommends in the first budget period that Government promote the evolution of urban form to enable low emissions transport and buildings through ongoing legislative reform. This should include ensuring a coordinated approach to decision making across government agencies and local councils. This would help embed a strong relationship between urban planning, design and transport. This may help ensure that communities are well designed, supported by integrated, accessible transport options, including safe cycleways between home, work and education.

Officials will use the emissions budgets to shape advice to Government and to inform the development of the first all-of-government Emissions Reduction Plan. The first Emissions Reduction Plan will focus on Budget 1.

Our transport system needs to shift to a low carbon pathway very rapidly to meet our targets

The most optimistic baseline modelling shows that transport emissions in Aotearoa will be nine percent above 2005 levels by 2030. We will not reach a 30 percent reduction in transport emissions (from 2005 levels) until 2038 – a decade beyond Government's agreed target.

If transport does not make a meaningful contribution to the first Emissions Budget, the transport system will face significantly higher pressures and expectations in later years. Actions to reduce emissions now could avoid the need for more drastic actions in the future. Changes in the transport system often take decades to play out (such as turnover of vehicle fleets, new infrastructure, and shifts in urban form), so the transport sector needs to move to a zero carbon pathway as soon as possible.

The transition towards zero emissions will deliver many social, economic, and environmental benefits

Decarbonising our transport system will not be easy. However, this transition could make Aotearoa a healthier, safer, more vibrant, and prosperous place to live and work. For example, our cities will become healthier and more peaceful as vehicle fleets go electric. Improvements in public transport and cycling networks will give people more travel options, manage road congestion, and make it safer and more enjoyable to access workplaces, schools, local services, and shops. More freight will move by rail and coastal shipping, while trucks transition to using biofuels, electricity, or hydrogen. Local energy production will grow, and Aotearoa will become less dependent on international oil markets.

While we focus our vision on reducing emissions, we also need to keep an eye on opportunities to deliver co-benefits from this transition. We need to ensure that the transport system is inclusive, safe, resilient, and supports economic activity. The Transport Outcomes Framework (see Figure 1), which guides all long-term planning in the transport sector, provides a useful framework for identifying these outcomes that could be enhanced, or affected, by initiatives to reduce emissions. This framework has guided Hīkina te Kohupara, and the opportunities within it.

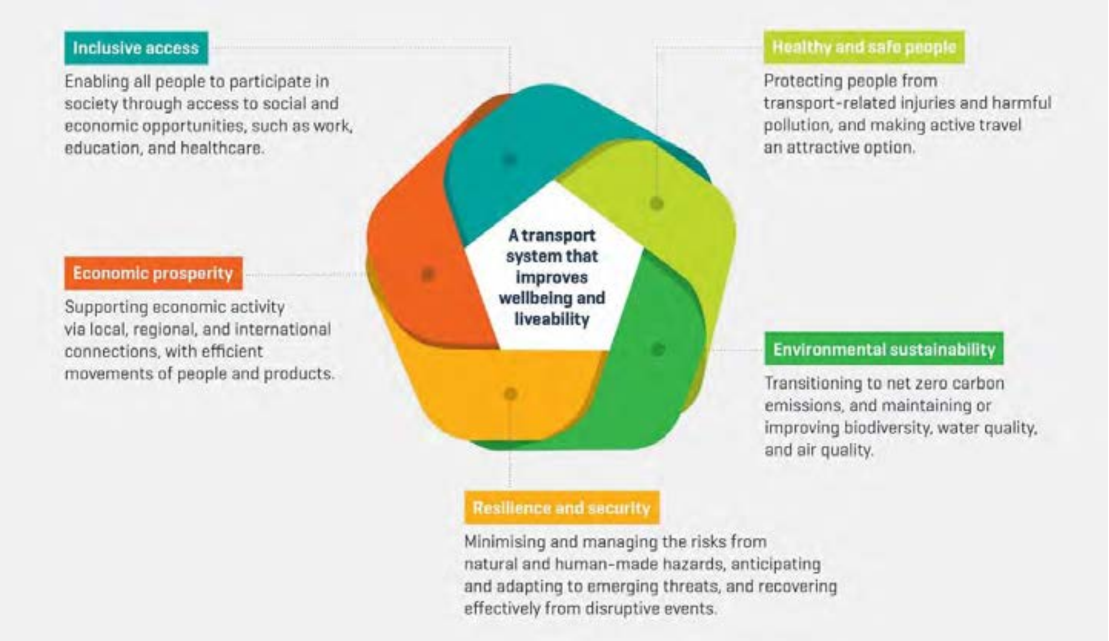


Figure 1 Transport Outcomes Framework

We need to make a Just Transition

While everyone in Aotearoa will be affected by the transition towards zero emissions, the impacts will not be evenly spread. People who already experience social/economic disadvantages could be disproportionately affected if transport costs increase. This means that Government needs to carefully consider the impacts of policies and changes on different communities and regions. The Government should consider investing in such communities early to provide them with more transport choices to support a Just Transition.

Hīkina te Kohupara identifies some of the distributional impacts of potential policies and actions, and highlights a need to mitigate these impacts for disadvantaged groups.

Te Tiriti o Waitangi will underpin policy development to reduce emissions

Te Tiriti o Waitangi (the Treaty of Waitangi) should underpin the Māori-Crown partnership, and collaboration to support the policy development required to reduce transport emissions.

Critical to this is understanding te ao Māori: the Māori world view. A te ao Māori world view inherently and intrinsically acknowledges the interconnectedness and interrelationship of all living and non-living things. It affirms mātauranga Māori – Māori knowledge systems – as fundamental to seeing, understanding, and living within te ao Māori. It also acknowledges te taiao as a taonga, and responsibility for its kaitiakitanga as a cross- and inter-generational responsibility.

It is therefore imperative to seek to understand the total system, not just parts of it. This is in harmony with the approach taken in this report – whereby we have chosen to review the whole transport system to better understand it's interconnectedness and opportunities to reduce emissions.

The principles of whanaungatanga (relationships) and kaitiakitanga (environmental guardianship) are central to this work and underpin our ongoing engagement to reduce emissions from the transport system.

We intend to commence this through the establishment of marae-based technical advisory groups with regional Iwi. This will provide an opportunity to build relationships for the ongoing work that results from Hīkina te Kohupara, such as the development of the Emissions Reduction Plan and specific transport policies.

Scope of this discussion document

Hīkina te Kohupara covers **domestic** transport GHG emissions. It does not cover international aviation and maritime emissions for travel to/from Aotearoa, as the Paris Agreement is silent on their inclusion (and subsequent domestic obligations). The government is addressing international emissions through its involvement with the International Civil Aviation Organization and the International Maritime Organization. However, Hīkina te Kohupara does consider some domestic opportunities for reducing maritime and aviation emissions, such as low carbon fuels, which could also reduce international emissions to/from Aotearoa.

Hīkina te Kohupara does not consider embodied emissions in transport infrastructure (such as roads, rail, ports etc.). This is because infrastructure emissions will be captured elsewhere in the Emissions Reduction Plan.

Principles used in Hīkina te Kohupara that shaped our advice

We developed a set of key principles to help shape our advice to the Government on transitioning to a zero carbon transport system. The intention of these principles is to guide discussions around which options Aotearoa should pursue further and prioritise.

Principle 1. The transport sector will play a lead role in meeting our 2050 net zero carbon target

Addressing climate change requires transformational and fundamental change to the transport system. The CCRA sets a domestic target for Aotearoa to reduce net emissions of all GHGs (except biogenic methane) to zero by 2050. Transport is responsible for 47 percent of total domestic CO_2 emissions, and 19.7 percent of total GHG emissions. Early, deep reductions in transport emissions are therefore needed for Aotearoa to meet its emissions reduction targets and our international climate commitments. Our analysis and advice aligns with putting us on a pathway to the 2050 target.

Principle 2. We need to focus on moving to a zero carbon transport system, rather than offsetting emissions

It is unclear how much carbon offsetting will be used at a national level to help meet Aotearoa's emission reduction obligations and targets. This means that we do not know how much we may or may not be able to offset Aotearoa's transport emissions going forward. Other sectors in Aotearoa are likely to find it harder, or take longer, to reduce emissions in comparison to transport, and therefore may be prioritised over transport when it comes to carbon offsetting. Given this uncertainty, we need to focus on what could be required to take us as close to zero transport emissions as possible. We acknowledge that absolute zero would be very difficult to achieve by 2050.

Principle 3. We need to take a strategic approach to reducing transport emissions

Some interventions may take a long time to play out, and require ongoing dedicated action over decades. We need to take a strategic approach that capitalises on short-term opportunities and puts in motion changes that deliver a large impact in the medium and long term. We also need to be strategic about which options we pursue to reduce emissions - prioritising initiatives that will have the largest impact on avoiding and reducing emissions, while delivering value for society (including co-benefits).

Principle 4. Co-ordinated action is required across the transport system to avoid and reduce emissions

We need to pursue multiple, co-ordinated actions to reduce and avoid emissions – both within the transport sector, and in other sectors (such as land use planning) that have a strong influence on transport emissions. This helps to manage risk by avoiding relying too heavily on one solution to meet our targets (for example, a solution that requires technological improvements or significant behaviour change). While Government will play a leading role in making the shift, it needs to work closely with iwi, communities, businesses, and councils to reduce transport emissions.

Principle 5. To ensure a Just Transition we need to manage the impacts and maximise the opportunities brought about by changes to the transport system

Everyone in Aotearoa will experience changes from the transition to a zero emissions transport system. However, some people may be more impacted – for example, people who already experience social/economic disadvantages could be disproportionately affected if transport costs increase. At the same time, policies to reduce emissions can deliver multiple benefits. For example, there are many opportunities to reduce air and noise pollution, improve physical health and mental wellbeing, and make our towns and cities more liveable.

The Government needs to carefully consider both the costs and benefits of policies and changes on different communities, iwi/Māori and regions to ensure a Just Transition and deliver maximum value for New Zealanders.

Principle 6. We need to forge a path to zero transport emissions by 2050, while recognising that there is not one way to get there

There are many pathways that Aotearoa could take to achieve a zero carbon transport system by 2050. Substantial and sustained actions will be required to decarbonise our transport system. Actions taken within the next five years will significantly shape this future pathway, and determine how close we get to, or stray from a zero carbon target. We base our advice on evidence as much as possible. However, we also need to recognise that we will never have all the evidence we need about the future, and that future modelling is often based on experience. We will need to keep adapting to reduce emissions along our future path.

Principle 7. Innovation and technologies will play an important role in reducing emissions, but people are the key to our future

Many existing technologies and techniques are already available to avoid and reduce emissions. Innovative approaches and business models, as well as new technologies, will keep changing the way that people and products travel. While the Government does not usually ‘pick winners’, it can play a powerful role in accelerating the uptake and diffusion of new transport technologies and services. However, ultimately, technological change and uptake depends on people – so we need to put people at the centre of our policy development.

Consultation question 1
Do you support the principles in Hīkina te Kohupara? Are there any other considerations that should be reflected in the principles?

Chapter 2: Transport emissions – our current state and pathway

Key points

- Transport is Aotearoa's second-largest source of GHG emissions, contributing 19.7 percent of gross domestic emissions.
- Transport emissions are increasing, while other sources of emissions have plateaued.
- The majority of transport emissions come from light vehicles (67%), followed by heavy vehicles (23%).
- Per capita, our larger cities generate fewer emissions than rural towns. However, because cities have so many people and vehicles, they produce more emissions overall than rural towns.
- Aotearoa's high level of car dependency has wider impacts on the environment, as well as public health and the economy.

Transport's contribution to Aotearoa's GHG emissions profile

Transport is Aotearoa's second-largest source of GHG emissions

Transport contributes 19.7 percent of gross domestic emissions. In comparison, about 48 percent of emissions come from agriculture, and 20 percent from other energy use.

In 2018, transport was responsible for 47 percent of Aotearoa's total domestic CO_2 emissions. Road transport (including cars, light duty trucks, heavy-duty trucks, buses and motorcycles) emitted 43 percent of Aotearoa's gross CO_2 emissions in 2018.

Transport emissions have risen more than any other emissions source with an increase of approximately 90 percent between 1990 and 2018. This compares with 24 percent for gross emissions across the total economy.

The Ministry's base case forecasts road transport emissions to keep rising until around 2024 (Figure 2), unless major interventions are made to put us on a different pathway.

Emissions will then plateau before slowly declining closer to 2030. This forecast assumes an increasing rate of electric vehicle uptake.

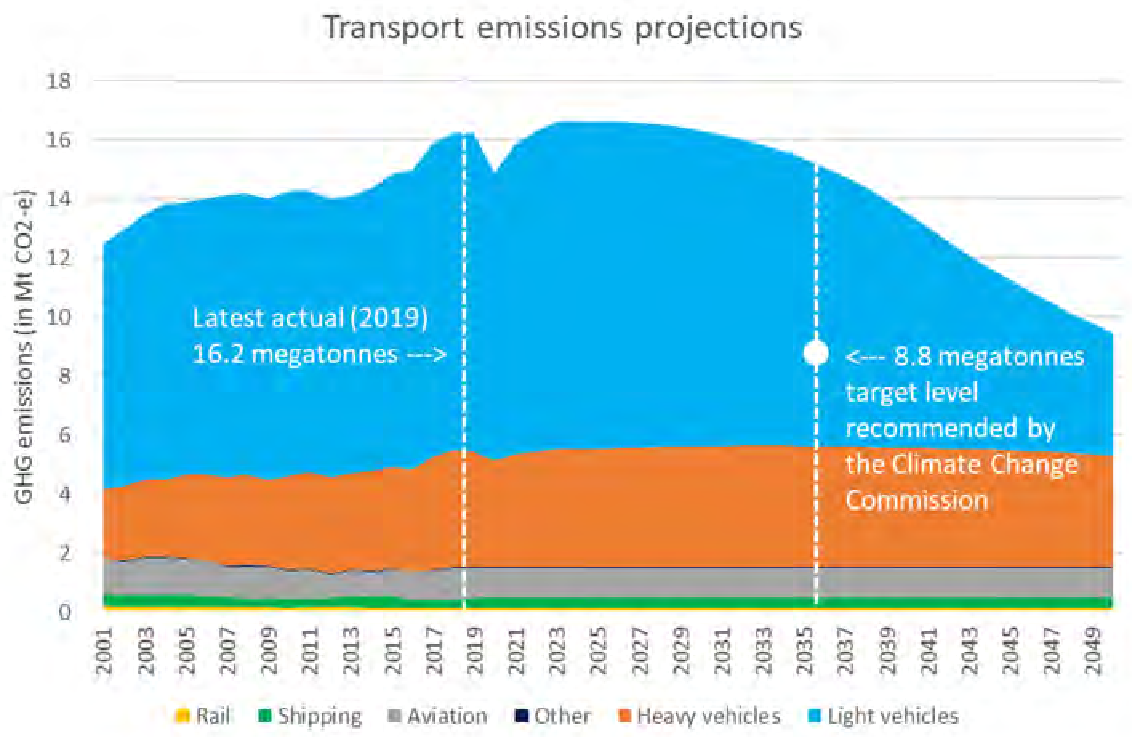


Figure 2. New Zealand's forecasted transport CO_2 emissions by vehicle type

Our per capita transport emissions are high in comparison to other countries

Aotearoa has the fifth highest per capita rates of CO_2 emissions from road transport in the 43 Organisation for Economic Co-operation and Development (OECD) countries with data for road transport emissions.[4] The top four countries were Luxembourg, the United States, Canada and Australia. Our high per capita transport emissions are a result of several factors, including:

- **Heavy reliance on fossil fuels for transport.** Electricity and biofuels are less than 0.1 percent of the transport fuels used in Aotearoa. In comparison, in Sweden, renewable fuels are 14.7 percent.

- **Poor fuel economy of light vehicles entering our fleet.** In 2020, light passenger vehicles (cars and SUVs) entering our fleet had an average reported emission intensity of 158 grams of carbon dioxide (CO_2) per kilometre travelled (g CO_2/km); and the figure was 219 g CO_2/km for light commercial vehicles (vans and utilities) entering the fleet. In

[4] OECD (2017) *Environmental pressures rising in New Zealand.* Retrieved from: Environmental pressures rising in New Zealand - OECD

contrast, it was 122 g CO_2/km for cars and 158g/km for light commercial vehicles registered in 2019 in Europe.[5]

- **Reliance on road freight.** Seventy percent of our freight moves by road, 16 percent by rail and 14 percent by coastal shipping, reflecting the needs of our more dispersed population when compared to Europe. In Europe, 50 percent of the freight task moves by road, 37 percent by shipping and just over 12 percent by rail.

- **Many of our urban areas are characterised by sprawling low-density land-use patterns supported by motorways.** This has contributed to vehicle dependence and has limited the potential for public transport and active transport use.

- **Decades of private vehicle oriented transport planning and funding have encouraged car use over alternatives.** For example building extra lanes to solve traffic problems rather than changing how we travel.

Breakdown of emissions by transport mode

Aotearoa's transport system is comprised of road transport, aviation, shipping and rail. However, as Figure 3 shows, our transport emissions come predominately from road transport (the heavy and light fleets), which contributes 91 percent of transport emissions.

Light vehicle fleet

The light vehicle fleet includes cars, sports utility vehicles (SUVs), utes, vans and light trucks with a gross vehicle mass of 3.5 tonnes or less. Travel by light vehicle accounted for 67 percent of transport GHG emissions and 13 percent of Aotearoa's total gross GHG emissions. The light vehicle fleet's CO_2 emissions were 7 percent higher than 10 years previously.

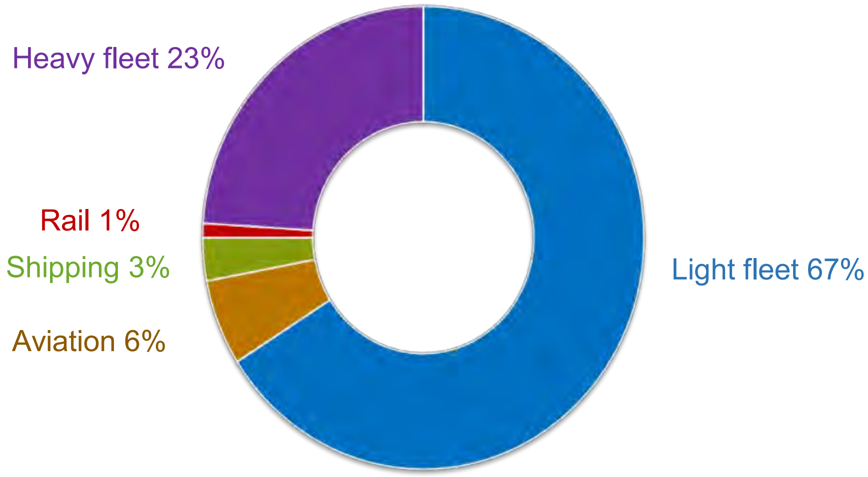


Figure 3. Aotearoa's domestic CO2 emissions by transport mode

[5] The NZ data is from Ministry of Transport analysis and the European data retrieved from: Average CO2 emissions from new light-duty vehicles registered in Europe increased in 2019, requiring significant emission reductions to meet the 2020 targets | Climate Action (europa.eu).

Currently, the majority of new and used light vehicles entering Aotearoa's fleet are powered by fossil fuels. Fully electric-powered vehicles made up a small portion of Aotearoa's fleet in 2018 at about 2 in every 1,000 light vehicles (about 0.5 percent). Further, the light vehicles entering our fleet are more emissions-intensive than in most developed countries Table 1 below shows emissions from the average vehicle entering the Aotearoa fleet compared to Japan and Europe. This is partially due to the high proportion of used vehicles that enter the Aotearoa fleet, with relatively higher emissions compared to new vehicles manufactured in Europe and Japan (and low numbers of used imported vehicles entering their fleets). It is also due to the fact that Japan and Europe do not purchase utes for personal use like we do in Aotearoa. Further Aotearoa no longer has a vehicle manufacturing sector.

Table 1. Average vehicle emissions entering the fleet for Aotearoa, Japan and Europe

Aotearoa	Japan	Europe
165 gCO_2/km[6] (2020)	105 gCO_2/km (2014)	105 gCO_2/km (2020) 95 gCO_2/km (from 2021)

Aotearoa was one of only three developed countries that had no regulations, and limited incentives to influence the fuel efficiency of light vehicles entering the country. As a result, the vehicles supplied to Aotearoa are among the most fuel inefficient of any OECD country. The new Clean Car Standard recently agreed by Government will begin to address this.

Heavy vehicle fleet

The heavy vehicle fleet consists of vans, buses and trucks with a 3.5 tonnes gross vehicle mass or more. The heavy fleet accounts for 23 percent of transport emissions even though it only accounts for 6 percent of the annual road vehicle kilometres travelled. Its disproportionate contribution reflects the fact that the heavier a vehicle is, the more energy it takes to get it moving.

Nearly all trucks in Aotearoa use diesel. The total amount of GHG emissions produced from road freight is directly related to the amount of diesel used by trucks. Fuel consumption by the truck fleet has been steadily increasing over the past 18 years. Heavy trucks contribute the most to overall GHG emissions as they travel the greatest distance and carry the most freight by weight.

[6] This figure is based on the New European Driving Cycle (NEDC) emissions test, as of 30 September 2020.

Figure 4 shows that without any new interventions, GHG emissions from trucks will be the main contributor to road transport GHG emissions by 2055.

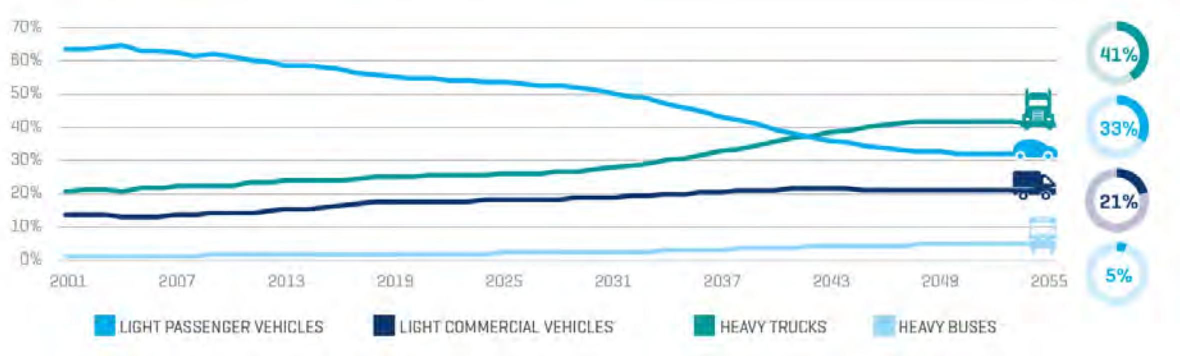


Figure 4. Current and projected greenhouse gas emissions from Aotearoa's transport fleet by vehicle type

While a fall in road emissions is expected in the light fleet (mainly due to an anticipated increase in the uptake of EVs), emissions from the heavy fleet are expected to steadily increase into the 2020s, then plateau at about 11 percent above 2015 levels by 2040. The markedly different emissions path for the heavy fleet reflects the difficulties with decarbonising heavy vehicles compared to light vehicles.

Aviation

Domestic aviation accounts for 6 percent of our transport emissions. In 2012, domestic aviation emissions fell below 1990 levels but since 2015 they have been steadily growing. Domestic aviation emissions have increased, in part, due to a reduction in the real cost of airfares. At the same time the fuel efficiency of air travel has increased due to higher load factors, advances in aircraft design and improvements in air traffic management for aircraft approaches to airports.

Most airports have experienced significant growth in recent years due to increases in domestic and international tourism and new routes offered by airline operators and regional airlines. COVID-19 has had a significant impact on aviation. It is too early to tell what the impact of COVID-19 will be on the aviation sector and its emissions going forward.

The Paris Agreement is silent on the inclusion of international aviation sector. This is because of the difficulty with attributing emissions from international aviation to particular States. Instead, States have agreed to work through the International Civil Aviation Organization (ICAO) to pursue emissions reductions in international aviation. Aotearoa is an active participant in environmental discussions at the International Civil Aviation Organization (ICAO).

Shipping and Maritime transport

Aotearoa is dependent on shipping for the movement of goods in and out of the country and for connectivity within and between the North and South Islands. The domestic shipping sector contributes around three percent of Aotearoa's overall transport emissions. Aotearoa's domestic fleet includes cargo vessels, passenger ferries, fishing trawlers, tugs, cement carriers and fuel tankers. GHG emissions from shipping have remained steady since

1990, in comparison with other domestic sectors e.g. aviation which has seen nearly 100 percent growth in GHG emissions.

International shipping, like aviation, is silent in the Paris Agreement due to the same difficulty with attributing emissions from international shipping to particular States. Rather States, including Aotearoa, work through the International Maritime Organization (IMO) to pursue emissions reductions from international shipping.

Rail transport

The national rail network totals approximately 3,700 kilometres. Emissions from rail are about 1 percent of our total emissions. The government, through the state-owned enterprise KiwiRail, owns and controls the rail infrastructure and the majority of the rolling stock. There are urban rail networks in both Wellington and Auckland, which provide approximately 26.1 million passenger trips annually, comprising 12.1 million trips in Wellington and 13.9 million trips in Auckland. Rail carries 16 percent of freight in tonne kilometres within Aotearoa.

Since 2000, emissions from rail transport have been largely consistent at just under 200 kt (CO_2-e). Since 2012 there has been a very gradual decline in emissions. This may be, in part, due to a gradual increase in the electrification of railway lines in Auckland but may also be attributable to a gradual decline in rail freight in favour of road freight.

Aotearoa’s rail system is currently in the midst of a 7 to 8 year rebuild, with significant investment, to improve and replace locomotives, rail lines, bridges and tunnels across the country. It is anticipated that this investment will lead to improved services and potentially grown Aotearoa’s freight task onto rail.

Regional versus urban patterns

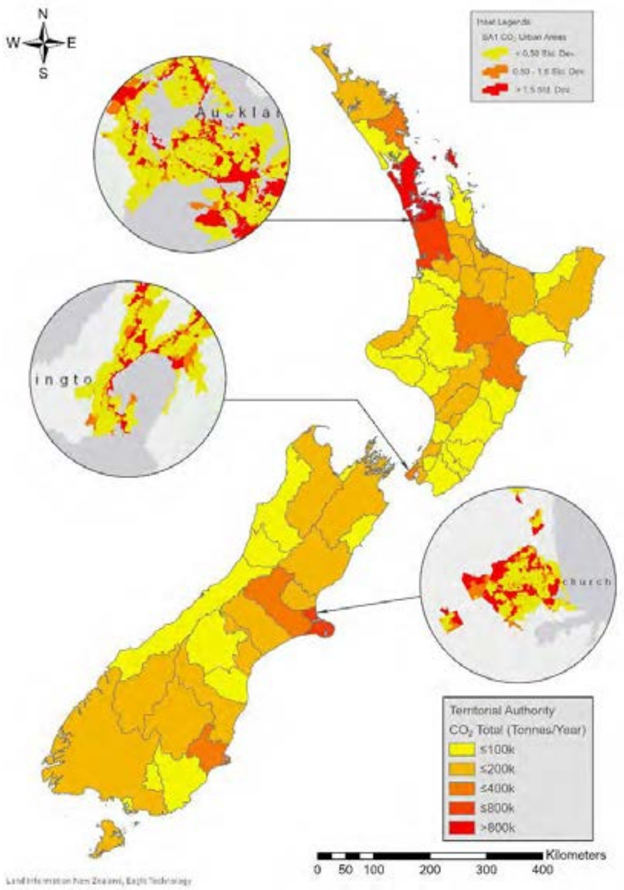
When we consider where our emissions are generated we need to acknowledge that there are different regional and urban patterns of travel. Our larger cities generate more emissions than rural towns based on population and the number of vehicles. Per capita, transport emissions are lower in cities.

Waka Kotahi’s Sustainability Monitoring Report[7] notes that nationally, urban areas contribute half of our land transport emissions. These emissions are concentrated in the largest urban centres of Auckland, Wellington and Christchurch where a large part of the population lives and where a large portion of economic activity occurs. Transport emissions in the Auckland and Wellington regions are particularly dominated by urban travel.

Rural travel accounts for the remainder of the emissions, and includes a combination of freight, local travel and regional travel.

[7] Waka Kotahi. (2020). *Tiakina Te Taio: Our Sustainability Monitoring Report.* Retrieved from: [Tiakina Te Taiao sustainability monitoring report (nzta.govt.nz)]

The following map shows the spread of emissions across regions. By examining Auckland, Wellington and Christchurch in greater detail we can see the higher GHG emissions on key road corridors.



Implications of COVID-19

As a result of lockdown due to COVID-19, global daily fossil fuel CO_2 emissions decreased by 17 percent.[8] Surface transport (i.e. the movement of people or goods by road, train or ship) accounted for nearly half of the decrease in emissions during the lock down period. While this resulted from drastic measures, it corresponds to the level of emissions seen in 2006.

A study examining the impact of lockdown measures on global CO_2 emissions, found Aotearoa's CO_2 emissions fell by 41 percent compared to 2018 levels.[9] This was second only to Luxembourg. The Ministry estimates due to travel restrictions in COVID-19 Alert Levels 3 and 4 that Aotearoa's annual CO_2 emissions were reduced by between 8 and 10 percent. Further, road traffic exhaust pollutants reduced by 75 percent on average across main centres during Level 4. Since Aotearoa lifted restrictions on travel movements CO_2

[8] Le Quéré, C., Jackson, R. B., Jones, M. W., Smith, A. J., Abernethy, S., Andrew, R. M & Friedlingstein, P. (2020). Temporary reduction in daily global CO 2 emissions during the COVID-19 forced confinement. *Nature Climate Change*, 1-7.

[9] Waka Kotahi Transport Agency. (2020). *COVID-19 impacts on transport*.

emissions, air pollutant emissions, motor vehicle sales and mode use (including public transport patronage) appear to be returning to near pre-COVID-19 levels.

These changes, observed globally and in Aotearoa, do not reflect the structural changes in the economic, transport or energy systems needed to maintain lower emissions. Aotearoa's statistics highlight that lockdown is not a sustainable method of reducing transport emissions, either socially or economically. Subsequently, we need to find other mechanisms that realise the same kind of benefits without the fallout. COVID-19 has given us a sense of the scale of change required.

On the other hand, the enforced lockdown meant that New Zealanders tried different ways of working, accessing goods and services, and connecting socially. This revealed opportunities to reduce emissions through remote working and for implementing targeted urban design interventions to reduce travel demand and encourage walking, cycling and public transport. It has resulted in ongoing changes to travel patterns (e.g. more people working from home post lockdown) and introduced a level of uncertainty regarding future mode use and travel demand.

Policies have been introduced to reduce transport emissions, but more is required from Aotearoa

Government has introduced a range of policies to mitigate emissions from the transport sector. For example, this includes road user charge exemptions for the light and heavy fleet to increase the uptake of low-emission vehicles; and increased investment for walking and cycling, public transport and rail freight. A contestable fund for low emissions vehicles is also set up to encourage innovation and increase its uptake.

Additionally, there are a range of actions that are being taken by central and local Government to address climate change, such as the Government Policy Statement on land transport, Waka Kotahi's Toitu Te Taiao – Sustainability Action Plan; and regional plans to address climate change. The Government's Urban Growth Partnerships programme, the National Policy Statement on Urban Development, and Resource Management reforms will also deliver more integrated transport and land use planning to support mode shifts and transport emissions reductions.

These collective actions are a good start to addressing transport emissions. However, a lot more is required if Aotearoa has a credible chance of reaching net zero by 2050.

Chapter 11 of this paper provides more detail on existing policies and overarching work that is underway. It also explores the opportunities across the transport system that would complement what has already been implemented and could be included in the future emissions budgets.

Chapter 3: The Government's role and levers for reducing transport emissions

Key points

- Achieving emissions reduction targets will require a combined effort from all New Zealanders including central and local government, iwi, communities and businesses.
- Central government has a particularly important role to play, given its influence in the transport system. Leadership will be required for the significant changes necessary to shift our transport system onto a zero emissions pathway.
- Government must build and strengthen its relationships with key stakeholders and partners to ensure success. This will include collaboration between central and local government, Iwi and hapū, the private sector, industry associations and advocacy groups.
- Sectors connected with the transport sector have a significant impact on transport emissions. Collaboration with these sectors will be important. The interdependencies between key sectors and transport include the planning system, housing and urban development, the energy sector, and the tax system.
- Many sectors and individual players, public and private, will need to align their settings and priorities to reduce emissions from the transport system.
- Government has a range of levers it can use to influence emissions reductions in the transport system including investment, regulation, and economic and education tools.

What is the Government's role in reducing transport emissions?

Achieving Aotearoa's emission reduction targets will require major and long-term changes and adjustments to all parts of the transport system. Government needs to influence change where it can, while recognising that it cannot make all of these changes on its own. Government needs to build on the social mandate for reducing emissions, by working with others. This includes working with local government, iwi, communities, and businesses to reduce transport emissions.

The Government has an important role to ensure our institutions (including, where appropriate, our legal and regulatory frameworks) support transport emission reductions.

The Government can also make it easier for people and businesses to access places by low-carbon modes, and to make sustainable transport choices that support a transition to a low carbon transport system. This will require leadership by Government, close collaboration with a wide range of stakeholders, and consideration of a wide range of policy levers within and beyond transport.

Leadership

Strong government leadership will be fundamental to achieving significant emission reductions from the transport system. The Government has many levers to achieve emission reductions from the transport system (discussed in more detail below).

The Government already has initiatives underway to reduce transport emissions. Further action, will be required to shift our transport system onto a zero emissions pathway. Aotearoa's international agreements and the CCRA both create an imperative for action.

As discussed in Chapter 1, the Government must prepare an ERP under the CCRA. This will identify policies for meeting five-yearly emissions budgets from 2022. This plan also needs to demonstrate that we are on a pathway to meet our 2050 target.

Hīkina te Kohupara will inform the Government's ERP, by outlining strategic approaches and opportunities to reduce transport emissions.

Ministry of Transport's role

The Ministry is both system steward and lead adviser to the Government on the best opportunities to decarbonise the transport system.

Our work is guided by the Transport Outcomes Framework, which aims to ensure our transport system improves wellbeing and liveability. This framework has five core outcomes for the transport system to deliver over time: inclusive access, healthy and safe people, economic prosperity, environmental sustainability, and resilience and security. The environmental sustainability outcome includes transitioning the transport system to net zero carbon emissions. This highlights the important role that the transport sector has to play in responding to climate change. The five outcomes are interrelated and need to be met as a whole to improve intergenerational wellbeing and the quality of life in Aotearoa. Where possible, it is important to pursue opportunities that deliver co-benefits across outcomes, rather than just trading off outcomes against each other.

There are levers outside of the transport system that can have a significant impact on transport emissions. For example, decisions affecting land use and urban development, such as how densely we build our cities, can have a significant impact on transport emissions, especially over the longer term. Subsequently, greater collaboration and leadership is required across government to align land use, urban development and transport planning to reduce GHG emissions from the transport system.

Further, leadership should be shown across the public sector and include strengthened cross-agency collaboration on modelling and policy development efforts to understand what will be required to reduce transport emissions. It should be part of a systems response to reduce transport emissions and include cross agency, sectors and stakeholder participation. This collaboration should include the Ministries of Housing and Urban Development, Environment, Transport, and Business, Innovation and Employment (MBIE); and the New Zealand Infrastructure Commission (Te Waihanga).

Collaboration within the transport system

The government has to engage with a wide range of players in the transport system. This requires a strong focus on collaboration, with the government growing and strengthening its relationships with Te Tiriti partners and key stakeholders to ensure success.

Central government

Central government is heavily involved in the transport system as a planner, funder, partner, enforcer and regulator. Transport sector agencies, including the Ministry, Waka Kotahi, the Civil Aviation Authority and Maritime New Zealand and KiwiRail, all play a role in reducing transport emissions.

Local government

Collaboration between central and local government is critical for achieving emission reductions. Local government has a significant role in planning and funding transport and urban development at a regional and local level. Under the Land Transport Management Act 2003 (LTMA), local government is responsible for local roads, planning and contracting for public transport, and walking and cycling infrastructure and initiatives. Many councils also partly or fully own airports and seaports in their regions.

Many councils are developing or have already developed plans setting out how they intend to reduce emissions and respond to climate change. An example is Te Tāruke-ā-Tāwhiri[10], Auckland's climate plan.

Stronger collaboration between central and local government will be important to ensure there is a joined up systems approach to mitigating transport emissions. This should include clear signals from Government regarding how Aotearoa will be stepping towards the net zero goal.

Iwi and hapū

Government has responsibilities under Te Tiriti o Waitangi – the Treaty of Waitangi – to acknowledge Māori as partners and their status as tangata whenua – the indigenous people of Aotearoa. Effective, meaningful partnership with Māori is key to improving transport and broader social outcomes for Iwi/Māori, and to ensure the transport system serves all New Zealanders equitably.

Private sector

The private sector is a major employer and investor in the transport system. It also leads innovation in many areas which will have a significant impact on the future of the transport system and on transport emissions. The government can make it easier for the private sector to reduce emissions by providing certainty and early notice of upcoming decisions that will impact them. It will be important for government to engage closely with the private sector, so that businesses can make the most of opportunities for transitioning to a zero emissions economy, and so that they can understand their responsibilities.

Industry associations and advocacy groups

Within the transport system, there are a large number of groups advocating for the perspectives and interests of particular parts of the sector. This includes groups advocating for particular types of transport (e.g. cycling advocacy groups), neighbourhood groups (e.g. for a public road) and other groups that may be established to support or oppose a specific policy or initiative.

As government develops its approach to reducing emissions, it will need to engage with these groups – bringing important perspectives, data, and evidence into the policy process.

[10] Auckland Council. (2020). Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan. Retrieved from: Auckland's Climate Plan (aucklandcouncil.govt.nz)

Collaboration with other sectors

There are also sectors outside of the transport sector, which have a significant impact on transport emissions. Co-operation is needed across sectors to reduce emissions across society. There are interdependencies between several key sectors and transport, including the following.

Planning system (including spatial planning)

The way we plan our towns and cities has a significant impact on transport emissions, especially over the long term. It affects the distance people need to travel to reach jobs, schools, shops, amenities, and other important destinations. This will in turn affect the volume and frequency of urban freight delivery. Transport and spatial planning also influences how people travel, by affecting the range and quality of transport options available, including low carbon modes such as public transport, walking, and cycling.

Greater collaboration and leadership is required across government to align land use, urban development and transport planning to reduce emissions from the transport system. This can help to ensure Aotearoa's infrastructure delivers value across multiple outcomes, and promotes an efficient land use system.

Housing and urban development

Closely related to the planning system, housing and urban development also has a significant impact on transport emissions. The type of buildings we construct, their location, and their accessibility to different transport modes, affects how much people and products travel, and associated transport emissions. To reduce emissions, there needs to be close collaboration between transport agencies, the Ministry of Housing and Urban Development, Kāinga Ora and the development sector.

Social development and health

The Ministry should work with the Ministries of Social Development and Health to ensure policies that implement mode shift opportunities for communities considers how equity in the transport system can be improved. With a greater emphasis on moving more New Zealanders onto public transport, there are many in our communities who are not adequately served either because no services exist, or the services don't meet local needs or the cost prohibits its use. Collaboration on how the transport system can help improve social and health outcomes would benefit all of Aotearoa.

Energy

There is a very close relationship between transport and energy. The shift to cleaner fuels in the transport system will have significant implications for the energy sector. In particular, the shift towards electric vehicles will significantly increase the demand for electricity (which needs to come from renewable energy sources), as well as the capacity for electricity storage. Increasing demand for biofuels will also affect the energy sector. If hydrogen is used for transport, this will also impact the electricity system (if electricity from renewable sources is used to produce the hydrogen).

To support the transition of heavy freight, aviation and maritime sectors, there is a need for the energy sector to secure the right type of alternative fuels at the right price. Additionally, fuelling and charging infrastructure is another area where transport and energy intersect. Work is underway across government on a plan (strategy) setting out a pathway for the future charging infrastructure Aotearoa needs for our low carbon future.

Taxation

The tax system in Aotearoa also affects transport emissions. For example, there are existing financial incentives and accounting practices that encourage the purchase and use of some vehicles, such as double cab utes, that produce more pollutants than other vehicles. Conversely, the tax system could play a role in stimulating demand for low emission transport options. Consideration should be given to how the tax system can be used to complement and support the pathway to net zero by 2050.

Other sectors

There are also opportunities for cross-government collaboration in other sectors. For example, with education (e.g. school travel plans), forestry (connection with biofuels and potential transport offsets), building and construction (e.g. in relation to transport infrastructure), and technology, information and digital innovation (e.g. innovative new transport services and technologies).

Reducing emissions will require many sectors and individual players, public and private, to align their settings and priorities to support reducing emissions from the transport system.

Levers within the transport sector that the Government can use to reduce transport emissions

Delivering emission reductions will rely on a variety of levers the Government can use to influence the transport system. This will often require multiple agencies, using a combination of levers together, and in a coordinated way over time.

Investment

The Government makes funding and investment decisions in the transport system. Funding can enhance or maintain existing infrastructure and services, and influence behaviour by providing a range of affordable, safe and attractive travel options.

The Government Policy Statement on land transport is a critical transport document outlining the government’s strategy for investment in land transport over the next 10 years. Prepared under the LTMA, the Government Policy Statement is implemented by Waka Kotahi through its National Land Transport Programme, which sets out a three-year programme of land transport investments.

A key purpose of the National Land Transport Fund (NLTF) is that it was designed and intended to fund and maintain the essentials for Aotearoa’s transport system, e.g. provision of roading where needed, maintenance of the system etc. Emissions reductions is a significant step change in investments for the NLTF, which will always be far beyond what the NLTF could do or was ever intended to do. There is no doubt that some big investments in public transport, for example, may have to be funded by the Crown.

The main current constraint of the NLTF is that more than three-quarters of the fund over the next ten years is already allocated to maintaining the existing transport network, funding public transport services, Road to Zero initiatives, public private partnership repayments and completing large projects for new infrastructure that are already underway. This limits how much impact investment through the existing NLTF can have on reducing emissions over and above current initiatives.

There will be a greater need for investment from alternative sources, such as Crown and Local Government funding, and third party investment. Such alternative investment sources will be critical for achieving and implementing the policies for emission reductions required from transport to meet Aotearoa's targets. For example, Crown funding has been provided to support the development of the CityRail Link and investment in rail.

Generational planning and investment

The Ministry is leading work on a Generational Investment Approach (GIA) that will evaluate investment choices for the transport system, out to 30-50 years from now.

The GIA takes a structured approach to compare the benefits that various investment options and interventions might achieve. Coordination across the system is facilitated by sharing and evaluating the same evidence, and this encourages trade-offs to be made so that investment and resources can be allocated efficiently. Understanding our long-term investment priorities is an important aspect of redesigning the revenue system and regulatory frameworks, which may also be used to encourage a reduction in transport emissions.

Regulation

The transport regulatory system ensures safety and helps protect New Zealanders from harm and achieve other transport outcomes, including, reducing emissions. It influences behaviour and provides the legal frameworks that enable the system to operate effectively.

The system is comprised of laws made by Parliament (primary legislation) and second order regulations, rules and instruments that those laws allow (secondary legislation). Legislation, however, is only part of the picture. Transport Crown entities, as well as the Ministry, need to deliver services, educate and inform and make sure that people follow the requirements set out in legislation. The regulatory system works together to influence people's behaviour.

To meet the net zero by 2050 better use of existing and more use of new regulatory tools may be necessary. As each future policy is scoped and developed, the Ministry will need to consider regulatory changes to enable future policies on climate mitigation.

Economic and educational tools to influence behaviours

To transition to a low carbon transport, we must drive sustainable changes in the behaviour of transport users. It is important that we invest efforts to gain a broader understanding of how people behave and make decisions. Behavioural insights can be used to help people make decisions that are in their long-term interests and that overcome the inertia of their habits.

Providing information about transport options at specific locations and times (making it easy), about changes other transport users are making (making it social) and about time, health and safety benefits (making it attractive) could be the strategies to use. For example, educational tools, such as journey planning apps, mobility as a service (MaaS) and social marketing can make it easy for people to change their behaviour without an economic push, and are most effective when those tools are used over a longer term.

In some cases, financial incentives or disincentives will be necessary to supplement these ‘softer’ measures. These instruments aim to provide better pricing signal to people of the impacts of their travel choices and influence the choices they make in the future, by putting a price on those which produce negative impacts (or otherwise a subsidy). The price of transport can reflect the direct costs of using the network, the externalities/indirect costs (such as emissions), or it can be set relative to other modes to influence the use of one mode over another.

The use of behavioural measures can help to develop transport policy interventions that account for behavioural biases, defaults and shortcuts. Combining different types of behavioural measures with other complimentary interventions can help to achieve the outcomes we want to see in the transport system such as reduced congestion, reduced emissions and better health outcomes in a more efficient way.

Analytics and modelling

Analytics and modelling plays a key role in understanding the expected effects of different measures on emissions outcomes, and the interactions between different transport and other non-transport measures. Over the past year, the Ministry has improved its tools and capability to project the long-term changes in vehicle fleet compositions, the level of travel, and GHG emissions. These projections have strong economic underpinnings with key drivers such as vehicle purchasing behaviours, population growth and economic conditions which are updated periodically.

The Ministry plays a lead role in providing evidence-based transport analyses and advice on behalf of the sector. This includes working closely with other departments such as Waka Kotahi, the Climate Change Commission, the Ministries for the Environment and Business Innovation and Employment, the Energy Efficiency and Conservation Agency. This includes participating in related interagency working groups. Tools such as the Vehicle Fleet Emissions Model, Electric Vehicles Uptake Model and Cost Benefit Analysis modelling are used frequently and will continue to be crucial to inform and estimate the impacts from ongoing transport emissions policy. Further work to understand how best to estimate and account for the benefits from improving urban land use development and transport planning will be needed to understand the relative roles infrastructure plays in reducing transport emissions.

Monitoring, evaluation and oversight

The Ministry of Transport has a key role in monitoring and evaluating the performance of the transport system. Annual reporting of Transport Indicators (based on the Transport Outcomes Framework) provides an ongoing mechanism to track high-level outcomes achieved from the transport system, including emissions. The Ministry also evaluates specific regulation, policy and investment, including as related to emission reductions.

The Ministry should strengthen its monitoring and evaluation role in relation to emissions by partnering with delivery agencies to undertake a more comprehensive monitoring and evaluation programme to track progress and drive greater accountability. This should stem from measurable outcome indicators, so that links can be made with the desired outcomes for climate mitigation alongside transport equity and other outcomes. This will be important for addressing future emissions budgets and the impacts of those budgets on our communities.

International standards

While international standards, such as those for the aviation and maritime sectors, are specific to international activities, they can provide a knock on effect by influencing behaviour and subsequently providean impetus to reduce domestic emissions. International standards can help overcome social mandate challenges and assist with garnering a broader commitment and social licence to implement change to reduce emissions.

Consultation question 2
Is the government's role in reducing transport emissions clear? Are there other levers the government could use to reduce transport emissions?

Chapter 4: The role of innovation in the transport system

Key points

- Innovation has always been an inherent driver of change in the transport system. Innovative ideas, policies, business models and new technologies can improve the way people and goods move around. The best innovations add value to the transport system by improving environmental, social and economic outcomes, which can include reducing emissions.
- Electrification, shared mobility and automation are likely to have a significant impact on how people and goods travel. Electrification and shared mobility will have a significant impact on emissions but the impact of automation is less certain.
- Exploring different approaches for reducing emissions in the transport system should include the role of urban design and placemaking.
- Government has a key role to implement policies that support transport innovation, including decarbonisation. Regulatory policies that encourage transport innovation with positive outcomes, building strong connections between government and non-government players in the innovation sector, leveraging the skills and expertise of the private sector and targeted investment can help direct innovation towards new products or services that can contribute to reducing emissions.

What do we mean by transport innovation?

Decarbonising the transport system is complex and challenging. Innovative ideas, policies, business models, and technology can improve outcomes from the way people and goods move around. Transport innovation, therefore, can support positive outcomes like decarbonisation. As well as new ideas, we can also take advantage of the many ideas and solutions already available, and address the barriers to using these solutions.

Innovation can range from improvements to vehicles and street design, new business models (e.g. bike share and car share schemes) and new vehicle technologies (e.g. autonomous vehicles (AVs), drones, and electric ships). It also includes innovative uses of transport data to improve transport services (including freight system movements), user experiences and infrastructure.

Some innovation in transport is continuous, such as making cars more efficient, or making improvements to public transport service operating models. In contrast, technologies can be disruptive by arriving unexpectedly or result in fundamental changes to the system or both together.

Autonomous vehicles, are an example of a disruptive technology that is not widespread in the sector yet but is likely to have deep impacts on how we move. E-scooters are an example of a new technology that arrived very quickly and the impacts on the system are still emerging.

How can transport innovation support GHG emission reductions?

Transport emissions in Aotearoa are increasing, so new ways of moving people and goods are essential to achieving the emissions reductions targets that have been set. Increasing the share of vehicles powered by electricity, biofuels and hydrogen will be important to reduce emissions. Improving the technology of these vehicles will be important in accelerating their uptake by consumers. However, the scale of uptake required is immense and there will need to be concerted and joint action across the government and private sectors to ensure low emission vehicle uptake targets are achieved.

Focussing on improving vehicles or fuels, can reduce the emissions they produce and encourage uptake, especially if technological developments lead to, for example, reduced battery costs or extended driving ranges for electric vehicles. Innovative business models, such as car sharing, and other innovative forms of shared mobility, can reduce car ownership and use, which can also reduce emissions and encourage more physically active modes like walking and cycling.

Different approaches to managing the transport system will also be important, including how urban design and placemaking can be used to support emissions reductions. Waka Kotahi's *Innovating Streets for People Programme* encourages councils to think about road space differently and try new approaches.[11] This Programme provides funding to councils for temporary cycle lanes, traffic calming devices, street art and other relatively new/modern street design and placemaking initiatives. Such approaches can encourage walking and cycling by making those options more attractive and accessible. This can encourage mode shift, which leads to reduced emissions.

Key examples in the transport sector of innovation and technology

Advancements in transport innovation to support GHG emissions reductions fit into three broad categories. These are:

1) Recent innovations that are likely to have a major impact on decarbonising vehicles
    - Light electric vehicles – EVs are increasingly accessible, the range is better, and costs are expected to fall.
    - Heavy vehicle technology – a few electric trucks are now in the domestic market, as well as electric buses in many public transport fleets. Additionally, hydrogen and biofuel also have potential for freight vehicles. The Ministry of Transport's Green Freight Project[12] highlights these opportunities.

2) Recent innovations that are likely to have a positive impact on avoiding or reducing emissions
    - Mass rapid transit technologies – new forms of mass rapid transit such as small autonomous shuttles, larger guided systems (for example, autonomous metro rail systems and trackless trams) and on demand public transport.
    - New street design principles and approaches – to designing streets for people and places may lead to increased mode share by active modes and potentially reduced emissions, as well as more pleasant spaces for people to use.
    - The integration and the better use of transport data by transport operators to make their services more efficient and by packaging information on transport options, booking and payment into one channel for consumers through apps on smart devices ("mobility as a service").

[11] Innovating Streets - All updates | Waka Kotahi NZ Transport Agency (nzta.govt.nz)
[12] Green freight project | Ministry of Transport

3) Emerging innovations may have a positive or negative impact, which depends on
    - how the technologies evolve
    - their uptake and penetration into the transport system, which will be driven by consumer preferences and, in some cases, government encouragement
    - how government regulation affects the roll out of new technology and how it is operated.

We are seeing three major innovation trends in transport relevant to decarbonisation - electrification, shared mobility and automation

The following trends are likely to have a significant impact on how people and goods travel. They could all contribute to decarbonisation, depending on how they are adopted and how government and society shapes them. This range of new technology, when managed effectively, creates an opportunity for a shift in the way we travel, and the need to travel.

- *Electrification*

  Advancing battery and charging technology is allowing a wider range of electric vehicles to be developed and sold, with better features like longer range. Electric cars, vans, buses, trucks, and drones will have a major role in decarbonising the transport system. Electric light aircraft, ferries, bikes and e-scooters may also make a contribution.

- *Shared mobility*

  Car sharing can support environmental sustainability and public health by reducing car ownership and use and encouraging active travel. While maintaining or increasing access, shared mobility can reduce the number of vehicles or the distance they travel. This reduces GHG emissions. Some other innovative forms of shared mobility, such as e-scooter rental schemes, may also contribute to emissions reduction but current evidence is mixed, especially where the technology has a short life cycle.

- *Automation*

  Automated vehicles, including cars, aircraft, drones, and ships, have the potential to make drastic changes to the transport system. However, the scale, nature and timing of this technology's impact is uncertain. Many new cars have autonomous features but the appearance of fully autonomous cars in significant numbers is likely to be more than a decade away. Initially, such cars are likely to be rolled out in constrained geographical areas, such as "robo-taxis" being introduced to urban areas. The speed of uptake will also be affected by how transport policies regulate the technology.

  Most new forms of automated transport are likely to be electric, including aircraft. As a result, automated transport may also contribute to emissions reductions if they become popular. For land transport as well, automated vehicle technology has the potential to reduce harm from vehicle accidents, make more efficient use of space in the road network, reduce the cost of travel, and provide accessible options to non-drivers. However, this technology could also have negative consequences. Automated cars, for example, may lead to more vehicle movements and increased urban sprawl, conflicting with strategies to avoid and shift emissions through more quality compact urban form. Drone technology may threaten privacy and cause noise and visual pollution.

The use of data, information and communication technologies holds another key opportunity for substituting physical travel in cities with digital communication and virtualisation. This means less commuting and more flexible working arrangements such as working from home or community ‘satellite offices’. Data, analytics and digital innovation also has a significant role in transitioning the transport system to low emissions.

Government has a role in supporting transport innovation

Much of the major transport technological developments including those that affect transport emissions, will be led internationally by large, global companies like Uber, Google and Tesla. These companies will have a major influence on the transition to lower carbon transport and whether this influence is positive or negative will depend on commercial incentives.

While Aotearoa will have a limited ability to influence what these companies produce, government can play an important role to steer and support innovation that reduce emissions. Government’s role can include:

- making sure regulation supports, encourages or mandates the uptake of positive innovations (and does not hinder it)
- encouraging collaboration and stronger connections between the government and non-government sectors, including leveraging the skills and expertise of the private sector
- providing targeted funding and other support for developing, trialling and supporting new technology and approaches (e.g. heavy vehicle charging stations).

There is considerable government support for innovation in the economy and some specific transport initiatives, such as the Low Emission Vehicle Contestable Fund administered by the Energy Efficiency and Conservation Authority (EECA). However, there has not been a strong focus in the past on transport innovation. New initiatives, such as making funding available for transport innovation through the Government Policy Statement on land transport are starting to address this gap. Investment from other sources may also be required.

To get the greatest benefit from innovative ideas, Government needs to ensure the transport system is flexible and adaptable to disruptive thinking and technologies. There needs to be a balance of adequately assessing the risk of disrupting business as usual, and the future benefits of new and innovative approaches. We need to ensure the system settings can quickly respond to new ideas, and support the people behind them to grow their ideas in positive directions and make them mainstream or widespread.

Consultation question 3
What more should Government do to encourage and support transport innovation that supports emissions reductions?

Chapter 5: The Avoid, Shift, Improve Framework

Key points

- Hīkina te Kohupara uses the Avoid-Shift-Improve (ASI) framework to identify opportunities to reduce emissions across the transport system.
- Transport emissions are driven by transport activity (number of trips and kilometres travelled), mode share (percentage share of different modes), energy intensity (quantity of fuel used per kilometre) and carbon intensity (emissions from quantity of fuel per kilometre).
- The ASI framework addresses each of these four elements:
    - Avoid – improve the overall efficiency of the transport system through interventions to reduce the need to travel and trip lengths.
    - Shift – improve the efficiency of trips by promoting mode shift to low carbon modes, such as walking, cycling, public transport, coastal shipping and rail freight.
    - Improve – lower the emissions of transport vehicles and fuels.
- The Ministry has developed three themes to group together opportunities within this framework and highlight interdependencies within different parts of the system. Theme 1 and 2 focus on people and Theme 3 on freight.

The Avoid-Shift-Improve (ASI) framework

Transport energy use and GHG emissions are driven by four key elements:

1. Transport activity (the number of trips and kilometres travelled)
2. Mode share (the percentage share of different modes)
3. Energy intensity (the quantify of fuel used per kilometre)
4. Carbon intensity (the emissions from the quantity of fuel per kilometre).

Together these elements contribute to total transport GHG emissions (Figure 5).[13]

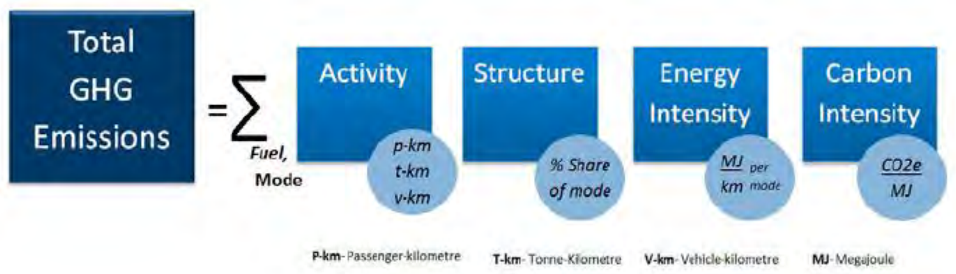


Figure 5. Avoid-Shift-Improve framework - key elements

[13] Figure from Deutsche Gesellschaft fűr international Zusammenarbeit (GIZ), Urban Transport and Climate Change. p. 12.

The Avoid-Shift-Improve (ASI) framework is a strategic framework that addresses each of these four elements to reduce emissions from the transport system (Figure 6).[14]

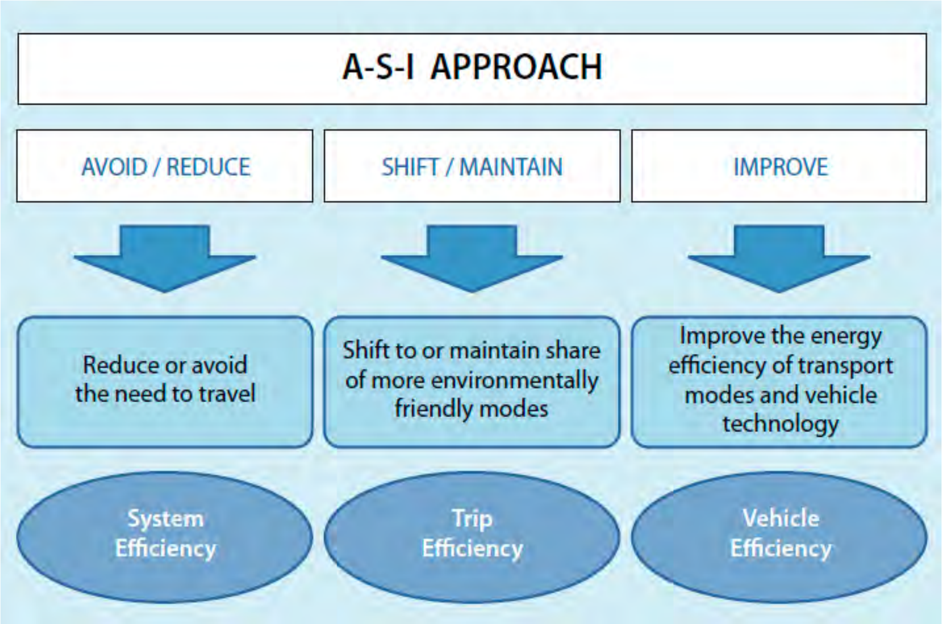


Figure 6. The Avoid-Shift-Improve Approach

Avoid/reduce – addresses 'transport activity'. It looks to improve the overall efficiency of the transport system through interventions that reduce the need to travel and trip lengths

Shift/maintain – addresses 'mode share'. It looks to improve the efficiency of trips by promoting mode shift from the most energy intensive transport modes towards low-carbon modes. In particular, a shift towards active transport modes and public transport. In places where mode-shift is already high, the objective is to maintain the mode share.

Improve – addresses 'energy intensity and carbon intensity'. It focuses on vehicle fuel efficiency, low carbon fuels, and optimising transport infrastructure. It seeks to improve the energy efficiency of transport modes and related technologies.

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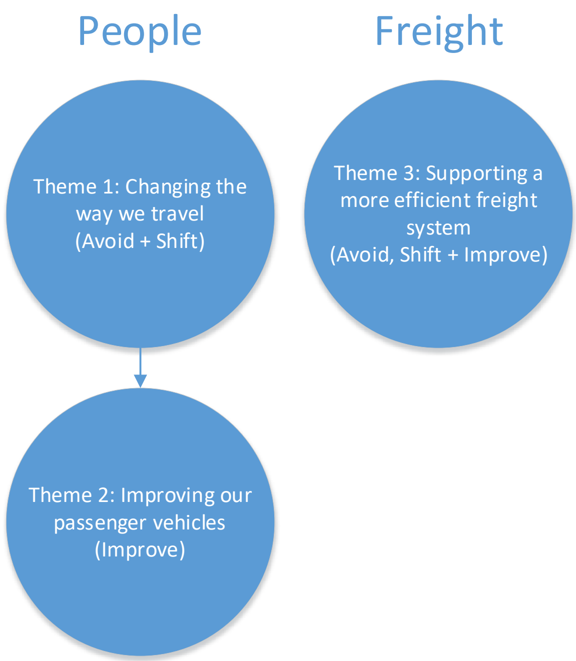
[14] Figure from Sustainable Urban Transport Project (SUTP). (2011). *Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I).* Retrieved from: [Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I) - SUTP]

The Ministry's three themes

The Ministry has used the ASI framework to identify opportunities to reduce emissions across the transport system. We have grouped these opportunities into three themes. This helps the Ministry to highlight key opportunities and interdependencies within different parts of the system. Theme 1 and 2 focus on people and Theme 3 on freight. However, there are overlaps and interdependencies between each of these three themes.



Theme 1: Changing the way we travel

This theme covers Avoid and Shift for people (as opposed to freight). It includes how we shape our towns and cities to avoid the need to travel, reduce trip distances and encourage sustainable transport modes. It also includes how we can support mode shift through providing better travel options, such as public transport, walking, cycling and shared mobility. This theme also explores the role of demand management (pricing) approaches to influence transport choices.

Theme 2: Improving our passenger vehicles (including light vehicles, public transport and planes)

This theme covers Improve for passenger vehicles, including light vehicles, public transport and planes - but not freight vehicles. It includes how we improve the energy efficiency and carbon intensity of light vehicles, public transport and aviation (acknowledging that aviation is also part of the freight system).

Theme 3: Supporting a more efficient freight system

Theme 3 covers Avoid, Shift and Improve for freight, including trucks, rail and maritime (acknowledging that maritime can also be used for passenger transport). It includes how we can improve the efficiency of our overall supply chain, shift freight to low emission modes and improve the fuel efficiency, and carbon intensity of freight modes and fuel.

Chapter 6: Theme 1 – Changing the way we travel

Key points

- Shaping our cities and towns is key to improving the overall efficiency of the transport system. We need to integrate land-use, urban development and transport planning to reduce emissions, especially over the medium to long term.
- To encourage mode shift to low emissions transport modes such as walking, cycling, and public transport, we need appropriate urban form. Quality compact, mixed-use urban development can reduce trip distances, reduce car dependence and encourage the uptake of walking, cycling and public transport.
- From an emissions reduction perspective, the need to orient urban development towards compact urban form is most pressing in our largest and fastest-growing cities where emissions are highest. This includes Auckland, Hamilton, Tauranga, Wellington, and Christchurch. However, we also need to encourage compact urban form, and multi-modal transport options in smaller cities and towns to avoid car use, especially as these places grow over time.
- Transport infrastructure investments have a major impact on urban form, and how people travel. For example, investments to expand urban state highways and roads encourage urban dispersal/sprawl and car use. In contrast, investments in frequent public transport services and rapid transit could support more compact urban form. To reduce and avoid transport emissions, central and local government have to reconsider planned investments in major urban highway and road expansion projects if they would induce more vehicle travel.
- We can influence how people travel by providing better travel options that are energy efficient and generate low or no emissions. This includes providing quality public transport services, safe and accessible walking and cycling networks, and shared mobility options such as car sharing and shared micromobility.
- We can design and manage our streets to be more inclusive of different people and to encourage travel by active modes and public transport. This includes applying multi-modal street layouts, lower speed limits, tactical street changes, and universal design principles. We can also discourage single-occupant vehicle trips through measures such as traffic calming and parking management.
- Street changes to support public transport and active travel could potentially be made swiftly, as it is possible to reallocate space on existing streets to deliver mode shift without building major new infrastructure. Regulatory and funding settings need to support rapid street changes.
- Placemaking is critical for supporting higher density urban developments, to create places that people want to live and work in, and that are good for people's wellbeing.
- Transport demand management, including transport pricing, is critical for supporting more liveable cities and encouraging people to make sustainable transport choices.

Shaping our cities and towns is key to improving the overall efficiency of the transport system

Eighty-seven percent of Aotearoa's population live in urban areas, with most people living in cities. As a result, much of our transport related GHG emissions come from our largest urban areas[15], where private vehicles are the dominant mode of passenger transport.

[15] Auckland, Hamilton, Tauranga, Wellington and Christchurch.

The shape of our cities and towns affects the overall efficiency of the transport system and Aotearoa's transport emissions. Urban form fundamentally affects transport GHG emissions in two connected ways. It affects the distance people need to travel to reach jobs, schools, shops, amenities, and other important destinations. It also influences how they travel, by affecting the range and quality of transport options available, including low carbon modes such as public transport, walking, and cycling.

At the same time, the transport system plays a pivotal role in enabling and shaping urban development. For example, investments to expand urban state highways and major roads (such as road widening and extensions) can encourage urban dispersal/sprawl by making it quicker for people to travel long distances between places by car. This, in turn, leads to more people living in car-oriented suburbs, which causes increasing car use and traffic, emissions, and higher travel times and costs.

In contrast, frequent public transport services and rapid transit systems can provide the backbone for transit-oriented urban development in cities. This enables growing populations to move efficiently through urban areas without creating more congestion and emissions. Improved walking and cycling networks enable people to access public transport services as well as places nearby.

There are significant interdependencies between the shape of our cities and towns and transport, which means that we cannot consider transport interventions in urban areas on their own. We need to integrate land-use, urban development and transport planning to reduce GHG emissions from the transport system (especially over the medium to long term), and achieve a wide range of co-benefits for our towns and cities. This requires significant collaboration between transport agencies, the Ministry of Housing and Urban Development, Kāinga Ora, and local government.

Quality compact, mixed use urban development can reduce trip distances and encourage the uptake of sustainable transport modes

Quality compact, mixed use urban development can play a pivotal role in reducing transport GHG emissions by reducing trip distances and car dependence in urban areas, and encouraging the uptake of walking, cycling and public transport.[16]

This kind of urban development does not simply involve increasing the density of buildings and housing. The quality, location, and type of densification (shaped by urban planning and policies) can result in different outcomes and emissions levels. In general, we expect transport emissions to decrease in urban areas with the following features: mixed land use, good access to public transport, recreational options and green spaces, and safe and attractive urban environments/streets for walking and cycling. This can happen at different scales in a wide range of urban environments from our larger cities to smaller towns. *Higher* density includes medium-density town houses, terraced housing and small apartments – it does not solely refer to high-rise buildings.

Quality compact, mixed use urban development needs to be encouraged around both public transport hubs and employment hubs (including areas of employment and economic activity outside of Central Business Districts), to make it easier for more people to access jobs, shops, schools, and other important destinations by walking, cycling and/or using public transport.

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[16] Intergovernmental Panel on Climate Change (IPCC), 2014, "Chapter 8: Transport" in *Climate Change 2014: Mitigation of Climate Change*, retrieved from: https://www.ipcc.ch/report/ar5/wg3/

The cumulative impact of urban development, land use and transport policies on transport GHG emissions has the potential to be significant.

International research has found that doubling residential density across an urban area can lower households' transport demand by 5 to 12 percent. If coupled with high employment concentrations, mixed land uses, and other supportive demand management measures, transport demand can decrease by 25 percent.[17] The OECD report "*Decarbonising urban mobility with land use and transport policies: the case of Auckland, New Zealand*" found that reforming existing land use policies in Auckland to enable greater densification could reduce emissions by an additional 10 percent when combined with policy packages that promote public transport and electric vehicles.[18]

Quality compact urban form supports GHG emission reductions in other sectors and delivers additional environmental benefits

By reducing the need for private motorised vehicles and the size of our fleet, compact urban form can also help to avoid emissions and other environmental impacts associated with the following:

- infrastructure construction, including road and state highway construction and maintenance;
- vehicle manufacturing/refurbishment, and disposal/recycling at the end of life;
- fossil fuel extraction, processing, and importing to Aotearoa; and
- mineral extraction and processing (including for electric vehicle batteries).

Quality compact, mixed use urban development offers significant co-benefits

The co-benefits of quality compact, mixed use urban development can be significant, and provide a compelling case beyond the GHG emission reduction component. For example, co-benefits include:

- maintaining and improving access as cities develop (e.g. by increasing the range and number of opportunities and amenities that people can access within a short distance or time frame and reducing the high costs associated with car ownership/use).
- supporting economic prosperity (e.g. by helping to manage/avoid congestion driven by car-based urban expansion; and reducing the size of infrastructure investments in water, sewage, and road infrastructure that are required for urban expansion).
- improving health and safety in communities (e.g. by reducing traffic speeds and volumes, increasing physical activity, reducing stress, improving air quality and quieter urban areas through lower vehicle volumes, and mode shifts to low emissions transport modes).
- improving environmental sustainability (e.g. by reducing run-off from vehicles into waterways, protecting urban ecosystems and habitats, ensuring future food security by reducing the development of productive land, and improving amenity by protecting natural areas on the urban periphery).

Planning rules that affect urban form affect housing and living costs

Planning rules that enable compact, mixed use urban development can increase the overall affordability of living in urban areas with good access to jobs, education, and amenities.

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[17] International Transport Forum (ITF). (2020). "Land-use Planning" in *Transport Climate Action Directory*, retrieved from: https://www.itf-oecd.org/tcad-measures?=Apply

[18] OCED. (2020). *Decarbonising Urban Mobility with Land Use and Transport Policies: The Case of Auckland, New Zealand*, retrieved from: http://www.oecd.org/publications/decarbonising-urban-mobility-with-land-use-and-transport-policies-the-case-of-auckland-new-zealand-095848a3-en.htm

Enabling housing intensification in appropriate areas can help to make urban land markets more competitive and increase housing supply. It can also reduce costs associated with the land required per housing unit, residential parking requirements, infrastructure and utility costs, and household expenses (including heating and transport). As a result, quality compact urban growth can potentially increase the affordability of living in urban areas overall, particularly for first homebuyers and lower income residents who live in multi-family housing and rely on walking, cycling and public transport. [19] The OECD modelling in Auckland in 2019 concluded that land use intensification policies can be powerful tools for improving well-being and can help to slow growth in housing prices. [20]

However, there is a risk that compact neighbourhoods with high amenity values can result in higher housing prices and rents, which can displace low-income residents and increase social inequity. Initiatives that increase the supply of social and affordable housing as part of urban development can help to address this challenge.

In the absence of supporting policies and a suitable transport system, higher density environments can also result in traffic congestion, noise and air pollution, and encroachment on biodiversity and green spaces. This can all result in adverse welfare impacts. Providing mixed land uses, vibrant public places, good access to public transport, green spaces and other public resources, and safe and attractive urban environments for walking and cycling is critical to mitigating these effects and encouraging people to live in higher density environments. This emphasises the importance of designing density well because poorly designed density can have adverse outcomes.

Planning rules that limit or control urban expansion into some areas also affect land prices, with spill on effects for housing costs, so these impacts also need to be carefully considered. One of the main drivers behind the Government's Urban Growth Agenda is to improve housing affordability in a way that also assists emissions reductions, improves access, and enables quality-built environments while avoiding unnecessary sprawl.

Supporting quality compact, mixed use urban development is an important strategy for reducing transport emissions and creating sustainable cities and towns in the long-term

Reshaping urban form can take a long time. Therefore, these changes generally only impact on travel and emissions over the medium to long term (e.g. 10-30+ years). This means that strategies to deliver quality compact, mixed use urban developments can play a valuable role in achieving long-term and enduring emissions reductions, but they will not deliver significant emissions reductions within a short time-frame (e.g. less than ten years). They need to form part of a package of initiatives to deliver net-zero emissions by 2050. However, we should aim to introduce measures urgently that support quality compact urban development to ensure that we realise the benefits as soon as possible. This also means that central and local government have to reconsider planned investments in major urban highway and roadway expansion projects if they would induce more vehicle travel.

From an emissions reduction perspective, the need to orient urban development towards compact urban form is most pressing in our largest and fastest-growing cities where emissions are highest. This includes Auckland, Hamilton, Tauranga, Wellington, and Christchurch. However, we also need to consider the benefits of compact urban form, and

[19] Victoria Transport Policy Institute. (2019). *Smart Growth*, retrieved from https://www.vtpi.org/tdm/tdm38.htm

[20] OECD. (2019). *Decarbonising urban mobility with land use and transport policies: The case of Auckland*

multi-modal transport options, in smaller cities and towns to reduce car-dependency, especially as these places grow over time.

The National Policy Statement on Urban Development 2020 (NPS-UD) has several policies that support quality compact, mixed use urban development. These include enabling greater intensification in urban centres and places close to rapid transit stops, as well as other areas with good access to destinations by active and public transport modes. Local authorities will also no longer be able to regulate minimum parking requirements. The removal of car parking minimums supports intensification and means that people who do not need or want a car park are not required to pay for one.

Greater alignment between land use, urban development and transport is required to further support quality compact, mixed use urban development. This includes reflecting land use and transport integration in the Government's resource management reforms, infrastructure funding and finance, Urban Growth Partnerships and wider urban policy.

Placemaking and inclusive streets can encourage walking, wheeling, cycling and public transport use in our towns and cities

The way we create places and design our streets affects how much people walk, wheel, cycle, and take public transport, which affects the liveability of urban environments and transport GHG emissions.

Since the middle of the last century, Aotearoa's cities and towns have predominately followed car-oriented forms of urban development. Although there have been some recent shifts, most housing has been characterised by low-density developments in areas without good public transport services. This has made many New Zealanders highly reliant on private vehicles to access jobs, education, shops, open spaces, and other amenities, which are often dispersed over wide areas.

Our streets reflect this reliance on cars, with most street space dedicated to moving and storing/parking cars and other light vehicles. There is less priority given to people travelling by other modes (e.g. by foot, bike, or bus), which can make it difficult, unappealing or unsafe to travel by these modes. This also affects the attractiveness of streets as destinations for meeting, shopping and spending time.

We need to design and manage our streets to be more inclusive of different people and transport modes

We can create our streets in a way that prioritises, encourages, or discourages any transport form, including walking, wheeling, cycling, public transport and private vehicles. For example, the way we allocate street space affects whether our streets are safe and attractive for people to travel using a range of transport modes. Multi-modal street layouts can reduce car traffic and encourage more sustainable transport modes. This often requires improvements to walking and cycling infrastructure, such as widening footpaths to prioritise intersections for walking and providing separated cycle ways. It can also include dedicated bus lanes and bus priority measures.

We can also design our streets to be inclusive of all people. For example, applying universal design principles can help to ensure environments are accessible for all people, regardless of age, disability or other factors. This in turn affects how people choose to travel and consequently transport emissions.

Lower speed limits in urban areas can also have significant benefits for the safety and amenity of urban areas, which can encourage walking, cycling and public transport use.[21] Lower speed limits need to be accompanied by traffic calming measures so that people travelling in cars travel below these limits.

We can also choose to turn our streets into vibrant places that encourage people to travel by active modes

Placemaking is the process of turning spaces into vibrant public places that are good for people's wellbeing, and that make urban areas attractive places to live, work and visit. Placemaking helps to make walking, cycling and public transport more attractive transport choices. It can also reinforce the context of a street as a low speed and people-friendly environment, which can encourage walking and cycling.

Public transport stops and stations provide natural opportunities for placemaking, given their focal point in public life.[22] Placemaking can enhance destinations, such as schools, libraries and playgrounds, and unlock transit orientated development by revitalising adjacent neighbourhoods and becoming a gravity point for social and economic activity.

The place function of a street can be enhanced by urban design that encourages business activity, social interaction and play, and makes streets include for people of all ages and abilities (e.g. through making it easy to cross roads and streets, providing places to stop and rest, things to see and do, and adequate lighting, shade and shelter).[23]

Alongside placemaking, integrating green spaces and living infrastructure (e.g. trees and green walls and roofs) into new urban developments and alongside transport routes also has the potential to encourage walking and cycling by increasing the walkability of urban environments. In addition to sequestering carbon, green spaces and living infrastructure can also support urban ecosystems to sustain biodiversity. This is critical to the health and wellbeing of residents in denser urban environments.

The growth of 'low-traffic neighbourhoods' in response to the COVID-19 pandemic

Low traffic neighbourhoods are being increasingly used in cities around the world to reduce vehicle traffic in residential areas, and increase local walking and cycling. In response to COVID-19, initiatives to revive local neighbourhood life and increase urban walkability, such as Barcelona's 'superblocks', Paris's '15-minute city' concept, New York's Open Streets, or London's 'low traffic neighbourhoods' have gained momentum for their co-benefit of supporting safe physical distancing. Many cities have adopted pedestrianisation, the temporary closure of streets to motor traffic, and re-purposing on-street car parking spaces to reduce vehicle traffic and create more space for pedestrians and cyclists. Already part of efforts to create a healthy urban environment and promote low-carbon transformations before COVID-19, such actions have now assumed even stronger value.

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[21] Todd Litman. (2020). *Land Use Impacts on Transport: How Land Use Factors Affect Travel Behaviour*, Victoria Transport Policy Institute. Retrieved from: https://www.vtpi.org/landtravel.pdf

[22] Project for Public Spaces. (2018). *Placemaking in Transit.* Retrieved from: https://www.pps.org/article/placemaking-in-transit

[23] Healthy Streets, *About*. Retrieved from: https://healthystreets.com/home/about/

Creating temporary or permanent car free or car-lite spaces in our neighbourhoods (urban areas that encourage little to no car use through a range of mechanisms) can be a low cost, rapid and efficient way to encourage mode shift, and improve the safety, wellbeing and liveability of communities. This is particularly important in higher density environments to ensure residents with limited access to private gardens or urban parks, or who live in crowded flats or poor quality homes, can take a breath of fresh air, play, exercise and socialise, while maintaining a safe physical distance. Longer term, establishing neighbourhoods in which it is possible to safely walk and cycle, linked to a wider network of safe pedestrian routes and cycleways, is a key strategy to encouraging a shift toward low carbon transport.

Placemaking and inclusive street design are also crucial for quality compact, mixed use urban development

To ensure that higher density urban environments attract more people to live and work in them, we need to ensure that they have high levels of access and amenity (including access to green spaces). Placemaking and street design can also minimise the potential adverse effects of increasing urban density on wellbeing and liveability (e.g. traffic congestion, noise and air pollution, and potential encroachment on biodiversity and green spaces).

Creating streets where people want to walk, wheel, cycle, and spend time supports a range of co-benefits

Creating vibrant, inclusive urban environments where people enjoy living, working and visiting supports social, environmental, economic and health outcomes. Co-benefits can include:

- supporting economic prosperity (e.g. by encouraging local shopping and economic activity);
- improving safety in communities (e.g. by reducing traffic speeds and volumes);
- improving physical and mental health (e.g. by increasing physical activity, reducing stress, and improving air quality through lower vehicle volumes, and mode shifts to low-emissions transport modes); and
- improving environmental sustainability (e.g. by reducing vehicle run-off into waterways, and supporting biodiversity).

Movement and place functions of streets need to be integrated across urban areas

Our urban transport systems need to enable both movement and place – with transport corridors and streets designed for a mix of purposes. The Movement and Place Framework (Figure 7)[24] aims to recognise the complex nature of road environments and provides a way to measure and prioritise the needs of all road users. This helps planners to balance the safe and efficient movement of people and goods along key movement corridors with enabling vibrant and inclusive places for people.[25]

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[24] Figure from Greater Newcastle Future Transport Plan, retrieved from: Customer Outcome 3: Movement and place framework | Future Transport (nsw.gov.au)

[25] Waka Kotahi is developing a new 'One Network Framework' based on the 'Movement and Place' approach but with more detail. One Network Framework | Waka Kotahi NZ Transport Agency (nzta.govt.nz)

In some cases, placemaking and inclusive street design will affect the movement and storage of vehicles (e.g. by slowing speeds, closing streets to cars or removing parking). While these types of interventions are likely to improve access for people overall, they may affect the access of some people in the community and how they travel. Roads and streets also need to accommodate the efficient movement of products and freight.

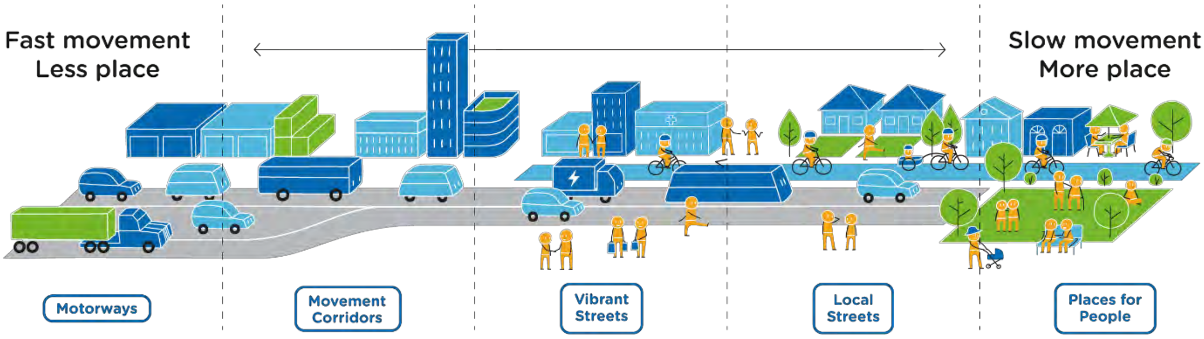

Figure 7. Movement and Place Framework

Reshaping streets to support public transport, active modes, and placemaking could potentially be done swiftly and cost-effectively

To deliver mode shift for emissions reductions, comprehensive cycling/scooting networks are needed in urban areas, along with more dedicated/priority bus lanes, and better urban environments for walking.

Street changes to support public transport and active travel could potentially be made swiftly and cost-effectively, as it is possible to reallocate space on existing streets to deliver mode shift without building major new infrastructure. Low cost, tactical street changes (often referred to as tactical urbanism), such as utilising street furniture, planter boxes, artwork and other features, can be used to calm and reduce traffic speeds and to create 'pop up' bike/scooter lanes. Waka Kotahi's Innovating Streets Programme provides good examples of this.[26]

The main challenge with reallocating street space is that communities are seldom united when it comes to changing existing streets. Even when a majority of people in a community support street changes, some people can strongly resist changes that involve removing on-street car parks and/or lane space for private motorised vehicles. While it is important for local government to engage well with local communities on proposed street changes, consultation requirements and processes can also make it difficult to enact changes. Councils often consult communities on city-level or neighbourhood-level changes (e.g. cycling networks or bus priority routes), and then consult communities again on every street-level change (e.g. removing individual car parks).

Local government is responsible for local road development and maintenance, and walking and cycling infrastructure and initiatives. This means that local government has more control than central government in making street changes. However, local government always

[26] Waka Kotahi's Innovating Streets for People programme aims to make it faster and easier to transition streets to safer and more liveable spaces – more information can be found here: [About the Innovating Streets programme | Waka Kotahi NZ Transport Agency (nzta.govt.nz)]

operates within a regulatory and funding context set by central government. Central government also co-funds local street construction and maintenance, and public transport services that use those streets. Central government can strongly influence local street layouts through rules, regulations, standards, guidelines, and incentives. It could therefore more strongly enable, support, and require local government to make some street changes to support active travel, public transport, and placemaking.

There are also opportunities to leverage street changes during the street renewals/maintenance process. Both local and central government invest substantially in maintenance and renewals. The vast majority of these are 'like for like' renewals. In some situations there will be opportunity to 'build back better' by upgrading streets (where appropriate) during the renewals process to improve streets for people walking, cycling/scooting, and using public transport. This would deliver better value for money, as it would avoid the need to change streets twice for renewals/upgrades. It would also build momentum for ongoing street improvements over time.

Shaping our towns and cities: possible key actions

The responsibility for reducing transport emissions does not rest with transport decision-makers alone, as many of the following possible actions require a coordinated approach by different agencies involved in land use, urban development and transport policy.

Quality compact, mixed use urban development:

- Through the proposed Strategic Planning Act (part of the RMA reforms), require spatial plans to be developed and implemented to better integrate land use, urban development and transport planning to achieve quality compact, mixed use urban development. Both central government and local government need to work together to improve capabilities for spatial planning. **(Underway through RMA reforms)**
- Integrate land use and transport planning and investment as part of the RMA reforms.
- Make transport investments conditional on having clear links to land use and urban development plans that support quality compact, mixed use urban development. This will affect the types of projects that are included in Regional Land Transport Plans.
- Require transport GHG emission impact assessments for proposed urban developments (including the transport GHG emissions of residents and business owners that would be located in the development). Developments that would result in high emission generation could potentially be required to undergo redesign and/or an acceptable form of durable mitigation.
- Develop clear guidance and expectations to link urban density and mixed land use with accessibility (particularly by way of public transport, walking, and cycling).
- Enable Waka Kotahi, Local Government, KiwiRail and Kāinga Ora to take more active roles in developing sites around frequent public transport stations.

Placemaking and inclusive street design:

- Remove barriers and improve funding for tactical urbanism and innovative approaches to street design (e.g. expand on Waka Kotahi's Innovating Streets for People Programme).
- Develop design guidance and expectations for quality high-density environments (including streets, public spaces, buildings, and green space).
- Invest in placemaking and urban design capability and capacity of transport agencies and transport functions within local government.
- Clarify the principles of living infrastructure, and set expectations that living infrastructure is incorporated into transport plans and projects.
- Review standards and guidance for street design, and develop nationally applicable consistent sets of standards for Aotearoa.
- Prioritise the need to reallocate street space and to create connected networks for delivering transport mode shifts in the next GPS on land transport, and/or for any additional funding for active modes and public transport.
- Set higher Funding Assistance Rates for walking and cycling investments and dedicated/priority bus lanes to strongly incentivise Road Controlling Authorities to prioritise and accelerate street changes.
- Investigate if regulatory changes are needed to empower Road Controlling Authorities to more easily consult on and make street changes to support active travel, public transport, and placemaking.
- Set targets for councils to deliver public transport and active travel networks that require street changes (e.g. dedicated/priority bus lanes on some routes; connected cycling networks) by a specific date. There could be funding consequences if Road Controlling Authorities do not deliver these changes within these timeframes.
- Make changes to policy and funding settings to ensure Waka Kotahi and Road Controlling Authorities maximise opportunities to 'build back better' when doing street renewals (to improve streets for people walk, cycling, and using public transport).

(Ministry of Transport and Waka Kotahi have some projects underway that support placemaking and street design e.g. Aotearoa Urban Street Guide, the One Network Framework, and Reshaping Streets scoping project)

Consultation question 4
Do you think we have listed the most important actions the government could take to better integrate transport, land use and urban development to reduce transport emissions? Which of these possible actions do you think should be prioritised?

Providing better travel options can support mode shifts and improve trip efficiency

As noted earlier, most New Zealanders are currently very reliant on private vehicles to meet their daily needs. Private vehicles are useful for many transport tasks due to their flexibility and speed (especially over long distances). However, private motorised vehicles also produce the majority of our transport emissions, and can be detrimental to people's wellbeing by contributing to air/noise pollution, and poor quality urban environments. Car-oriented urban expansion/dispersal also leads to increased traffic, congestion, journey times, and travel costs.

We need to develop a transport system that addresses these issues and improves the wellbeing of New Zealanders. Increasing the share of travel by public transport, walking, cycling, and shared mobility in our towns and cities is important for reducing emissions and achieving a wide range of co-benefits.

We can influence how people travel by providing better travel options that are energy efficient and generate low or no emissions. This includes providing quality public transport services (both intra-regional and inter-regional), safe and accessible walking and cycling networks in urban areas, and shared mobility options, such as car sharing and shared micromobility.

Note: The street changes discussed in the previous section on Placemaking and Inclusive Streets are also highly relevant to this section, as street changes are needed to encourage travel by public transport and active modes.

Public transport can be the foundation for more sustainable mode use in cities

Attractive, safe, and reliable public transport systems (including shuttles, buses, rail and light rail) can provide a foundation for the use of more sustainable modes in cities. Shifting travel from cars to public transport, in urban areas where its provision is viable, can save energy and reduce emissions. Net energy savings depend on how much public transport services are used.

Public transport is critical for supporting higher density urban environments

Frequent public transport services become more viable and well used in medium to high density urban environments where high concentrations of people can easily walk/wheel/bike to a public transport service. At the same time, public transport is critical for supporting compact, mixed use urban development because it is the most efficient way of moving high volumes of people quickly. For example, cars travelling at 50 kilometres per hour are estimated to require about 20 times as much space as trams or buses to move large quantities of people.[27]

When people use public transport instead of private cars, it also reduces the amount of space needed for car parking/storage. Most cars currently sit in car parks or in garages for approximately 90 percent of their working life, taking up space in streets and in buildings, and around businesses, homes, parks, and recreational areas.

Public transport services can therefore help to free up valuable urban space that could be used for housing, commerce, or civic purpose instead of for moving and parking/storing private motorised vehicles. By reducing pressures for more and wider roads, as well as car

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[27] Nello-Deakin, S. (2019). "*Is There Such a Thing as a 'Fair' Distribution of Road Space?*" Journal of Urban Design 24 (5): 698–714.

parking, public transport can also help to reduce GHG emissions (as well as other harmful pollutants) from road construction and maintenance.

Coaches and trains also offer an alternative to interregional air travel and car travel

Rail and bus/coach services offer a lower-emission alternative to interregional air travel and travel by car. There are currently two inter-regional passenger rail services operating in Aotearoa (Palmerston North to Wellington, and a trial service from Hamilton to Auckland). Historically, for passengers who wish to travel longer distances, air travel and road transport (including buses and coaches) have largely replaced rail as the favoured, more economical, and faster means of travel in Aotearoa. Where it is feasible, increasing the number, efficiency and quality of inter-regional passenger rail and bus/coach options has the potential to reduce transport GHG emissions by providing an alternative to regional travel by air and private vehicle. Before decisions are made on if Aotearoa should increase interregional rail, we would need to consider its economic viability and competitiveness against changes in our vehicle and aviation fleet to be low-emissions. Inter-regional passenger rail travel can take longer, and choices made by individuals will be dependent on their purpose for travel and the time they have available to use this alternative mode.

Domestic air travel for some is a form of public transport, but it needs to be low-emissions aviation

Domestic air travel is a public transport option, and for some users it may be the only logical method of transportation to meet their needs. Air travel meets the needs of people who might travel for medical reasons, business, are time poor or are unable to travel long distances in alternative modes. Air travel is also important for its role in connecting our regions and provides opportunities for regional development. The popularity of domestic travel is likely to increase post-Covid 19. Consideration must be given to how Aotearoa will improve its domestic air fleets, to make them more sustainable. Options to achieve this include increased production and availability of sustainable aviation fuels, consideration of electric planes as the technology evolves (noting smaller 19-seater electric planes are now commercially available) and continued operational improvements by aviation operators. Cleaner aviation is discussed in more detail in Theme 2.

Public transport provides co-benefits, including supporting the access of non-drivers

Attractive, safe and reliable public transport has a number of co-benefits in addition to those outlined above. For example:

- Improving health and safety in communities (e.g. reducing road accidents and fatalities, as public transport is the safest mode of travel[28], increasing physical activity, reducing stress, and improving air quality and reducing noise through lower vehicle volumes, and mode shifts to low emissions transport modes).
- Maintaining and improving access to social and economic opportunities including for those who do not drive or cannot afford their own private motorised vehicle
- Supporting economic prosperity (e.g. by helping to avoid congestion created by private vehicles).
- Improving environmental sustainability (e.g. by reducing vehicle run-off into waterways).
- Increases resilience to shocks and disruptions in the transport network (e.g. through providing an alternative transport option to private, road transport).

[28] Frith et al. (2015). The role public transport can play in Safer Journeys and, in particular, to advance the Safe System approach. Waka Kotahi research report, retrieved from: Research report 581: The role public transport can play in Safer Journeys and, in particular, to advance the Safe System approach - December 2015 (nzta.govt.nz)

Public transport improvements can make a difference to GHG emissions both in the short and long term

Improvements to public transport infrastructure and services can make a difference in the short and medium to long term. For example, increasing the number and frequency of public transport routes/services, and street changes to prioritise bus movements, can increase mode shifts and reduce transport GHG emissions in the short term. Major improvements to public transport infrastructure, such as busways and rapid transit services, also shape urban form in the longer term (e.g. 10-30+ years) to encourage quality compact mixed-use urban development. We should take into account any potential rebound effects of improving public transport services (such as induced travel demand from reducing congestion on roads) and look for opportunities to address it through measures that manage car travel, such as street changes, road pricing and parking pricing.

Walking, cycling and other active modes can reduce emissions, improve access and have significant health benefits

Walking, cycling and other active modes can reduce transport emissions by substituting motor vehicle trips and supporting public transport. Walking and cycling are separate modes but share many of the same benefits and therefore we have discussed them together.

There is a significant opportunity for Aotearoa to increase the uptake of active modes. In 2014, over three-quarters of journeys to work in Aotearoa were by car, while only four percent involved walking and three percent were by bicycle.[29] A third of all transport trips in Aotearoa are less than two kilometres – a distance that is easy for most people to walk or cycle. Some other countries, particularly in Europe, have much higher rates of walking and cycling (for example, 44 percent of trips are made by walking and cycling in the Netherlands).

There is major untapped potential for walking and cycling in Aotearoa

Some cities in Aotearoa have higher uptake of active modes, demonstrating the potential for these modes. For example in Wellington and Dunedin nine percent of people walked to work in 2014, compared to four percent of people in Auckland.[30] Evidence also consistently shows that there is significant latent demand for cycling in Aotearoa's cities.[31] However, most of our cities are making slow progress in making streets safer and more attractive for cycling. Some flagship cycling projects and routes are making progress, but there is less progress being made on connecting and completing currently disconnected urban cycling networks.

Changes in travel behaviour also demonstrate the potential for mode shift in our towns and cities. One of the most profound changes in the past several decades has been the reduction in the number of children that walk or cycle to school. Research from 2013 revealed that the key predictor of whether children would walk or bike to school was the distance between their home and school.[32] The Ministry's 25 Years of Travel study in 2015 showed that 42 per cent of school journeys by primary school pupils were made on foot in

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29 New Zealand Household Travel Survey (Ministry of Transport).

30 Ibid 6.

31 Waka Kotahi. Assessing Cycling Demand. Retrieved from: Assessing cycle demand | Waka Kotahi NZ Transport Agency (nzta.govt.nz)

32 F Conlan (2013). *Getting to School.* Retrieved from: FConlon-Gettingtoschool-dissertation.pdf (sustainablecities.org.nz)

the late 1980s. By 2014 that had fallen to 29 per cent. Cycling fell from 12 per cent of journeys, to fewer than five percent.

E-bikes are increasing the potential for cycling in Aotearoa

E-bikes are growing in popularity and have potential to improve efficiency, sustainability and wellbeing within Aotearoa's urban transport systems. E-bikes enable people to cycle more quickly, with less effort and sweating, and to cover longer distances.

A study by Auckland University highlighted a number of other benefits of E-bikes experienced by users, for example:

- increased commuting efficiency (e.g. higher levels of commuting 'control' and arrival time reliability, especially in congested conditions);
- easier trip chaining for active transport (e.g. pedal-assist makes trips quicker and less tiring, easier to carry things and children);
- reduced commuting stress; and
- increased uptake of active transport by women (a count on Auckland's North-western cycleway showed that while women represented 27 percent cyclists, they made up 41 percent of e-cyclists).[33]

The key benefit of E-bikes is that they broaden the pool of people who would cycle if there was safe and connected infrastructure to do so in Aotearoa. Therefore, creating networks of safe, separated cycleways is likely to be the best way to harness the potential of E-bikes in Aotearoa.

Walking and cycling offer significant co-benefits, especially for public health

In addition to reducing GHG emissions, encouraging the uptake of walking and cycling can result in major co-benefits. The main co-benefit is improving public health through increasing levels of physical activity[34]. Aotearoa has the third highest adult obesity rate in the OECD, partly due to lack of physical activity. Further, obesity rates are rising. On average, New Zealanders spend less than an hour walking per person, per week. A 2010 Aotearoa study found that physical inactivity costs $1.3 billion a year.[35] Physical activity also has mental health benefits, with stress relief, increased social interaction, and possible reduced risk of depression. Other co-benefits include improved air and noise pollution outcomes.

Improving non-motorised transport options can also contribute to greater social equity and economic opportunities for people who may not have access to a car. Some of these people may be socially, economically, and physically disadvantaged. Additionally, increased rates of walking and cycling can reduce traffic and parking congestion.[36]

[33] Kirsty Wild and Alistair Woodward. (2018). *Electric City: E-Bikes and the future of cycling in New Zealand.* Retrieved from: https://cpb-ap-se2.wpmucdn.com/blogs.auckland.ac.nz/dist/c/520/files/2018/08/Electric-City-Ebikes-and-the-Future-of-Cycling-in-NZ-1rihn5y.pdf

[34] World Health Organization. (2018). *Global Action Plan on Physical Activity 2018-2030.* Retrieved from: https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf

[35] Auckland Council, Waikato Regional Council, Wellington Regional Strategy Committee. *The Costs of Physical Inactivity: Toward a regional full-cost accounting perspective*. Retrieved from: WGN_DOCS-#1153301-v1-The_Costs_of_Physical_Inactivity_-_Toward_a_regional_full_cost_accounting_perspective_-_F (waikatoregion.govt.nz)

[36] Todd Litman. (2010). Quantifying the benefits of non-motorized transportation for achieving mobility management objectives. *Victoria Transport Policy Institute*, *28*.

Taking a network approach is key to reducing emissions through walking and cycling

In Aotearoa there are real and perceived safety risks with cycling, and providing a safe way to cycle is key to increasing the uptake of this mode. The key opportunity is investment in safe and high quality infrastructure for both walking and cycling. Infrastructure must be joined up in a network to enable convenient movement around a city. Different speeds of active modes need to be separated from each other. Infrastructure also needs to be integrated with other modes (e.g. secure cycling facilities at public transport hubs). There is a risk that if we take a piecemeal approach to developing walking and cycling infrastructure then we will not see the benefits. The challenge of this approach is that it requires us to reconfigure streets across large urban areas (see also the discussion on reallocating street space in the section on Placemaking and Inclusive Streets).

Alongside investment in infrastructure, public education and information campaigns could play a useful role. When successful, these types of campaigns can increase the social acceptance and understanding of alternative modes. These campaigns can be specific, for instance not only helping drivers understand cyclists perspectives more, but encouraging active mode users to more considerately share space as well. The inclusion of walking and cycling in travelling planning information and apps can also encourage these modes by showing travel times, and safe cycling routes. Some apps show the nearest bike hire location and cost.

Cargo-bikes, and other forms of micro-freight, could play a key role in supporting compact, mixed use urban development and car free streets

Increasing urbanisation, population growth, and demand for 'just-in-time' deliveries has lead to growth in freight movements in many international cities. As a result, the distribution of urban goods has become associated with negative impacts such as increased traffic congestion and higher emissions.

Cargo bikes, especially electric cargo bikes, may be a promising solution for congested and polluted urban centres for some types of freight, such as parcel and food delivery. Electric cargo bikes offer two improvements on traditional bike couriers: they can carry larger loads and their electric pedal assistance allows riders to more easily ascend hills and cover long distances.

In urban centres, electric cargo bikes can be more efficient and produce less air and noise pollution than cars, vans and trucks. They are also easier to park and take up less space – reducing the impact of unloading operations on traffic congestion.[37] In addition, repurposing streets to create more space for pedestrians and cyclists can affect the access of larger vehicles. Cargo bikes can help to overcome this barrier and can also operate in low emission zones and avoid congestion charging.

Cities around the world are looking at innovative ways to incorporate electric cargo bikes into urban freight systems. For example, Berlin has piloted the use of electric cargo bikes as a sustainable solution for delivery in urban areas. The city set up a cooperative micro-hub for use by several parcel service providers. The service providers use larger vehicles to drop off parcels to the central location, and then electric cargo bikes distribute the parcels in the local area. This pilot was successful and the companies involved have agreed to continue using the micro-hub beyond the funding period.[38]

Consideration could be given to expanding existing funds, such as the Low Emissions Vehicles Contestable Fund administered by EECA, to include support for these modes.

As our towns and cities look for opportunities to encourage the uptake of cycling, we should keep in mind how cycling networks can also be used to move goods as well as people.

Shared mobility forms part of the suite of transport options that enable people to reduce their car dependence

Alongside public transport, walking and cycling, shared mobility forms part of the suite of transport options that enable people to reduce their car dependence and choose more sustainable transport options. By reducing car dependency, shared mobility also supports quality compact, mixed use urban development, which can contribute further GHG emission reductions.

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[37] Sandro Melo and Patricia Baptista. 2017. *Evaluating the impacts of using cargo cycles on urban logistics: integrating traffic, environmental and operational boundaries*, European Transport Research Review, retrieved from: https://etrr.springeropen.com/articles/10.1007/s12544-017-0246-8

[38] Smart City Berlin, *KoMoDo – cooperative use of micro-depots*, retrieved from: https://www.smart-city-berlin.de/en/projects-list/project-detail/komodo-cooperative-use-of-micro-depots/

Shared mobility refers to various modes and services that may increase transport system efficiency by sharing vehicles and rides, including car sharing, micromobility sharing (bike and scooter sharing), carpooling/ride sharing and shared on-demand shuttles.

The benefits of shared mobility differ depending on the type of shared mobility and its location – Cities have experienced different impacts with shared mobility depending on the market (e.g. car ownership levels, ease of driving), scheme coverage and maturity, and the level of policy support. In many cases (such as with shared scooters or E-bikes), the direct impact of shared mobility on GHG emissions is uncertain. In other cases (such as car sharing), their emission reduction potential could be more significant.

In general, shared mobility options are most likely to affect emissions in larger urban environments, where they can grow to a scale that attracts a significant number of users. On their own, these schemes will only have a small impact, but they play a more significant role when considered as part of the broader urban transport system. In smaller towns and rural areas, shared mobility options can supplement or be an alternative to traditional public transport services, which are often not as viable in low-density areas.

When it comes to supporting shared mobility, the Government needs to undertake further work to understand when and how it should act relative to the market.

Car sharing can reduce GHG emissions by reducing car ownership and Vehicle Kilometres Travelled (VKT), and encouraging the uptake of public transport, walking and cycling

Car sharing refers to a system in which a group of people share a fleet of vehicles and access them on an as-needed basis. The basic premise is that vehicle costs and usage are shared amongst a group of people. The cars are parked in a network of locations in a city or neighbourhood. Users are typically charged each time they use the vehicle, which can be by the hour/minute, or for several days at a time. Car sharing is a type of car rental service rather than a ride hailing/taxi service because people drive themselves.

Car sharing can reduce GHG emissions through reducing car ownership and vehicle kilometres travelled and encouraging the uptake of public transport, walking and cycling.[39] Car sharing, as part of an integrated transport system, gives people the opportunity to drive when they need to because the alternatives do not make sense for a given trip. Car sharing options give people comfort that if they choose not to own a car because they prefer to drive less, they can still access one when they need it.

Car sharing also supports people living in inner city suburbs to not own a car but still have convenient access to a car for when a car is the best transport option. At the same time, quality compact urban form makes car sharing a much more viable option because you need a car less for access to opportunities.

Wellington has approximately 90 car share vehicles, shared by over 7000 members. Data from 2019/20, provided by Wellington's two car share providers Mevo and Cityhop, shows that across the two schemes, one car share vehicle now replaces 11 private vehicles in the city.[40]

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[39] Todd Litman. (2015). *Evaluating Carsharing benefits*, Victoria Transport Policy Institute. Retrieved from: https://www.vtpi.org/carshare.pdf; Shaheen, S., Cohen, A., & Farrar, E. (2019). Carsharing's impact and future. In *Advances in Transport Policy and Planning* (Vol. 4, pp. 87-120). Academic Press.https://escholarship.org/uc/item/2f5896tp

[40] Wellington City Council. (2020). Car Share schemes driving force for eco-city status. Retrieved from: https://wellington.govt.nz/your-council/news/2020/09/car-share-schemes.

In addition to reducing GHG emissions, car sharing can also result in a wide range of co-benefits. This includes reducing congestion and demand for parking and vehicle storage, improving public health by supporting the uptake of active modes, improving transport choices and increasing access, and saving individuals, businesses and other organisations money (car sharing can be a cost effective alternative to low use cars e.g. cars only used once a week).

Shared micromobility is playing an increasing role in some cities, which may be supporting emission reductions

Shared micromobility, including bike share (standard bikes and E-bikes) and scooter share (kick and e-scooters), enables people to have short term access to these modes on demand from a variety of locations.

The impacts of shared micromobility on the environment are still largely unknown internationally and in Aotearoa. It varies depending on the business model (station based or dockless) and its location (e.g. which city/country). International research suggests that shared micromobility can reduce GHG emissions by encouraging trips that would otherwise have been made by private vehicles.[41] However, many people also use shared e-scooters to make trips that they would otherwise make by walking or using public transport. Total energy use for bike and scooter rebalancing (redeploying the vehicles around the network) may affect the net environmental impacts of a sharing scheme.

Shared micromobility could support GHG emissions reductions by contributing to the suite of sustainable transport options that are available, which enable people to reduce their car dependency. Auckland Council has indicated that shared e-scooter schemes support the council's goal of quality, compact urban form and the ability for car free living.[42]

Technology may lead to new breakthroughs with carpooling – encouraging people to share rides

Carpooling allows travellers to share a ride to a common destination. Carpooling can reduce the number of cars needed by travellers, which can reduce VKT, fuel consumption and GHG emissions.[43]

There are several forms of carpooling, including casual carpooling – generally an informal arrangement between friends and colleagues or strangers (picked up at designated car pooling spots). Typically, no money is exchanged or only nominal amounts to reimburse drivers for expenses. There is also app-based carpooling – people arrange ad hoc rides on-demand, usually shared with strangers, using smartphone apps or websites. Typically, passengers are picked up at their current location or an agreed upon pick-up location.

In addition to reducing GHG emissions, carpooling can result in a wide range of co-benefits, including reduced air pollution and improved public health, mitigating congestion, reduced demand for parking, enhanced accessibility and economic opportunity for low-income households, and provides cost savings from shared travel costs.

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[41] Shaheen, S., Cohen, A., Randolph, M., Farrar, E., Davis, R., & Nichols, A. (2019). *Shared Mobility Policy Playbook*. Retrieved from: https://escholarship.org/content/qt9678b4xs/qt9678b4xs.pdf?t=q3qu5m

[42] Auckland Council. *Rental e-scooter trial: Provisional Strategic Evaluation.*

[43] Shaheen, S., Cohen, A., & Bayen, A. (2018). *The benefits of carpooling*. Retrieved from: https://escholarship.org/content/qt7jx6z631/qt7jx6z631.pdf?t=ph07of

On-demand shared shuttles may also play a role in reducing emissions by supplementing or replacing public transport in lower-density areas

There is growing interest around the world in the potential of on-demand shared shuttle services (also called microtransit) to improve access in lower density areas or for specific groups of the population (e.g. the elderly and the disabled).[44] They are considered particularly suitable for rural areas because of their flexibility, and ability to adapt to local needs. On-demand services are usually designed to either supplement or replace a fixed route public transport service. Waka Kotahi sponsored some research that found that there is significant potential for these types of shared transport services in Aotearoa's small towns and rural communities.[45] International research has found that demand-responsive services should be part of a broader, multimodal package of solutions, including supplementing regular public transport services.[46] The impact of on-demand shared shuttles on GHG emissions still needs to be investigated but it is likely to depend on the type of scheme and the local context.

In the future, Mobility as a Service could facilitate the use of sustainable transport modes

Mobility as a Service (MaaS) is a concept describing the integration of various forms of transport services, allowing users to see, plan, and book a multi-leg and multi-mode journey from a single accessible on demand platform. If implemented in Aotearoa, MaaS could help facilitate the use of sustainable transport modes and encourage shifts in behaviours, which could help to reduce transport emissions. However, more research is needed to understand how MaaS might enable reduced GHG emissions.

Providing better travel options in our smaller cities, towns and regions

As noted earlier, 87 percent of Aotearoa's population lives in urban areas, with most people living in cities. Aotearoa's main urban areas contribute over half our land transport emissions, with emissions concentrated in our largest cities – Auckland, Christchurch and Wellington. This provides a strong argument for initially prioritising efforts to reduce emissions (from the movement of people, at least) in New Zealand's cities, especially when these places are growing quickly.

However, we also need to reduce transport emissions and make our transport system safer and more inclusive in smaller cities and towns in the regions. The majority of emission reductions for regional transport will come from Theme 2 and 3 initiatives (discussed in chapters 7 and 8), which focus on decarbonising both the light and heavy vehicle fleets. However, there is still a role for land use planning and mode-shift initiatives to reduce transport emissions in regional Aotearoa.

People living in towns and rural areas tend to be highly car dependent because housing, jobs, schools, and amenities are widely dispersed, and frequent public transport services do not usually exist.

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[44] OECD, *International Experiences on Public Transport Provision in Rural areas*. Retrieved from: 15cspa_ruralareas.pdf (itf-oecd.org)

[45] Cheyne C and Imran M. (2010). *Attitudes and behaviour in relation to public transport in New Zealand's non-metropolitan regions*. Retrieved from: https://www.nzta.govt.nz/assets/resources/research/reports/419/docs/419.pdf

[46] OECD, *International Experiences on Public Transport Provision in Rural areas*. Retrieved from: 15cspa_ruralareas.pdf (itf-oecd.org)

It is possible to encourage compact mixed-use urban development, as outlined earlier in this chapter in small settlements as well as large ones. For example, housing, public services, and shops can be clustered closely together in town. In addition, planning that protects the rural landscape can help to preserve agricultural land and open space, protect air and water quality, provide places for recreation, and create tourist attractions that bring investments into the local economy.

Smaller settlements could also benefit from improved public transport services. This could include improved interregional public transport services and local demand-responsive shuttle services (such as the on-demand service being trialled in Timaru[47]). Research sponsored by Waka Kotahi found that there is significant potential for this type of shuttle service in small towns to expand people's transport choices – particularly for people who are mobility disadvantaged (e.g. the elderly, women, youth and the disabled).[48]

New technologies are also making shared mobility services, such as carpooling and car sharing, more viable in rural communities. Informal carpooling already happens in rural communities and can be an important option for people who do not drive or own a vehicle. Technology could make it easier to match people, trips, or vehicles.

Pedestrian and cycling improvements can also be implemented in small towns and settlements, enabling residents and visitors to enjoy active travel. Improving the walkability of main streets, including through placemaking, can also attract more people to the area for shopping and recreation. Good cycling networks can link rural neighbourhoods and destinations, serving both the community and tourists.

Providing people with better transport options in towns and rural areas could help to make these places more accessible for people who do not drive, which as Aotearoa's population ages, could become a larger percentage of people living in these communities.[49] However, there is always likely to be a high level of car dependency in regional Aotearoa. This means that we will need to focus our efforts on encouraging the uptake of low emission vehicles in regional communities and ensure there is adequate infrastructure to support their use (see discussion in the next two chapters).

Providing better travel options: possible key actions

For all of these possible actions, we need to consider where they are appropriate. Some of them should be targeted at our major urban growth areas where they are most viable, and where they can make the biggest impact on reducing emissions. Public transport could be improved in all of our cities, and is most needed n our largest and fasted-growing cities where most people live. Walking and cycling improvements could be made in towns and cities throughout Aotearoa. Shared mobility schemes could be provided in a range of settings, depending on population levels and urban density.

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47 Doug Sail, 2020, *Timaru's on-demand bus service eclipses traditional public transport,* Stuff. Retrieved from: https://www.stuff.co.nz/timaru-herald/news/121887016/timarus-ondemand-bus-service-eclipses-traditional-public-transport

48 C Cheyne and M Imran, 2010, *Attitudes and behaviour in relation to public transport in New Zealand's non-metropolitan regions.* Retrieved from: https://www.nzta.govt.nz/assets/resources/research/reports/419/docs/419.pdf

49 Ministry of Social Development, *Our ageing population.* Retrieved from: https://www.superseniors.msd.govt.nz/about-superseniors/media/key-statistics.html

Note: this section should be read in combination with the possible key actions from Shaping our towns and cities (above), which includes options to accelerate street changes to support public transport and active travel.

Public transport:

- Further invest in public transport infrastructure to increase the capacity, frequency, quality, and reliability of services. **(Some investment currently occurring through GPS on land transport, NZ Upgrade programme, and local Government)**
- Increase incentives to use existing public transport (such as reduced fares or service improvements). **(Councils already provide some incentives to specific users e.g. students, children. The Government's SuperGold card provides free travel to over 65s off-peak)**
- Invest in improving public transport operations (e.g. bus priority measures, and more efficient payment options etc.).
- Invest in additional public transport services (e.g. increasing service frequencies, extending existing services, adding new routes).
- Invest in better passenger amenities (e.g. better shelters/terminals, improved access and facilities at stops, and better connections with walking and cycling).
- Clarify the roles of agencies to deliver large frequent public transport systems in Aotearoa, and ensure that there are legislative settings in place to enable them (e.g. land acquisition and consenting).
- Review the Public Transport Operating Model to ensure that it remains fit for purpose and contributes to the Government's transport priorities. **(Underway)**

Walking and cycling:

- Invest in high quality cycling infrastructure (connected urban cycling networks, as well as secure bike parking and storage at key journey points). **(Some investment currently occurring through GPS on land transport, NZ Upgrade Programme, and by local Government)**
- Invest in better walking infrastructure, including improvements to footpaths and intersections, and reducing severance between places that are difficult to access by walking. **(As above)**
- Invest in and support walking and cycling for utility journeys, including to/from school and work (develop clear travel planning guidance including expectations around secure bike parking facilities).
- Invest in and support public education campaigns to promote walking and cycling (including supporting cycle skills training).
- Develop clear and nationally consistent guidance for wayfinding for walking and cycling.
- Require greater network planning for walking and cycling to support network connectivity.
- Investigate whether there are regulatory barriers, or historic design practices that pose barriers, in relation to walking and cycling (following on from the Accessible Streets work currently underway).

- Investigate legislation that defines and regulates the use of E-bikes to remove potential barriers.[50]
- Support road controlling authorities to develop integrated plans for schools and education sites that enable students to walk and cycle to school (including for example, speed reduction, travel planning, infrastructure delivery, training for pupils and parents, etc.).

Shared mobility:

- Provide dedicated on/off street parking for shared mobility in convenient, highly visible locations and encourage shared mobility parks to be incorporated in new and existing facilities (e.g. through national car parking guidance). **(Some Councils already provide dedicated parking for car sharing)**
- Provide car share companies with grants, loans or other incentives or subsidies (e.g. providing on street parking at low or no cost to help reduce car sharing operator costs and rates for users). **(Some car share companies have received funding through the Low Emission Vehicle Contestable Fund)**
- Increase incentives to use shared mobility (e.g. reduced rates).
- Develop procurement guidelines and expectations for the All of Government vehicle fleet (e.g. to encourage greater use of car share by Government in place of having a fleet or permit the fleet to be used by car share businesses at night and on weekends to reduce costs).
- Enable and support shared micromobility hire schemes, including investing in appropriate infrastructure, parking, and local government capability to support the safe and effective operation of shared micromobility).
- Partner with employers and carpooling providers to support local carpooling efforts (e.g. providing tools to make it easier for employees to match with others for carpooling).
- Define a national vision/strategy for MaaS in Aotearoa and invest in pilots.
- Regulate for data access/data sharing between public and private transport providers.

Consultation question 5
Are there other travel options that should be considered to encourage people to use alternative modes of transport? If so, what?

50 [Research Report 621 Regulations and safety for electric bicycles and other low-powered vehicles | Waka Kotahi NZ Transport Agency (nzta.govt.nz)]

Transport demand management is critical for supporting more liveable cities and encouraging people to make sustainable transport choices

Transport demand management is the application of strategies, policies and interventions to create and manage capacity on the transport network. This includes initiatives that optimise networks and redistribute trips to other modes, times, routes or by removing the trips from the network. Transport demand management can encourage people to shift to public transport, walking and cycling, or to encourage people to reduce their travel or not travel at all. These choices can affect transport emissions. They can also support quality compact, mixed use urban environments by reducing congestion and managing demand for parking.

Transport demand management is the overarching umbrella under which transport pricing, Low Emission Zones and parking management fit.

Transport pricing can help to capture the environmental costs of travelling by private car and deliver meaningful behaviour changes

Transport pricing generally refers to charges imposed on transport users for the use of the system. Examples include congestion charging and distance pricing. These mechanisms can help to capture the social and environmental costs of travelling by private motorised vehicles, and with the right incentives, can deliver meaningful behavioural changes. For example, they can encourage people to make choices that minimise the negative external impacts of their travel, while delivering cost savings and health and safety benefits.

Transport pricing can also help to address any rebound effects that come from investment in public transport, walking and cycling, such as induced car travel from reducing congestion. This helps to make investment in other modes more effective and increase their mode shift potential.

Transport pricing can be a strong signal to change people’s behaviour but it can have material impacts on household budgets and access to essential goods and services. It is important that we clearly understand the distributional impacts of pricing mechanisms, before imposing costs on users that could have unintended social consequences. We should also consider the distribution/allocation of any revenue raised.

The government could also consider subsidies or incentives that could encourage the uptake of low carbon modes, such as cycling and public transport, rather than solely focusing on pricing changes that impose costs.

Congestion charging can improve traffic flows and network performance, which can affect GHG emissions

Congestion charging is an example of a pricing mechanism that can improve traffic flows and network performance in urban areas, which in turn can have a second order effect on GHG emissions in areas where congestion is severe. Congestion in urban centres slows traffic down especially in peak periods. In Aotearoa, our six largest metropolitan areas experience between 20 and 31 percent average extra travel time because of congestion.[51] Congestion pricing is a method used to improve network performance by charging road users to encourage some to change the time, route or way in which they travel. Road users

[51] TomTom Traffic Index 2019

can respond by paying the charge, shifting to alternative modes to avoid the charge, changing the time of travel to outside peak times, or by not travelling at all.

The ability for congestion charging to have an impact on emissions is dependent on the resulting behaviour change from the charge (i.e. choosing to drive at different times or not driving). In addition, an impact of congestion is that people spend time moving in stop-start traffic, which consumes more fuel and therefore causes more emissions. By increasing the speed of traffic flow, there are some second order emission benefits from decreased idling time.

In terms of co-benefits, reducing congestion can reduce harmful emissions (such as nitrogen oxides and particulate matter) in dense urban areas where it affects human health. Congestion charging helps to improve the flow of traffic and can therefore increase efficiency for the movement of goods and increase economic productivity. A congestion zone can help create more liveable city centres by reducing traffic in cities.

An increased fuel tax could shift behaviour towards more fuel efficient and low-carbon vehicles

All users of fuel for vehicles pay an Emissions Trading Scheme levy, approximately 9 cents per litre for petrol, and 10 cents per litre for diesel.[52]

This is a fuel tax, but it is very low. An increase in the fuel tax (i.e. a higher carbon tax on fuel) is a mechanism that can be used to assist with changing vehicle owner's behaviours and encourage the use of more fuel efficient vehicles or a change to a more efficient or low-carbon vehicle. A fuel tax is a user pays mechanism. Such a fuel tax would be larger than the existing small fuel tax changed at the pump. It would impose an additional cost per litre of fuel on users and would be paid in direct proportion to the fuel used and therefore the emissions that are generated from its use. Payment of such a tax by vehicle owners would be difficult to avoid if they use fossil fuelled vehicles. Additionally, this type of tax would have low implementation costs.

Revenue from an increase in fuel tax could be recycled back to activities that support climate mitigation and adaptation. An example of this occurring is in Canada, which in 2020 introduced a price on carbon pollution, with the proceeds from its collection being returned to communities.[53]

Distance-based road user charges could be used to encourage the uptake of cleaner vehicles

Distance-based road use charges (sometimes called vehicle miles taxes) are a land transport revenue tool, used to charge road users an amount linked directly to how much they drive. Our existing RUC system is a pre-paid system where users can buy licenses in 1,000 kilometre increments, and is designed to recover the costs of road damage – it currently does not include the cost of emissions or other externalities.

In a number of developed countries, fuel tax revenues are declining as vehicle fleets consume less fuel by transitioning to more fuel-efficient and low emission vehicles. A

52 Petrol Tax - How Fuel Excise is Made Up | AA New Zealand

53 Government Announces Climate Action Incentive Payments for 2021 - Canada.ca

distance based charge such as RUC ensures that motorists contribute equitably based on road usage, regardless of vehicle type or fuel use.

A distance-based road user charge could incorporate some sort of subsidy to low or zero emission vehicles, and high emission vehicles could have an additional GHG emission surcharge. This could incentivise people and businesses to purchase a car that produces low or zero GHG emissions. However, we need to understand the social impacts of this type of policy. The Ministry's position is that it should be looked at, but support for it is yet to be established.

Smart road pricing could reduce vehicle kilometres travelled and encourage the uptake of public transport, walking and cycling

Smart road pricing is the pricing of the road network via electronic means and has the potential to influence demand and incentivise behaviour change by encouraging greater mode share of public transport, walking and cycling, or reduced overall vehicle kilometres travelled. Such a system does not currently exist on a nationwide scale anywhere in the world. However, there is increasing international interest in the concept of smart road pricing, including city or state level schemes. A range of approaches, including pilots and staged approaches to smarter road pricing are being considered in some jurisdictions.[54]

Road users could be charged for road use in a way that seeks to reduce external impacts of transport by increasing the price of using the network in close proximity to alternative mode options. Smart road pricing could inform road users about their road use making them more acutely aware of road use. Information generated from smart road pricing could be used to help road users to make better travel decisions, considering costs, traffic conditions and their carbon footprint.

Smart road pricing could also result in several co-benefits. It could improve liveability by reducing traffic in certain areas and encouraging the uptake of cleaner, safer and quieter modes. It could support economic outcomes by improving the overall efficiency of the road network and supporting access to employment, increasing supply chain efficiency and reducing congestion.

A smart road pricing system could also provide the benefit of consolidation of various charging schemes (e.g. low emission zones, congestion charging etc.).

Depending on the technology chosen, smart road pricing could potentially be expensive to set up. If pursued as a tool, further analysis of its costs and how the privacy / ethics aspects of the tool would be managed would need to be fully examined. As for distance-based RUC, the Ministry's position on this option is that it should be looked at, but support for it is yet to be established.

New technologies are enabling more customised pricing approaches

The development of technology and devices that record and store information about transport journeys and patterns can be utilised for more complex and influential pricing mechanisms.

Technology is an enabling factor for smart road pricing. A successful scheme needs technology that can support four core information parameters – time of day, location,

[54] D'Artagnan Consulting. 2018 -, *Review of international road pricing initiatives, previous reports and technologies for demand management purposes.*

vehicle type, and an observation or measure of chargeable events. It will also need to consider the privacy of collected information. Any scheme will also need to be supported by information to enable users to understand and react to change behaviour. Three key developments in technology are driving the increase in the status of smart road pricing:

- increasing use of Automatic Number Plate Recognition (ANPR)
- improvements in the accuracy of Global Navigation Satellite Systems (GNSS) and the emergence of new systems
- increasing engagement and use of smartphones.

Consolidation of travel information, including costs and payment interface, can also enable complex and effective pricing and transport management approaches. Integrated ticketing in particular, would not only bring all travel information to one central place making it easier for users to interact with, but would provide a platform for smart pricing initiatives across modes to have more influence. The advancements in technology could be coupled with greater investment in research and design to obtain the benefits of this digital transport solution.

There are significant implementation challenges associated with new pricing mechanisms

To implement transport pricing would likely have implementation costs, and in the case of a nation-wide scheme, potentially significant changes to the transport revenue and funding system.

Aotearoa does not currently have comprehensive pricing tools intended for outcomes broader than revenue raising. We do have a successful distance-based road user charges scheme (including provisions for electronic road user charges) that could be built on to create a smart pricing scheme. However, it would still be a major reform for road pricing to incorporate a wider range of costs into the calculations, and to bring all vehicles into the scheme. Previous international attempts to implement national smart pricing schemes have been unsuccessful, with the key barrier typically being public opposition. Therefore, new pricing tools could be difficult to implement and we cannot be certain that they will result in significant changes to the outcomes we are seeking.

If we are to pursue more complex pricing tools, we need to ensure that initial policy development is done well, and considers the broad range of impacts that pricing could have on different groups and communities. The Ministry has done some advanced thinking on congestion pricing in Auckland, scoped an electronic distance-based RUC scheme for light vehicles, and has a project underway considering how the transport revenue system might be replaced. The Government needs to be clear of the benefits and ensure they will outweigh the risks and costs of implementation.

Low Emission Zones could reduce GHG emissions and harmful pollutants in urban areas

Aotearoa could use the low emission zone approach that is utilised in European cities. Internationally, the focus of Low Emission Zones is to reduce harmful pollutants from vehicles by implementing a charge for specific vehicles to enter the designated zone. Application of Low Emission Zones here could focus on vehicles with high carbon dioxide

(CO_2) emissions and harmful emissions like nitrous oxide and reduce vehicle traffic in cities, encourage the use of cleaner vehicles, and reduce transport GHG emissions.

Low emission zones also create more liveable and pleasant urban environments. Consequently, this increases the attractiveness of public transport, walking and cycling, which can also reduce transport emissions. The main co-benefit that comes from low emission zones is the reduction in harmful emissions and noise, which supports better health outcomes. In addition, reducing traffic and increasing the attractiveness of public transport (especially if it is low carbon), walking and cycling can also improve the quality of public spaces, and the quality of life in cities and towns.

To ensure these measures do not have a negative impact on access to employment, education and healthcare, there needs to be adequate provision of public transport, walking and cycling.

Parking management can significantly influence demand for parking and encourage people to shift to more sustainable transport modes

Car parking is a significant factor in private vehicle travel because when people drive a car they require a car park at both the origin and destination of their trip. Therefore, effective parking management can significantly influence the demand for parking and encourage people to shift to more sustainable modes or reduce overall private vehicle trips. This in turn affects transport GHG emissions.

Parking management can help to control the supply of parking spaces, and who, when and how long vehicles may park at a particular location. Unlike other pricing mechanisms, parking management interventions are available now. This includes time restrictions, user restrictions, and distribution of parking in urban areas. Parking management also includes parking pricing and the ability to remove parking and minimal requirements for parking in urban development, which can be an effective way of encouraging people to use other modes or avoid travel. A typical privately owned vehicle is parked for the majority of its lifetime. Parking spaces can have relatively high construction and maintenance costs – especially those provided in structures or basements in centres, owing to space constraints/value of land. Yet most parking facilities (both commercial and private housing) are unpriced, with their costs borne indirectly through taxes, rents, higher prices for retail goods, and lower employee benefits.[55] The opportunity cost of land used by parking spaces is also a significant issue for sustainable urban development.

Combined with other measures, such as improving public transport, parking management can lead to significant shifts towards public transport use. For example, an integrated transport plan that incorporated access restrictions, public transport enhancements and parking policies saw public transport modal share increase from 11 percent to 30 percent in Strasbourg over a period of ten years. After introducing a similar strategy in Oxford, public transport mode share increased from 27 percent to 44 percent.[56]

Parking management can also deliver significant co-benefits. For example, by reducing parking demand, it could support the repurposing of parking space for walking and cycling

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[55] Victoria Transport Policy Institute. (2020). *Parking Pricing Implementation Guidelines*

[56] ITF. *Parking Pricing, Transport Climate Action Directory measures*. Retrieved from: https://www.itf-oecd.org/transport-climate-action-directory-measures

infrastructure, which encourages active travel and better health outcomes. It can also reduce cruising for parking, which reduces vehicle traffic and related impacts.[57]

Using blunt charging tools could change behaviour but has distributional impacts and risks

In Aotearoa, there are a limited set of existing mechanisms that the Government uses to charge users for their use of roads, to recover costs imposed on the road network, and to fund investment in infrastructure and services for the land transport system. New Zealanders pay fuel excise duty for all petrol purchased. This is a revenue tool and is one of two key land transport revenue tools used to fund investment and infrastructure for land transport in Aotearoa.

A deliberate tax on fuel, in addition to the Emissions Trading Scheme (ETS), for the purpose of reducing emissions from transport could be one way of encouraging mode shift, a change to cleaner vehicles and avoidance of discretionary travel by car. A tax on fuel should also consider the equity between different levels of charges applied to different vehicles using the same road and the different fuels used. For example a car using bioethanol does not pay excise duty but a vehicle using biodiesel has to pay road user charges, and liquefied petroleum gas (LPG) and compressed natural gas (CNG) are taxed at a much lower rate than petrol.

Transport pricing and management: possible key actions

Transport pricing:

- Consider congestion pricing. **(Already being investigated for Auckland through Congestion Question project)**
- Investigate distance pricing as a means to encourage mode-shift, dis-incentivise discretionary travel, and address the rebound effects caused by public transport investment.
- Consider incentives (subsidies or rewards) that could encourage alternative modes of travel.

Low emission zones:

- Enable and implement low emission zones to reduce CO_2 (based on GHG emissions).

Parking management:

- Require councils to continue to develop and implement parking pricing strategies.
- Introduce maximum parking standards/requirements in some areas, e.g. for new high-rise buildings and shopping centres.
- Enable and implement workplace/private property/commuter parking levies.
- Implement car parking regulations in the land use planning system as per the NPS-UD. **(Underway)**

Carbon charges:

- Increase rates of fuel excise duty after 2023.
- Implement an increased transport fuels only carbon tax. **(Already small charge through the Emissions Trading Scheme)**

Where we work and learn impacts transport emissions

Teleconferencing and online learning has now enabled many people to work and learn from home. This was illustrated through the COVID-19 lockdowns with environmental and economic savings resulting from the large reduction in travel.

The Energy Efficiency and Conservation Authority's (EECA) Gen Less information campaign encourages New Zealanders to work from home and travel less for business meetings. EECA found that if just one in five people who currently drive worked from home one day a week, it would save 84,000T[58] of CO_2 emissions, equivalent to emissions from 35,000 cars on the road.[59] Business travellers moving between Auckland and Wellington are responsible for 65,000 tonnes of carbon each year, the equivalent of 27,000 cars on the road. If a portion of these commuters chose to connect online, significant carbon emissions could be avoided. Further, working from home reduces road congestion and air pollution, particularly in central business districts. For example, NIWA analysis found that air pollution from traffic in Aotearoa's major cities dropped dramatically during the first week of the COVID-19 lockdown.[60]

The potential emissions savings from working from home vary widely. There have been extensive international studies on telecommuting and teleworking, showing at best a modest net energy saving. While it could cut the number of work-based trips, it could also lead to increases in acceptable commute distances (living further from the workplace), other vehicle travel and home energy consumption.[61]

Similarly, we could also save transport emissions by students learning from home. Distance or e-learning allows students to take courses and study without having to attend school or university in person. Emissions savings could also be found by simply ensuring students go to their closest school.

COVID-19 lockdowns have shown that there are varied ways some New Zealanders can work and learn that are less carbon intensive. There have also been flow on and ongoing changes to travel patterns, including more people working from home post lockdown. While the Ministry cannot create policies to enforce working from home, information campaigns encouraging people to work from home could operate alongside other interventions, such as road and parking pricing, to reduce travel demand and greenhouse gas emissions. Such steps can also be supported and influenced by other agencies and Local Government.

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58 This is equivalent to about 0.51 percent of total domestic transport emissions in 2018. Annual transport emissions are about 16.6 mega tonnes.

59 Live more with less energy, 6 July 2020. genless.govt.nz/stories-and-case-studies/stories/live-more-with-less-energy

60 'Coronavirus: Traffic pollution plummets across the country during lockdown', 2 April 2020. Retrieved from: www.stuff.co.nz/environment/climate-news/120763215/coronavirus-traffic-pollution-plummets-across-the-country-during-lockdown

61 Axsen, J., Plötz, P., & Wolinetz, M. (2020). *Crafting strong, integrated policy mixes for deep CO 2 mitigation in road transport*. Nature Climate Change, 10(9), 809-818.

Consultation question 6
Pricing is sometimes viewed as being controversial. However, international literature and experiences demonstrate it can play a role in changing behaviour. **Do you have any views on the role demand management, and more specifically pricing, could play to help Aotearoa reach net zero by 2050?**

Chapter 7: Theme 2 – Improving our passenger vehicles

Key points

- Passenger vehicles include light vehicles (e.g. cars, vans, SUVs), public transport, planes, and associated infrastructure
- Decarbonising the light vehicle fleet is critical for meeting our emission reduction targets. We need to increase our supply of clean cars and increase demand for them, as well as provide supporting infrastructure.
- Given the slow turnover of vehicle fleets, we need to consider options to decarbonise the existing fleet. This includes removing fossil-fuelled vehicles from the fleet and transitioning to biofuels.
- As we encourage mode-shift to public transport, we also want to ensure our public transport modes are low emission, including transitioning our bus fleet to cleaner fuels and electrifying more of the passenger rail network.
- Cleaner aviation technologies are in the early stage of development but there are still opportunities to reduce emissions, including with sustainable aviation fuel.

Decarbonising the light vehicle fleet is critical for meeting our emission reduction targets

While the opportunities outlined in Theme 1 will support people to travel by public and active transport, the majority of trips in Aotearoa will still be by car, especially in the short to medium term. Therefore, decarbonising the light vehicle fleet[62] is an important part of reaching a net zero emissions transport system.

Two thirds of transport emissions come from the light vehicle fleet. We have a strong reliance on private vehicles in Aotearoa and over half of all household travel time is spent driving.[63] The vehicle fleet must shift from its reliance on international combustion engines (ICE) vehicles, towards a greater uptake of low emission options such as electric, hydrogen fuel cell vehicles and biofuels. This requires us to consider opportunities to increase the availability and access to low emission vehicles, and ensure that vehicles entering Aotearoa's fleet move towards low emission, and eventually the elimination of all ICE vehicles. In addition, high-emitting vehicles should be effectively removed from the fleet.

The scale of uptake required to reach a net zero emissions transport system is significant. Electric vehicles only comprise less than one percent of the current vehicle fleet. If Aotearoa continues at the same pace of uptake we are currently projecting, there will not be enough of an impact on emissions.

We need to increase our supply of clean cars to make them a viable alternative to fossil fuel vehicles

There are currently over 27,000 electric vehicles in the Aotearoa vehicle fleet, and each month this year, around 400 to 600 electric vehicle registrations have been recorded (aside from April and May 2020 due to the COVID-19 lockdown).[64] However, this is still a very small proportion of the overall vehicle fleet. There are currently more than 4 million light vehicles in

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62 The light vehicle fleet includes passenger vehicles and light (under 3.5 tonnes gross mass) commercial vehicles such as vans and utes.

63 Ministry of Transport, Household Travel Survey, 2015-2018.

64 Ministry of Transport, Vehicle fleet statistics.

our fleet. The Government can signal the importance of low emission vehicles by supporting their supply into Aotearoa with regulatory levers. This could have a very direct and potentially strong impact on emissions reduction – if regulatory interventions are well timed, well designed and well implemented within wider transport system changes.

We need to recognise that the supply of cleaner cars relies heavily on the global market. Government has a role in understanding global supply trends for electric vehicles and other emerging vehicle types, and ensuring policies allow these vehicles to arrive in Aotearoa's market to keep up with demand.

There is an opportunity to align with road safety objectives

Regulating the supply of vehicles to Aotearoa is not a new idea and can support Government in achieving broad system objectives. The New Zealand Road Safety Strategy – *Road to Zero* – sets out our vision for Aotearoa where no one is killed or seriously injured in road crashes. As part of the immediate actions in the 2020-2022 Action Plan, Government has set an initial action of raising the safety standards for vehicles entering Aotearoa.

Aligning low emission vehicle standards with *Road to Zero* safety standards presents a wider opportunity to ensure vehicles that enter Aotearoa's vehicle fleet achieve positive health, safety, environmental and wellbeing outcomes for New Zealanders.

Introducing a fuel efficiency standard is key to driving the supply of cleaner vehicles

Introducing and implementing a CO_2-based fuel efficiency standard is one example of Government action in this priority area that can support this objective. A fuel efficiency standard, commonly known as the Clean Car Standard policy, would restrict the type of vehicles that can be imported, resulting in an overall improvement of fuel efficiency and emissions reductions. Other similar actions include a maximum CO_2 limit, setting a progressively more stringent 'average' target for vehicles and fleets of vehicles over time. In line with other countries, a schedule for phasing out of the importation of fossil fuelled vehicles could also be implemented. All of these actions should be signalled well in advance to support the vehicle imports and sales industry to transition and ensure compliance.

Countries around the world are signalling the phase out of fossil fuel vehicles

Many countries around the world have signalled commitments to phase out fossil fuel vehicles to help to reduce their transport emissions. In an aim to speed up the rollout of low emission vehicles, the United Kingdom (UK) recently announced it was bringing forward the end of fossil fuel vehicle sales and importing to 2030, as opposed to the original target of 2040. The sale of hybrid vehicles will be permitted until 2035.[65] Many other countries are taking the same action, or are due to. Japan plans to phase out the sale of conventional fossil fuel vehicles in 2035, though hybrids will still be permitted.

California was the first state in the United States to commit to a phase out of fossil fuel vehicles and will require sales of all new passenger vehicles and trucks to be zero-emission by 2035. California also intends to mandate that all medium and heavy duty

[65] Prime Minster's Office, 10 Downing Street, '*PM outlines his Ten Point Plan for a Green Industrial Revolution for 250,000 jobs*', https://www.gov.uk/government/news/pm-outlines-his-ten-point-plan-for-a-green-industrial-revolution-for-250000-jobs.

vehicles be zero-emission, where feasible, by 2045. Transport currently accounts for more than half of California's carbon emissions.[66]

China plans to require all new cars sold after 2035 to be 'new energy vehicles'. The plan states that 50 percent of new cars sold in China will be electric, plug-in hybrid, or fuel cell vehicles and 50 percent of new cars will be conventional hybrids. Vehicle manufacturing will have the same 50/50 requirement. China has a large vehicle manufacturing industry and has an opportunity to make a significant global impact in producing zero and low emission vehicles.[67]

As more countries announce targets to phase out the production and importation of fossil fuel vehicles, we need to consider what Aotearoa should do. If we do not put in place our own ambitious targets to reduce our fossil fuel vehicles we risk becoming a dumping ground for high emitting vehicles with the associated economic, environmental and health related consequences.

We also need to increase demand for cleaner vehicles by ensuring they are the safest, easiest and obvious choice

Increasing the supply of clean cars will not achieve significant emissions reduction without encouraging the demand for these vehicles. As people make purchase decisions about vehicles, an electric vehicle (or similarly clean car) needs to be an easy and safe choice that is cost-competitive with the costs of owning and running ICE vehicles.

Government has a range of levers available to encourage the uptake of low emission vehicles. The actions Government chooses to take need to focus on mitigating the most significant barriers to the purchase of low emission vehicles. Some of the common barriers include: high upfront purchase costs, range anxiety (fear that an electric vehicle will run out of charge and be stranded), and the availability and cost of relevant infrastructure (such a charging stations). Additional issues are the high cost of hydrogen production, distribution and storage, higher costs of biofuel production and risks of compatibility with components that we know little about.

Beyond these common barriers, car ownership in Aotearoa is intrinsically tied to socio-cultural identity. There will be behavioural factors such as the look and feel of vehicles that will also be a continuous barrier to uptake of clean vehicles. Fuel efficient vehicles have typically been smaller vehicles, which does not match Aotearoa's increasing preference for utes and SUVs. Broader challenges around the marketing and images associated with larger light vehicles in Aotearoa will need to be addressed in some way.

Vehicle technology is continuously evolving in this space, meaning that a range of vehicle preferences and features can be incorporated into low emission vehicles, such as models of electric powered utes due to come to market and be available in Aotearoa shortly.

[66] Office of Governor Gavin Newsom, '*Governor Newsom announces California will phase out gasoline –powered cars'* https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/.

[67] Dow, Jameson, '*China plans 2035 gas car ban that doesn't actually ban gas cars',* https://www.popularmechanics.com/cars/hybrid-electric/news/a28140/china-ban-cars-combustion-engines/

Consumer research indicates that the high purchase price for electric vehicles is the biggest obstacle to uptake

Once low and/or zero emission vehicles achieve price parity, the high purchase price barrier to widespread adoption will reduce. In the meantime, we can mitigate the upfront cost barrier and Government can use levers to incentivise people to purchase low emission vehicles. The Government is currently considering options for an incentive scheme to help New Zealanders switch to cleaner vehicles.

The safety of low emission vehicles should also be considered. A lot of light electric vehicles have different safety profiles to ICE vehicles. We need to encourage both low emissions and safe vehicles in our frameworks.

We need to invest in the infrastructure required to support low emission vehicles

We need to give further consideration and investment to infrastructure that supports low emission vehicles; clean fuels, biofuels and hydrogen networks, charging networks for electric vehicles. This should include smart home charging infrastructure; and the standardisation of such infrastructure; and parking and priority use on roads for low emission vehicles (while not undermining other transport outcomes). The Ministry has commenced work to develop a strategy to support the ongoing implementation of infrastructure, which should also include charging infrastructure for other modes such as for ships at ports.

Government supply and funding of infrastructure that supports the uptake of low emission vehicles can help to mitigate some of the barriers to uptake. In addition to public infrastructure, Government could regulate new developments to give consideration to charging infrastructure or similar infrastructure when the development provides car parking.

Government can support the uptake of electric vehicles through its own procurement

Government has announced a requirement for an all-of-government policy to decarbonise. This includes the procurement of the Government fleet vehicles to be electric or another low emission vehicle or fuel type. This has an added co-benefit of using Government procurement to ensure low emission vehicles transition into the used vehicle market once their lifetime in the Government fleet has ended.

Where possible, there could be incentives for other non-government fleets to show leadership in this area as well. Local government, industries, and the volunteer/charity sector could be good groups to target, as a way to increase procurement of clean cars.

Further investigate the potential for tax incentives

There are many tax levers available. We are aware that the specific tax treatment of certain vehicles has created financial incentives that could work against reducing emissions and these need to be addressed as part of transitioning to a low carbon fleet. The intrinsic link between vehicle kilometres travelled and land transport revenue is another tension that needs to be acknowledged in the treatment of clean cars in the tax system.

Taxes could stimulate the demand for low emission vehicles. Some suggestions are: reducing fringe benefit tax on zero emission vehicles, reducing GST on the purchase of zero-emission vehicles, offer refundable tax credits on the purchase of zero-emission vehicles, replacing the road user charges (RUC) exemption for electric vehicles with an upfront subsidy, increasing tax depreciation for electric vehicles.

Taxes pertaining to fossil fuelled vehicles could increase. Some suggestions are: elevating the carbon price under the ETS or increasing the price of diesel through a health/environmental tax.

Such changes could introduce equity concerns as any changes would inevitably create winners and losers. International research suggests tax advantages at the point of purchase have a stronger influence on consumer choices than annual tax payments.[68]

Given the slow turnover of Aotearoa's vehicle fleet, we also need to consider options to decarbonise the existing fleet

Government has been exploring a range of initiatives to improve Aotearoa's vehicle fleet. This includes a recent agreement to implement the Clean Car Standard and an agreement in principle to implement a sustainable transport biofuels mandate. Government is also giving consideration to options for an incentive scheme to encourage uptake of low-emission vehicles. These policies step Aotearoa's fleet towards being low emissions.

Increasing the supply and demand for low emission vehicles will be important, but vehicles in Aotearoa currently remain in the fleet a long time after they are imported, so there needs to be incentives to remove high emission vehicles as soon as possible.

Removing fossil-fuelled vehicles from the fleet

Government has levers available that can encourage the sustainable rollover of vehicles in our fleet, including a potential rolling age ban for used vehicles to combat emissions from ICEs. A wider rollout of a vehicle scrappage scheme could be considered. For both of these policies more evidence of their effectiveness at contributing to reducing emissions may be required. Additionally, if chosen as policies for implementation, these policies would need to be done alongside other policies to create a whole of system approach. For example these could be done alongside investigating opportunities linking licensing to emissions, i.e. warrant of fitness (WOF) and certificate of fitness (COF) fees including how to mitigate the behaviour risk of people not obtaining a WOF or COF. This supports the creation of demand for lower emission, safer vehicles with newer technology. It also works to encourage the earlier disposal of fossil fuelled vehicles, therefore having a somewhat indirect impact on emissions reduction as it depends on what vehicle, if any, replaces the vehicle exiting the fleet.

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68 Wappelhorst, S., Mock, P., Yang, Z., (2018). *Using vehicle taxation policy to lower transport emissions: An overview for passenger cars in Europe*. International Council for Clean Transportation, December 2018. https://theicct.org/publications/using-vehicle-taxation- policy-lower-transport-emissions.

Reducing reliance on fossil fuels by transitioning to biofuels would go some way in decarbonising the fleet

In December 2020, Government agreed in principle to implement a sustainable transport biofuels mandate, subject to the outcomes of officials' review of the 2008 Biofuels Sales Obligation.

Biofuel presents an immediate opportunity for decarbonising the vehicles that are already in the fleets. It is highly likely that we will need to use biofuels to reduce emissions from the vehicles already occurring in the fleet. Biofuels can be used immediately in most vehicles that are fossil fuel powered and produce significantly less emissions than fossil fuels. This will be an important and significant part of emissions reduction from transport in Aotearoa's transition.

Funding and investment for the transport system will need to be planned for

The NLTF is generated from road user charges (RUC) and fuel excise duty (FED). It supports transport activities by funding things like maintenance of infrastructure, public transport, and cycling, but is essentially reliant on maintaining if not increasing vehicle kilometres travelled in order to generate sufficient revenue to fund such activities.

EVs are subject to RUC, but are currently exempt to encourage their uptake. The exemption to date has resulted in a small loss of revenue to the NLTF. Decisions will need to be made to determine if the current RUC exemption for EVs is extended. Longer term planning for transport system requirements will be needed to address the resultant funding challenges as Aotearoa steps towards next zero, including how funding will be provided to meet future investment needs.

A cleaner vehicle fleet will result in several co-benefits

The benefits of these actions, in addition to reducing emissions, could be wide-ranging. There would likely be benefits to individuals and households, business and Government.

Low emission vehicles could help reduce overall household transport costs generally. A clean car standard and clean car discount in particular would encourage households to purchase low emission vehicles and lead to reduced transport costs from having a more efficient ICE or electric vehicle. Public health benefits of low emissions vehicles may also be significant. Lower harmful emissions lead to improved air quality, which can reduce emissions related harm such as respiratory and cardiovascular illnesses. In addition, low emission vehicles reduce the health and wellbeing impacts of noise pollution, particularly in cities and densely populated urban areas.

There are business opportunities for sectors to transition, or new employment opportunities for those not transitioning. Ensuring the safe and environmentally friendly reuse, recycling and disposal of vehicle waste, (such as electric vehicle batteries, and ICE vehicle parts), provides a business opportunity that we could seize locally rather than exporting the work overseas. In addition, it would support a circular economy that has wide environmental benefits. We can also expect that the demand for services relating to new vehicle technologies (mechanics and technical experts), and infrastructure (charging and communication networks) would increase and provide employment opportunities.

Aotearoa's energy security would be improved as we become less reliant on imported fossil fuels and therefore more resistant to oil price shocks. Increasing the uptake of electric vehicles in particular would encourage greater energy efficiency, sustainability and resilience, particularly as over 85 percent of our electricity comes from domestic renewable sources and the Government is working to increase this.

Shifting to cleaner vehicles poses some challenges for transport industries

As mentioned earlier, regulation and restrictions on the supply of clean cars will affect the motor trade industry and their concerns will need to be accounted for. Fuel suppliers and retailers would incur disruption, including a fall in sales and revenue as a result of consumers reducing or avoiding the purchase of liquid fossil fuels. However, the cost of not meeting our emissions targets will result in higher costs for our communities. Further, early involvement by these industries to transition to lower emission vehicles and fuels will help to mitigate some of the disruption that might result.

Although there will be an inevitable long-term reduction in opportunities for businesses servicing ICE vehicles, there will be new business opportunities to service the new technology vehicles. Business changes will also include new methods needed for repairing accident damaged electric vehicles, and battery replacements, along with niche businesses converting vehicles (including agricultural vehicles) to electricity-powered operations.

Distributional impacts

The Ministry has assessed the social impacts of the Clean Car Standard and the Clean Car Discount (feebate) scheme. Currently, hybrids and electric vehicles cost more to buy than conventional vehicles. However, the increased cost can be recouped through considerable fuel savings. The Clean Car Discount is intentionally designed to mitigate any equity impacts that arise from the increased price of hybrids and electric vehicles by lowering their purchase prices. It would make it easier for low income households to access the savings in motoring costs that higher income households can more easily enjoy. This is important because low income households spend more of their disposable income on fuel costs.

The Ministry's social impact analysis found that compared to high income households, a greater proportion of low income households would either receive a rebate, or not be charged a fee under the feebate scheme. This is because low income households tend to buy more relatively lower emission vehicles.

Considering the potential distributional impacts of the Clean Car policies, and any future transport policy seeking to reduce emissions will be an important part of our transition. However, we can use mitigating policies to ensure no group is left behind in Aotearoa's transition to a zero emission transport system. Additional support measures for the most vulnerable transport users will need to be a focus.

For example, a policy such as the clean car discount (feebate) scheme (applied on new and used imports not the existing fleet) could achieve a net benefit to the nation. The Government is considering options for an incentive scheme to help New Zealanders switch to cleaner cars such as electric vehicles. Depending on the design of the scheme, it may have an impact on households that cannot alter their vehicle purchasing choices may be required to pay a fee. We may also find that rural populations are affected disproportionately.

In relation to the Clean Car Discount again, its design may have an impact on the number of rural households that may be affected. Other policies to support minimising the distribution impact could also be considered, such as a scrappage scheme with incentives (noting the lack of evidence that such a scheme is effective in reducing emissions).

Decarbonising the light vehicle fleet: possible key actions

Increasing the supply of clean cars:
- Introduce and implement the fuel efficiency standard agreed by Government. **(Agreed by Cabinet and underway)**
- Consider the potential for a rolling age limit for used vehicles.
- Investigate how a maximum CO_2 limit would improve the fleet.
- Consider a schedule for phasing out the importation of fossil fuelled vehicles.
- Investigate how Aotearoa could mandate a market share of zero emission vehicles.

Encouraging the demand for clean and safe cars:
- Investigate and implement a vehicle feebate/subsidy. **(Government is considering options for an incentive scheme)**
- Investigate introducing a Government subsidy to support the uptake of cleaner cars. **(As above)**
- Further investigate potential tax incentives (including Fringe Benefit Tax, Depreciation and Tax Grants and RUC).
- Further investigate infrastructure funding. **(Some infrastructure has already been funded through the Low Emission Vehicle Contestable Fund, and the Ministry of Transport is doing a strategy to consider future infrastructure needs)**
- Pursue the standardisation of charging infrastructure.
- Consider how parking and priority use on roads for low emission vehicles can encourage uptake, or reduce the use of ICEs.
- Encourage acceleration of Government procurement of low emission light vehicles, including encouraging the procurement of safe low/zero emitting vehicles. **(Underway through Carbon Neutral Government Programme)**

Decarbonise the existing fleet:
- Investigate the use of a vehicle scrappage scheme to encourage the removal of inefficient, unsafe vehicles.
- Consider basing vehicle licensing on emissions.

Consultation question 7

Improving our fleet and moving towards electric vehicles and the use of sustainable alternative fuels will be important for our transition.

Are there other possible actions that could help Aotearoa transition its light and heavy fleets more quickly, and which actions should be prioritised?

As we encourage mode shift to public transport, we also want to ensure our public transport modes are low emission

Public transport vehicles, including buses and ferries, are largely diesel powered, which contributes to GHG emissions and other air pollutants harmful to public health. We estimate that around 300 kilo tonne CO_2 equivalent emissions are emitted by all heavy buses (with a gross vehicle mass over 3.5 tonnes) in 2018 and 2019. This represents two percent of total road emissions. Public transport buses accounted for roughly half of this, i.e. one percent of road emissions.

While this is a comparably small amount when compared to the emissions from the light vehicle fleet, this is still an important part of our transition to net zero. We expect emissions from buses would increase in the future if no significant interventions are in place particularly if public transport uptake increases substantially.

We can transition our bus fleet to cleaner vehicles

Cleaner buses are an important part of the system-wide move to cleaner transport, and to reaching our emissions targets. The number of electric buses in active use in our public transport network at the end of January 2021 was 36. This number is expected to grow rapidly during 2021 as more electric buses join the fleet. The remainder of the approximately 2,600 public transport buses operating in Aotearoa are powered by diesel.

Electric buses are commercially available but there are still barriers to their uptake

Electric buses are now developed and suitable for public transport fleets. However, there remains a range of barriers to uptake. Some of the challenges are the significantly higher purchase costs for an electric bus relative to a diesel bus (although operating costs are expected to be lower), as well as the accompanying infrastructure for charging that is needed at depots. There is a lead in time for the purchase of buses and subsequently local government decisions need to be made early for benefits to be realised a few years later. There is also concern that the framework for public transport planning and procurement (Public Transport Operating Model (PTOM)) may not support the uptake of electric vehicles.

There are several ways the Government can support the uptake of cleaner buses

Supporting local government to invest in clean buses and related infrastructure is one way Government can support public transport operators to shift to electric buses. Funding for the buses themselves, or the supporting infrastructure can incentivise the uptake and realise emissions reductions sooner. Electric buses require more significant depot investment than what is currently utilised - a depot typically needs larger spaces for servicing e-buses compared to diesel buses.[69] There is also the challenge of charging entire fleets en-masse on local power supplies/transformers that will need to be considered.

Government can also reduce the ongoing operational costs of electric buses by continuing the current RUC exemption. If this exemption was extended beyond the current expiration date of 31 December 2025, it may provide an incentive for public transport operators to consider if they need to purchase new electric buses for any tender or contract variation they may have. Councils in the three largest metro areas, Auckland, Wellington and Christchurch,

[69] Auckland Transport has modelling suggesting that a 30-40% increase in spacecould be required

have already made commitments towards decarbonising their bus fleets. Government could push this further by implementing a mandate requiring zero emission new buses and/or setting a date for the fleet to be zero emission.

Government has recently announced it will require Councils to purchase only zero emissions buses by 2025 and to target the decarbonisation of the public transport bus fleet by 2035. It is also supporting regional councils to achieve these outcomes through a $50 million fund over four years. Work on this policy is underway.

The Government is considering whether changes to PTOM could remove or reduce system barriers to decarbonisation. It is also exploring whether changes to the usual procurement and ownership arrangements for zero-emission buses, depots and supporting infrastructure could reduce the current cost premium faced by councils, allowing a faster transition.

Supporting the use of technology and innovation for public transport vehicles to reduce energy use, together with investigating a biofuel mandate could also be considered.

Supporting the uptake of cleaner buses can also achieve co-benefits, including improving air quality and reducing noise in our cities

In terms of co-benefits, health is significant. Nitrogen oxides and particulate matter from diesel vehicles creates city pollution known to cause respiratory and associated diseases. Auckland Transport estimates that diesel vehicles (including buses, trucks and other diesel vehicles) are responsible for 81 percent of all vehicle-related air pollution health costs in Auckland, which are estimated to have a social cost of $466 million annually[70]. Improvement in city liveability is linked to decarbonising buses as a cleaner healthier city environment makes inner city living more desirable.

In terms of Just Transition, we recognise the business opportunities from cleaner buses such as coach building, manufacturing components for zero-emission powertrains, and alternative fuels (and associated infrastructure). Aotearoa has two domestic coach manufacturing companies that are already building on electric bus platforms and one manufacturer is also building the country's first hydrogen bus. Regional employment could be bolstered by the manufacture of zero emission public transport vehicles because the local contribution to manufacture is higher in comparison to diesel buses. There could be flow-on export potential from this industry.

Aotearoa's major cities have already set targets to decarbonise their bus fleets

Auckland Transport

- In November 2017, the Mayor of Auckland joined 11 international cities in signing the *C40 Fossil-Fuel-Free Streets Declaration*. The Declaration commits Auckland to buy only zero-emission buses from 2025 and ensuring a major area of the city is zero-emission by 2030. This commitment is reflected in Auckland Transport's detailed plan to transition to a zero-emission bus fleet by 2040.

70 Auckland Low Emission Bus Roadmap - attachment-1-to-item-111-auckland-low-emissions-roadmap.pdf.

Greater Wellington Regional Council (GWRC)

- On 21 August 2019, GWRC declared a climate emergency and formally established a target to become carbon neutral by 2030. One of the key actions to achieve this is decarbonising the bus fleet.

Environment Canterbury

- *ECAN's Regional Public Transport Plan* targets a transition to a zero-emission bus fleet, including a short-term target that more than 40 percent of the public transport vehicle fleet is low or zero-emission by 2025 and a medium-term plan that all new buses procured after 2025 are zero-emission.

Over the next few years these councils will deploy an increasing number of zero emission buses, including 98 additional zero emission buses in Wellington, 25 in Canterbury, and 32 in Auckland.

There is an opportunity to electrify more of the passenger rail network

Rail is an important part of Aotearoa's public transport system in our two biggest cities, Auckland and Wellington. Metro rail provides rapid, mass transit to and from the city centres, providing access to jobs, education and social opportunities. It helps reduce congestion on roads and supports productivity in our cities. It also supports more sustainable urban development, housing and growth. Metro passenger rail services share the network with freight and inter-regional services, and use electric trains, which are faster, quieter and more energy efficient with low emissions.

Most of the metro passenger rail networks in Auckland, Wellington and Christchurch are fully electric, but there are some exceptions such as the Wairarapa and Capital Connection commuter train from Palmerston North to Wellington (which is diesel powered). A fully electric public transport system is an important start to transforming our transport system in its entirety. This transition requires investment from the Government to ensure upgrades to existing networks have the funding needed. Electrifying existing parts of the network complements measures in Theme 1 that seek to improve and extend the overall public transport network, encouraging mode shift. Electrification of the rail is expensive. Further expansion to electrify the rail network would need to consider the cost, scale of change required (i.e. only metro rail rather than the whole network) and the challenges such as Aotearoa's topography, to determine if it is a sensible investment.

Decarbonising the public transport fleet: possible key actions

- Implement the mandate for local government to procure only electric buses by 2025. **(Underway)**
- Provide support for the decarbonisation of the bus fleet and its required infrastructure.
- Extend the RUC exemption for electric buses (which is due to expire in 2025). **(Under consideration)**
- Consider how to fund foregone revenue for the National Land Transport Fund if road user charges exemptions are extended for heavy electric vehicles or expanded to include hydrogen or other low carbon fuels.

- Examine if the Public Transport Operating Model can be adjusted to enable accelerated decarbonisation of the public transport bus fleet. **(Underway)**
- Consider the further electrification of existing parts of the passenger rail network.
- Consider future investment needs to ensure existing rail networks are fit for purpose.

Consultation question 8
Do you support these possible actions to decarbonise the public transport fleet? Do you think we should consider any other actions?

Cleaner aviation technologies are in the early stage of development but we still have opportunities to reduce emissions

There is a strong commitment in Aotearoa aviation to reduce emissions, but still significant room for improvement.

Aviation has a role in moving both people and freight to domestic and international destinations. Its role is important for Aotearoa given our distance from markets. Aviation's contribution is critical because of its freight role to move freight that has high value or is of high importance, such as medical supplies. Its freight role is important to our role in the Pacific, our social needs and for Aotearoa's trade markets.

Aviation's role is not easily replaced by other modes of travel. Reducing air travel will be challenging, and subsequently efforts must be made to make aviation, domestic and international, greener. Aotearoa is an isolated country where air travel is an essential mode for inter-city and inter-regional travel. Air travel is a high emission mode, with carbon emissions estimated to be in the magnitude of 1.5Mt per annum (representing about six percent of Aotearoa's domestic emissions).

We can reduce emissions from domestic aviation through a variety of interventions, although some technologies that could substantially reduce emissions are still in the early phases of development, for example, electric powered large commercial passenger planes.

Compared to the light fleet, or buses, new vehicles or fuels for aviation are less developed. As noted earlier, in December 2020, Government has agreed in principle to implement a sustainable transport biofuels mandate, subject to outcomes of officials' review of the 2008 Biofuels Sales Obligation. This mandate will be mode agnostic, and will also apply to aviation.

The New Southern Sky and Performance Based Navigation procedures contribute to improvements for aviation. New Southern Sky[71] gives direction on incorporating new and emerging technologies into the aviation system to ensure the safe, cohesive, efficient and collaborative management of Aotearoa's airspace and air navigation to 2023. New Southern Sky will enable shorter journeys, improved safety and lower carbon emissions. Performance Based Navigation[72] procedures effectively redesign airspaces, which improves air traffic flow and efficiency. These actions provide significant benefits in fuel savings, which in turn reduces emissions.

[71] New Southern Sky - About the programme (nss.govt.nz)
[72] Airways | Performance Based Navigation

Efforts must be made to invest in aviation to ensure it rapidly moves towards being low emissions. This will require research and development, and investment to develop sustainable aviation fuels and improve plane technologies. Aotearoa cannot afford to delay efforts to move aviation in this direction given our reliance on international markets and partners.

Improving planes to reduce emissions will be a key action for decarbonising aviation

There are currently two main technologies being developed to improve planes. These are the use of sustainable aviation fuel (SAF)[73] and electric planes.

Sustainable aviation fuel has the most potential to reduce aviation emissions in the short to medium term

A significant change that could reduce emissions is the wide adoption of SAF. This could now replace up to 50 percent of the jet fuel burn, and probably will be approved for a higher proportion in the future. For shorter routes in Aotearoa it is likely that electric powered planes could be used, with the design of some suitable aircraft now underway internationally.

Currently there are high costs and long time frames for research and development of aviation technology. SAF provides a shorter term and relatively easy abatement of up to 40 percent of emissions: around 600,000 tonnes CO_2 per annum. In time, electrification has the potential to make all short route flights zero-emission. This will be dependent on battery weight and the low specific energy stop becoming limiting in terms of aviation physics. Additionally, hydrogen aircraft could be used for short or long-haul flights, once the technology is sufficiently advanced.

SAF could present an opportunity for Aotearoa woody biomass processing. Woody biomass from plantation-grown trees is Aotearoa’s most significant renewable energy resource. Increasing the area of planted forest by 1.8 million hectares could supply around 60 percent of the country's transport fuels by 2040. Planted on low to medium quality land, energy forests would also provide ecosystem services such as erosion and flood prevention.[74] Producing biofuels from woody biomass would contribute significantly to our energy sustainability and system resilience.

Domestic biofuels (including SAF) production and processes would create jobs related to construction and other development work as well as enduring jobs, so it supports a Just Transition (this is further discussed in the context of Theme 3).

Electric aircraft technology is developing quickly, and may have significant potential in the future especially for smaller aircraft

For efficient electrification, a new approach to aircraft frame design is needed. We support the development of an industry strategy to give direction to decarbonising the aviation sector, alongside investigating alternative fuels in aviation and the potential for a fuel efficiency standard or a biofuels mandate for aviation.

COVID-19 has presented unique challenges, as the aviation sector is one of the worst impacted industries, with many countries closing borders and suspending air travel. The decarbonisation or improving aircraft is nowhere near as simple as transitioning to low emission light vehicles – but there is hope. Sounds Air have endeavoured to purchase

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[73] SAF is an advanced biofuel with similar chemical and physical characteristics to conventional jet fuel. SAF reduces some 80% of emissions compared to jet fuel.

[74] Scion. *Increasing the use of bioenergy & biofuels*. Retrieved from: Scion - Increasing the use of bioenergy & biofuels (scionresearch.com).

electric 19-seater planes – offering Aotearoa's first zero emission flights, which are scheduled for operation in 2026.

There are also opportunities to improve airports and operations to reduce emissions

We consider that immediate operational improvements have the potential to abate around five percent of aviation emissions. Two potential immediate actions that could have an impact would be to implement better air traffic flow management and improved navigation to reduce fuel burn. This could include considering if the current air navigation system could be more efficient. The effort and cost of making some of the improvements identified is not high. In terms of co-benefits, there will be some positive advantages in all categories. New Southern Sky and Performance Based Navigation already contribute to these improvements.

The specific action identified is to support the facilitation of operational improvements to reduce emissions from aviation. Better air traffic flow management and improved performance based navigation can allow aircraft to reduce taxi times, fly direct routes, navigate weather, have shorter approach paths and facilitate continuous descent, all of which reduce fuel burn, therefore reducing emissions. There is also an opportunity to improve ground operations to reduce emissions such as the use of low emission tender vehicles.

The abatement potential for improving ground operations may not be as large as electrification or the use of biofuels in the skies, but it is a fast, low-cost measure with an emissions abatement potential of five to seven percent of gross aviation GHG emissions. These are gains quickly made, and contribute to our overall goal of a cleaner transport system.

There is also large airport constructions that are implemented as airport owners make decisions about expanding or improving their airport facilities. As these evolve, efforts should be made to ensure the construction of airports give due consideration to how they are constructed and how emissions might be reduced.

International Aviation is moving to being more sustainable

In 2016, the Government agreed to participate in the Carbon Offsetting Reduction Scheme for International Aviation (CORSIA) at the 39th International Civil Aviation Organization (ICAO) Assembly. This is a global market-based measure for reducing and offsetting carbon emissions in the international aviation sector.

International aviation is responsible for approximately 1.3 percent of global CO_2 emissions, and the Paris Agreement is silent on its inclusion. For both international aviation and maritime, it was agreed the respective sector bodies would be responsible for taking action to reduce emissions. The Paris Agreement has set an expectation of universal participation in the global response to climate change.

CORSIA is one of four measures the international aviation sector is focused on to reduce its carbon footprint. The other measures are sustainable aviation fuels, aircraft technology and standards, and operational improvements (e.g. improved ground operations and air traffic management).

Technological and operational improvements alone will not be enough to meet ICAO's aspirational goal of carbon neutral growth from 2020. Sustainable alternative fuels require further development and maturity to make a significant contribution to reducing CO_2 emissions.

Efforts Aotearoa makes towards alternative fuels that can be used for aviation activities will contribute to the global goal of reducing international aviation emissions.

CORSIA commenced on 1 January 2021. Member States, including Aotearoa, began monitoring and reporting activities on 1 January 2019, to assist ICAO to set the baseline for CORSIA. The baseline will form the carbon neutral growth baseline from 2020 for ICAO.

The COVID-19 pandemic has reinforced the important role that aviation links have to Aotearoa's economy. These links are critical to our imports, exports, support of the Pacific and social connection. In order to sustain this as Aotearoa transitions to being low-emissions will require more investment in greener long-haul aviation than some other countries given our distance from markets.

Decarbonising the aviation fleet: possible key actions

- Invest in, produce and mandate sustainable alternative fuels that can also be used by the aviation sector. **(This has commenced with work on a biofuels mandate)**
- As technology advances, consider its implementation for Aotearoa, e.g. wider use of electric planes.
- Support research, development and production of sustainable aviation fuel.
- Examine if the current air navigation system is effective or could be more efficient. **(Partially underway through New Southern Skies and Performance Based Navigation)**
- Implement operational improvements such as better air traffic flow management and improved navigation to reduce fuel burn. **(As above)**

Consultation question 9

Do you support the possible actions to reduce domestic aviation emissions? Do you think there are other actions we should consider?

Chapter 8: Theme 3 – Supporting a more efficient freight system

Key points

- The Ministry is starting work on a National Supply Chain Strategy that will provide strategic direction and set out priorities amongst the various objectives for the supply chain, one of which being the reduction of emissions.
- Given the market-led nature of the supply chain system, initiatives to reduce emissions would have to be carried out in close consultation with the freight industry and/or be private sector-led, with government providing a vision and direction for change and/or supporting infrastructure. Concerted effort by industry has the potential to drive rapid emissions efficiency gains, with the right incentives.
- Shifting some of the freight task to less carbon intensive modes will help reduce emissions, including to rail and coastal shipping. The Government already has work underway to support improvements in rail and coastal shipping.
- Decarbonising freight vehicles will be critical for reducing transport emissions. This could include increasing the uptake of alternative green fuels, such as biofuels, electrification and/or green hydrogen. There is a high degree of uncertainty around the timeframe in which zero emission freight vehicles will be commercially available, more rapid than expected technological progress could accelerate decarbonisation of this sub-sector.
- Our international obligations will help to drive emission reductions in shipping, including through encouraging cleaner, more efficient ships and ports. The Government is also investing to improve our rail network, including through renewing locomotives and the inter-island ferries which will support reductions in the emissions from rail.
- Aviation plays a role in our freight system through its movement of people and freight domestically and internationally and efforts to decarbonise it must be considered given our trade and social connection needs and Pacific responsibilities.
- Improving the efficiency of our supply chain considering the role that all modes play could also help to avoid and reduce emissions. There are a range of possible initiatives trialled overseas and the feasibility of applying them in Aotearoa could be studied in more depth. These include optimising freight routes, equipment and vehicles, and through making better use of data and supporting information sharing and collaboration.

Improving the efficiency of our supply chain can help to avoid and reduce transport GHG emissions

Heavy vehicles, the majority of which are freight vehicles, contribute almost a quarter of Aotearoa's transport GHG emissions.

The movement of freight within Aotearoa plays a vital role in the economy. It allows producers to get their goods to consumers, including domestic goods and international imports and exports. In 2017/2018 Aotearoa's freight task (i.e. the freight transported within Aotearoa) was 278 million tonnes of freight or 30 billion tonne-kilometres. Our modelling indicates that the freight task will increase at 0.86 percent compounding over the next 30 years. For the most part, this forecast is driven by assumptions on population growth and demand for Aotearoa goods (both domestically and internationally).[75] This forecasted growth in the freight task has significant implications for transport emissions.

Supply chain systems are complex

Freight supply chains are a complex system of systems. These consist of networks of infrastructure, services, information and operators through which freight is transported from producer to end user. This means that to reduce freight emissions, we need to take a systems approach that looks for opportunities to improve efficiency and value across the whole of Aotearoa’s supply chain. This will also help us to take into account the relationships and interdependencies between different parts of the freight system. It will also help improve Aotearoa’s overall productivity. We do have to recognise that parts of Aotearoa’s freight industry are highly competitive, have low margins and contains a large number of operators. This makes them sensitive to change, and less able to make large or long-term investments that have commercial risk.

We also have to be realistic about how Aotearoa’s geographical context has and continues to shape its supply chain. Aotearoa is a geographically dispersed country with relatively low density population centres, which encourages a reliance on roads for its system. We have built-in imbalances between centres of consumption (primarily the Upper North Island region) and where exports are generated (primarily rural regions further south), which poses challenges for freight load optimisation.

A National Freight Strategy will consider opportunities to reduce supply chain emissions

The Ministry is starting work on a National Freight Strategy that will provide strategic direction and set out priorities amongst the various objectives for the supply chain, one of which being the reduction of emissions. It will take a systems view across the Aotearoa’s supply chain instead of a purely mode-by-mode analysis, which may help to identify opportunities for greater emissions reduction.

The following sets out potential measures to reduce emissions generated from freight. Many of these have been identified by the International Transport Forum (ITF) as having some evidence of potential impact on GHG emissions[76]. These could help inform future discussions on emissions reductions in the freight sector. Much of the ITF’s evidence has been obtained outside of Aotearoa, the feasibility of applying these initiatives within Aotearoa’s context has to be studied in more depth. Given the market-led nature of the supply chain system, analysis of these measures would also have to be carried out in close consultation with the freight industry and/or be private sector-led. Given the industry’s interest in whole-of-life costs, efficient fleet management, and containing fuel expenditure, more rapid than expected gains could be made if low-emissions freight vehicle technologies arrives more rapidly than assumed here.

[75] Ministry of Transport. (2017). *Transport Outlook: Future State*. Retrieved from: TransportOutlookFutureState.pdf

[76] International Transport Forum. *Transport Climate Action Directory.* Retrieved from: https://www.itf-oecd.org/transport-climate-action-directory-measures

Optimising freight routes, equipment and vehicles has the potential to reduce transport emissions

There may be opportunities to optimise freight routes, the freight moved, equipment and vehicles to reduce transport emissions. However, further work and sector consultation is required to gain a comprehensive understanding of Aotearoa's freight system and the best options to improve efficiency across our supply chain to reduce emissions.

We need to understand if the spatial layout of our freight routes and logistics nodes can be improved to identify opportunities to reduce emissions

Aotearoa's major population and production centres are widely dispersed across two main islands and challenging terrain. Our geography presents significant distances that domestic freight potentially has to travel. We need to fully understand the optimal spatial layout of transport and logistics nodes (e.g. ports, rail, freight hubs, etc.) in Aotearoa.

A comprehensive mapping of the spatial organisation of key freight nodes and corridors could help private operators and infrastructure owners identify if there are any inefficiencies, avoid duplication, and guide better investment decisions in freight infrastructure. Work on a national freight strategy should consider whether the system is set up as well as it can be given the challenges Aotearoa faces as mentioned above. A freight strategy should also consider and be informed by the context of the Resource Management Act reforms.

In addition, complementary land-use planning and resource management activities could support supply chain efficiencies, by minimising freight trips, assisting freight consolidation, and minimising the friction between freight and other network users and activities (e.g. in creating dedicated lanes for freight). Alongside other aspects of the freight system, this should be discussed with the freight logistics sector and other community stakeholders to better understand the opportunity it provides and the trade-offs involved.

We may be able to improve the efficiency of first/last-mile urban deliveries

A January 2020 World Economic Forum report has forecasted a 32 percent increase in emissions from last-mile deliveries over the next 10 years as the number of urban dwellers and online shoppers grows.[77] Globally, demand for urban last mile delivery is predicted to grow 78 percent by 2030, with a corresponding 36 percent rise in delivery vehicles in inner cities. This trend is likely to have relevance in Aotearoa as well. Other countries have been able to improve urban freight efficiency through consolidating deliveries in urban consolidation centres (UCCs) or drop-off/pick-up points for self pick-up. Some forms of UCCs are already being used in Aotearoa in the large population centres of Auckland and Wellington. How much more scope there is for Aotearoa to open further consolidation centres and complement these with last-mile low emission modes such as electric vans or cargo-bikes remains to be studied.

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[77] World Economic Forum. (2020). *The Future of the Last-Mile Ecosystem.* Retrieved from: The Future of the Last-Mile Ecosystem | World Economic Forum (weforum.org)

Consumer and business owner demands could influence freight patterns

There are a range of ways that consumer demands affect freight activity. For example, the significant growth in online shopping and increasing demand for quicker delivery or 'just-in-time' delivery has influenced how freight companies operate. In particular, it has lead to freight companies focussing on speed and efficiency. This makes slower and lower emission modes (such as rail and coastal shipping) less competitive.

If supply chain managers and consumers accepted slightly longer delivery times, it could enable slower modes, which are often lower emission, to play a larger role. This may require efforts to shift and shape consumer preferences, which will be challenging. Alternatively, continuing to focus on speed and convenience could also change where and how goods are manufactured. For example, centralised manufacturing may change to more dispersed locations. This could enable businesses to deliver their products to consumers more quickly. Higher levels of confidence in the resilience and reliability of the supply chain could also reduce the demand from business owners for speedy deliveries that often means goods are hurried to their final destination only to then wait.

The key is that if consumers demand more sustainability in the supply chain it could lead to innovative ways to deliver goods. This could include improving the efficiency of the supply chain, switching to lower emission modes or changing where goods are manufactured in the first place. Demand sustainability could be supported through engagement, promotion and education activities to create public demand for sustainable supply chains.

Some companies are already responding to consumer demand for more sustainable freight options by providing customers with information on the emissions arising from their current transport choices and the option for slower 'greener' delivery of their goods.

Improving the efficiency of freight payloads could potentially reduce GHG emissions

Payload refers to the carrying capacity of vehicles. Improving the load factor for freight is one of the most efficient ways to improve energy efficiency and lower carbon emissions. By transporting as much freight as possible per load, the number of trips required is reduced, and empty running (which arise due to an imbalance in outward and return freight volumes) could be minimised. This also depends on the type of goods that are being transported and their value. There are also cost savings to be gained by logistics companies and freight owners. However, there are challenges in doing so in Aotearoa given the imbalance in freight flows where there is more freight flowing from the North Island to the South compared to flows from South to North.

The use of high productivity motor vehicles (HPMVs) increases the ability to transport a given freight task with fewer vehicle kilometres travelled, resulting in lower fuel consumption per unit of transported cargo. The gains come from a mix of either increased mass and/or increased vehicle length which increases cubic capacity. The evidence in the literature on the impacts of HPMVs on emissions has been mixed, largely due to varying assumptions about road freight price elasticity and the specific payloads, distances, and costs considered. The introduction of HPMVs in some countries like Canada, Australia and Sweden and also in Aotearoa has been associated with freight efficiency, reduced road traffic and lower GHG emissions.

Since 2011, Aotearoa has increased the maximum capacity of heavy vehicles beyond the 44 tonne standard limit on gross vehicle mass and also provided increased length. The limit of 50 tonnes and longer vehicle with a corresponding 9-axle configuration (50 MAX) compared with a standard 8-axle truck and trailer has been calculated to incur no additional material wear and tear on pavements and bridges after allowing for efficiency gains. Waka Kotahi has also invested in upgrading strategic freight routes to allow for more widespread use of these 50 MAX trucks and other HPMVs. Some routes have even been approved for use by specifically designed 62 tonne HPMVs. It may be possible to explore whether more sections of the road network could support higher capacity trucks and whether any additional costs of maintenance and infrastructure upgrades could be justified. However, allowing heavier and greater cubic capacity loads on trucks might conversely lead to competition with lower carbon modes on some routes.

Intelligent Transport Systems (ITS) can help to improve freight efficiency

Intelligent Transport Systems (ITS) make use of technologies like wireless communication, cloud computing, and big data analytics to provide better quality, real time, automatically collected data to transport users. They could be applied to vehicles, infrastructure and operating systems to improve freight management, including improving load factor, finding optimal delivery routes, and improving delivery times.

The impact on emissions would result from better fleet and traffic management and energy consumption, although this is difficult to quantify as it would depend on the specific technologies applied. Its effectiveness in the Aotearoa context needs to be assessed.

In Aotearoa, some form of ITS is being used by many freight operators, e.g. to track freight movements and monitor fuel utilisation. Raising the awareness and benefits of ITS could encourage further uptake by smaller operators.

Promoting eco-driving can reduce GHG emissions, as well as offer significant co-benefits for businesses

Truck and train driver training and technologies that assist fuel efficiency and lower maintenance provide a good opportunity to reduce transport emissions. Driver training can involve techniques as simple as scanning the horizon or paying attention to traffic lights to avoid sudden stops and starts. Assistive technologies include on-board equipment that monitors and provides feedback to inform driving, and tyre pressure management systems, which dynamically adjust tyre pressure according to the terrain.

According to the Aotearoa Safe and Fuel Efficient Driving (SAFED) programme (administered by Waka Kotahi), eco-driving on roads could lower fuel consumption by as much as 10 percent, with corresponding impacts on reducing emissions. It also presents a strong business case and co-benefits to encourage businesses to implement this approach which assists them in lowering maintenance costs, reducing damage to goods transported and improving road safety. Effort will be required to embed new behaviours with the road and wider freight industry, including improving their ability to monitor fuel use.

We can make better use of data and support information sharing and collaboration to reduce freight emissions

Data and information sharing will be essential to assist us to gain a better understanding of the freight system and opportunities to reduce transport emissions. The availability of more and better quality data could assist the government to gauge the efficiency of the freight sector, design fit-for-purpose interventions, determine their effectiveness, price in externalities and make efficient infrastructure investment decisions. Privacy and commercially sensitive data considerations would need to be balanced, especially if we give consideration to making this data available to the private sector to assist with guiding their business decisions.

Currently, the Ministry of Transport’s Freight Information Gathering System (FIGS) and the National Freight Demand Study provide valuable information on freight volumes, origins and destinations, modes used and types of commodities. However, more detailed, real time data could be required to build a better understanding of the overall system, identifying risks and emerging trends, and assessing the impact of infrastructure decisions through dynamic modelling. Data from the E-RUC could also be more routinely analysed to identify risks and emerging trends to assist future uptake of electric vehicles. Additional data which would be useful to have includes (but is not limited to) freight interactions across modes, peaks and troughs of freight traffic along key corridors, and ownership and operating structures of various players in the industry. There may be resistance from the highly competitive freight industry. It would need to see clear private benefits before publicly divulging potentially commercially sensitive information.

The gathering of more data will require a cross-government response and should include departments such as Stats NZ and MBIE to address data gaps.

We could encourage data sharing and cross-business collaboration

The sharing of data and best practices could be encouraged through voluntary collaborations between businesses that aim to build sustainability into their operations. Collaboration between businesses across the supply chain may generate opportunities to optimise routes and modal share, share loads, and leverage back-loading opportunities. This would likely require freight owners and operators to share their data in a way that protects commercial confidentiality. We understand that customers are already starting to demand improved transport emissions performance in their normal course of business. The extent to which cross business cooperation and sharing is already happening could be further explored, as well as whether there is scope to encourage more of such collaborations or provide more support to existing ones.

Improving the efficiency of our overall freight supply chain: possible key actions

Optimising freight routes, logistic nodes, equipment and vehicles:

- Undertake an examination of the efficiency of the spatial organisation of supply chain nodes (e.g. location of ports and freight hubs).
- Examine the potential to improve the efficiency of first and last-mile delivery centres (e.g. urban consolidation centres, drop-off/pick-up consolidation points, use of micro-freight, pilot of concessions).
- Consider if there is potential to optimise payloads, e.g. load maximisation and back loading.
- Support the further use of Intelligent Transport Systems (ITS).
- Analyse if there is opportunity or restrictions to the further expansion of the weight and length limits of high-productivity motor vehicles (HPMVs).
- Further promote eco-driving and driver training programmes.[78] **(Promoting work already being implemented by industry)**

Information sharing and collaboration:

- Examine opportunities for the collection and better use of data to improve efficiencies in the freight system.
- Consider encouraging/supporting voluntary business collaborations to reduce emissions in logistics.

(Many of these actions will be considered through the National Freight Strategy)

Consultation question 10
The freight supply chain is important to our domestic and international trade. Do you have any views on the feasibility of the possible actions in Aotearoa and which should be prioritised?

[78] Waka Kotahi Transport Agency. (2020.) *Operator Rating System (ORS).* Retrieved from: https://www.nzta.govt.nz/commercial-driving/operator-rating-system-ors/

We can improve the resilience and reliability of less carbon intensive transport modes to improve modal choice

Shifting freight movements from road to more efficient and less carbon intensive transport modes would reduce emissions. Currently, freight movement is dominated by road transport which carries about 92.8 percent of tonnage of 75.1 percent of tonne-kilometres. This is compared to the 5.6 percent tonnage/11.5 percent tonne-kilometres and 1.6 percent tonnage/13.4 percent tonne-kilometres carried by rail and coastal shipping respectively.[79] Road freight emits on average 136g of CO_2 equivalent per tonne-kilometre, compared to 28g by rail (21 percent of road) and 16 to 45g by coastal shipping (12 to 33 percent of road).[80]

However, the amount of freight that can be shifted to these modes is limited due to Aotearoa's geographical characteristics, market expectations around timeliness and total costs (including transfer costs), limited access to rail and coastal shipping for rural freight users, infrastructure constraints (e.g. fixed tunnel heights for rail), the characteristics of the cargo, as well as the distance travelled. Road freight tends to be the cheapest option where distances are short and cargo volumes are low and where geographic constraints prohibit cost effective rail and coastal shipping infrastructure.

Some studies, albeit from some time ago, have estimated that rail[81] and coastal shipping[82] could increase their respective mode shares to 20 percent of the freight task on a tonne-kilometre basis. However, these studies looked at rail and coastal shipping separately and did not consider how the two modes may compete for some of the same contestable freight.

Both rail and coast shipping are important parts of the supply chain system, and the National Freight Strategy will have to consider how systems settings can better enable modal-choice by freight shippers.

Long-term investment is required to improve modal choice in the freight system

Our rail infrastructure has suffered from a lack of long-term investment and inadequate planning and funding frameworks. There have been issues around the resilience and reliability of the rail network to support supply chains. To address this, the Land Transport (Rail) Legislation Act 2020 implements a new long term planning and funding framework for the heavy rail track network under the Land Transport Management Act 2003. Investment in a reliable and resilient rail network is anticipated to take 7 to 8 years to complete, and will enable it to maintain and improve service levels. This will provide a platform for future investment in growth in rail freight services.

Current investment priorities for rail as outlined in the draft New Zealand rail plan, include the replacement of freight locomotives and the inter-island ferry assets which are at or beyond their economic lives. Renewing these assets will lead to further reductions in the emissions from the rail network. The Government is also already investing extensively in the Wellington and Auckland passenger networks to improve reliability and support the growth of these

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79 Ministry of Transport.(2017). *National Freight Demand Study.* Retrieved from: NFDS3 Final Report 011019-Rev1 (transport.govt.nz)

80 Ministry for the Environment. (2019). *Measuring Emissions: A Guide for Organisations. 2019 Detailed Guide*.

81 Mackie H, Baas P and de Pont J. (2007). *Prediction of freight growth by 2020 and rail's ability to share the load*. IPENZ Transport Group Conference, Tauranga.

82 Rockpoint Corporate Finance Ltd. (2009). *Coastal Shipping and Modal Freight Choice.*

networks into the future. This includes joint investment in the City Rail Link in Auckland, with the Auckland Council, which is the biggest infrastructure project in Aotearoa.

Going beyond these investments and considering matters such as additional electrification of the rail network, will need to be carefully weighed against the relative benefits of other initiatives to reduce emissions, given the substantial costs of these investments.

Similarly, the Government Policy Statement 2021 includes a coastal shipping activity class of up to $45 million over three years, but more work is required to determine how this could best support coastal shipping.

The government has invested to support the development of inter-modal hubs to facilitate employment opportunities, modal choice and improve supply chain efficiency

Intermodal freight terminals are nodes in the logistic chain which enable the efficient transfer of goods between different modes of transport. While there may be transfer costs incurred, intermodal terminals could optimise the use of transport modes, providing greater capacity, efficiency, reliability and resilience for operators. They could therefore allow freight owners more choice in the mix of modes they use. Existing examples of intermodal freight terminals in Aotearoa include log transfer yards, rail-enabled distribution terminals, container transfer sites, inland ports or industrial parks with transfer facilities.

There has been little public sector investment in intermodal terminals in Aotearoa over the last forty years. However, around the world, the use of inter-modal solutions by the private sector has increasingly been supported by government investment. The government has invested in inter-modal hubs through the Provincial Growth Fund (PGF) in light of the objective to revitalise our heartland regions through growing employment and economic opportunities. Examples include the following.

- Central North Island Regional Economic Growth Hub – KiwiRail has received investment to undertake the design (Master Plan) of the hub, have the land designated for rail use and has commenced purchasing the required land.[83]

- Kawerau Container Terminal Rail Siding - Development of a Kawerau Container Terminal with rail siding access and related infrastructure. The terminal develops adjacent to the current KiwiRail yard with a second line being built to create a rail siding.[84]

The extent of emissions reduction from the use of intermodal terminals largely depends on the mix of modes and transfer costs used in the freight journey, including whether the journey taken reduces the emissions generated during any international legs involved. Movements where the road component is minimised compare more favourably than when extensive road transport is required at the start or end of the rail/shipping component.

[83] https://www.kiwirail.co.nz/what-we-do/projects/regional-freight-hub/

[84] Public list of projects: https://www.growregions.govt.nz/media-centre/funded-projects/

Rail and coastal shipping also provide co-benefits

Rail and coastal shipping provide demonstrable value in the form of reduced road congestion, air and noise pollution and maintenance costs, as well as improved road safety outcomes.[85] Coastal shipping and rail could also build resilience in supply chains by providing alternative transport option during road and/or wider land-based disruptions.

Enabling modal-choice in freight through the use of low emissions modes: possible key actions

Rail and coastal shipping:

- Improve the resilience and reliability of the rail network through completing investments over the next decade outlined in the New Zealand Rail Plan.[86]
- Consider how coastal shipping fits within the supply chain and how its activity class in the Government Policy Statement for land transport 2021 could be implemented. **(Underway)**
- Complete the development of PGF funded intermodal hubs. **(Underway)**

Decarbonising freight vehicles will be critical for reducing transport emissions

Aotearoa uses a combination of aviation, truck, rail and coastal shipping to move freight. All of these modes contribute to our domestic emissions, and therefore we need to consider steps towards decarbonising them. There are opportunities for Aotearoa to use more efficient, cleaner trucks, rail, ships and planes, and improve supporting infrastructure.

Decarbonising road freight provides the best opportunity for Aotearoa to reduce freight emissions

There are about 150,000 trucks on the road, travelling a combined total of nearly three billion kilometres. These heavy vehicles, the majority of which are freight vehicles, are responsible for almost a quarter of Aotearoa's transport GHG emissions. Given that the majority of the freight task is likely to continue to be transported by road, decarbonising road freight will be important for achieving Aotearoa's emission reduction targets.

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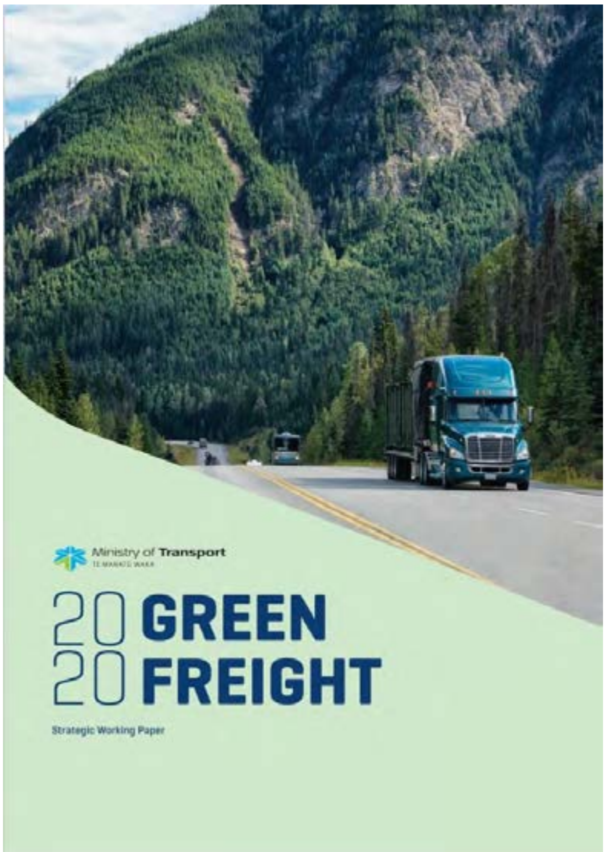
[85] Ministry of Transport. (2020): *The Externality Value of Rail in New Zealand;* Ministry of Transport. 2020. *The Externality Value of Coastal Shipping.*

[86] Ministry of Transport. (2020) *Te anamata o te ara tereina: future of rail,* retrieved from: https://www.transport.govt.nz/area-of-interest/infrastructure-and-investment/future-of-rail/

The Ministry of Transport's Green Freight Strategic Working paper highlights several opportunities to transition road freight to alternative green fuels



The Green Freight working paper highlights a range of options to support the uptake of biofuels, electrification and green hydrogen in the road freight industry.[87]

Conventional biofuels, along with the advanced biofuels being produced commercially overseas, have the potential to provide an immediate solution to reduce GHG emissions

Conventional biofuels are already being produced in Aotearoa in low volumes, and could be scaled up with greater investment. Aotearoa could also look at options to increase the uptake of advanced biofuels, which could also be used in aviation and maritime. Aotearoa could also consider if imposing penalties on high GHG emitters or incentives for lower emitters operating truck fleets is a feasible option that could shift behaviour change.

Battery technology is developing quickly but battery electric heavy trucks are still not readily available and there remain significant barriers

Aotearoa is well placed to reduce emissions through electrification because of our high level of renewable electricity. However, the current upfront cost of battery electric vehicles is a significant barrier to their uptake in Aotearoa, as is the uncertainty around their ability to deliver the freight task. At this time, electrification is best suited to medium trucks undertaking shorter urban freight delivery tasks, and heavy trucks with return-to-base operations or delivering niche services across the freight industry. Electric vehicle technology is improving and becoming cheaper very rapidly; a more rapid introduction of low emission freight vehicles than assumed in the pathways in this document may be achievable, subject to further progress. We should consider options that help to influence vehicle supply chains, and incentivise the uptake of low and zero-emission vehicle options across the freight industry.

[87] Ministry of Transport. (2020). *Green Freight Strategic Working Paper,* retrieved from: https://www.transport.govt.nz/assets/Import/Uploads/Our-Work/Documents/Green-Freight-Strategic-Working-Paper_FINAL-May-2020.pdf

Green hydrogen is increasingly being considered as a transport fuel but there are also significant barriers facing the adoption of hydrogen fuel cell vehicles

In 2019, Government published a green paper called "A vision for hydrogen in New Zealand.[88] This report notes that Aotearoa possesses large, and as of yet undeveloped renewable electricity resources. This renewable electricity could be used to produce predominantly green hydrogen, which could become a fuel source for Fuel Cell Electric Vehicles (FCEV).

Green hydrogen can be used as a transport fuel source by storing it under pressure in cylinders in the vehicle and converting it with oxygen to electricity. There is global recognition that hydrogen has the potential to be a significant fuel of the future for certain applications.[89] Yet in balancing this, converting electricity into hydrogen and back to electricity can involve energy loss in the order of 45 percent making it an inherently inefficient process.[90]

FCEVs appear best suited to long-haul freight tasks, along with emerging heavy electric trucks and ultra-fast charging technologies. However, as with battery electric trucks these vehicles are not readily available globally.

Supporting infrastructure is critical for enabling the transition to both battery electric vehicles and FCEVs

Freight companies are unlikely to invest in vehicles that cannot be easily recharged/refuelled. If the Government pursues widespread adoption of biofuels, electrification and green hydrogen then it should consider how to support market investment in infrastructure, as well as provide clear signals through its own investments.

Cleaner trucks will also support co-benefits, such as improving air quality in our towns and cities

Increasing the number of low-emission trucks on Aotearoa's roads could have benefits for the health and wellbeing of New Zealanders. In particular, by reducing air and noise pollution in densely populated parts of the country and on freight routes.[91]

Our international obligations will help to drive emission reductions in shipping, including through encouraging cleaner, more efficient ships and ports

Aotearoa is dependent on shipping for the movement of goods in and out of the country and for connectivity within and between the North and South Islands. It is currently projected that global maritime freight transport will grow at a compound annual growth rate of 0.86 percent over the next 30 years.

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[88] New Zealand Government. (2019). *Green Paper: a vision for hydrogen in New Zealand*. Retrieved from: https://www.mbie.govt.nz/dmsdocument/6798-a-vision-for-hydrogen-in-new-zealand-green-paper

[89] International Energy Agency. June 2019. *The Future of Hydrogen*

[90] Youmatter. (2019). *Hydrogen Cars vs Electric Cars: Which is More Sustainable.* Retrieved from: Hydrogen Cars Vs Electric Cars: Which Is More Sustainable? (youmatter.world)

[91] PIARC. (2020). *Road Traffic Noise.* Retrieved from: https://www.piarc.org/en/PIARC-knowledge-base-Roads-and-Road-Transportation/Road-Administration/Environment/Act-on-Road-Traffic-Noise

Global increases in maritime freight are expected to happen due to new international trade agreements, emerging markets and new trade routes. Growing e-commerce is also expected to increase demand for container shipping. Ninety-nine percent of our international trade is transported by sea[92]. Our future freight movement growth will depend on if we pursue new trade agreements and routes, and if our growing population puts greater demand on e-commerce transactions. Aotearoa will likely see some growth in its freight movements but probably not anywhere near the rate that is predicted globally.

Subsequently, if freight movements increase and there has been no change to improving the efficiency of ships that shift freight, it is likely that emissions from this activity would increase.

Ships visiting Aotearoa are part of the international shipping sector, whose emission reductions are being progressed through the International Maritime Organization (IMO). As part of Hīkina te Kohupara we are focusing on possible actions that could reduce emissions from ships undertaking domestic journeys in Aotearoa's national waters. This is irrespective of whether they are Aotearoa-flagged vessels or foreign vessels.

Aotearoa is currently in the process of acceding to Annex VI of MARPOL (International Convention for the Prevention of Pollution from Ships)

Annex VI specifically controls emissions to air from ships. As most port calls are made by international ships registered in countries that have already ratified MARPOL Annex VI, the greatest environmental gains for Aotearoa from acceding relate to our application of the emission rules to domestic shipping.

The domestic shipping sector contributes a relatively small proportion of Aotearoa's overall transport emissions and several key players in the maritime industry are already driving improvements to the sector without any direction set by government. Ships however contribute significantly to local air pollution in Auckland and Wellington.

Domestic ships in Aotearoa are a mix of new and second hand ships with a lifespan of approximately 25-30 years. Technical energy efficiency measures (improved ship design) are generally most effective for new ships. Therefore, additional actions will be needed to address emissions from the existing fleet.

There are several opportunities that address the energy efficiency of ships and port operations, as well as associated activities

Operational measures such as slow-steaming and hull cleaning are already undertaken by some ships to improve their operational energy efficiency and fuel consumption. We could introduce incentives for those ships already operating as efficiently as possible with incentives to encourage others to implement operational measures to improve their energy efficiency.

There is also opportunity to electrify the maritime sector through encouraging the use of fully electric/hybrid vessels; installation of renewable shore-side power supply for ships; and implementation of hydrogen/electric infrastructure for port operations. Other activities that might contribute to reducing emissions are improving the ship-port interface (reducing

[92] Ministry for the Environment. (2019). *Our marine environment.* Retrieved from: https://www.mfe.govt.nz/sites/default/files/media/Environmental%20reporting/our-marine-environment-2019.pdf

waiting time for ships entering ports), and green procurement (the inclusion of requirements relating to low- or zero-emission transport in public procurement processes, the purchasing of energy efficient vessels and the procurement of services in which vessels are used). The Commission acknowledges that the installation of a larger dry dock in Aotearoa could reduce emissions (which would mean large domestic ships would not have to travel overseas for maintenance and repair), however the contribution to emissions reductions may not be significant given the small size of Aotearoa's domestic shipping fleet.

All of these opportunities are likely to need significant capital investment and therefore cost effectiveness would need to be explored.

The most significant emissions reductions are likely to be realised following the uptake of alternative fuels. Those being explored internationally for use in shipping include LNG, methanol, biofuels, hydrogen and ammonia.

Supporting the uptake of cleaner ships will also result in co-benefits, such as improved local air quality in our port-cities and reduced ship noise

By reducing the time a ship spends in port, or changing the fuel it burns while berthed, we can improve local air quality through a reduction in pollutants such as nitrogen oxides (NOx, NO_2), sulphur oxides (SOx) and particulates. This would have positive impacts on the health of those communities living near ports and improve the liveability of the surrounding area. Onshore charging facilities could have additional benefits in terms of reduced noise pollution particularly in ports that have visiting ships that run auxiliary engines.

While the impact of shipping on biodiversity is not well documented, a reduction in pollutants and noise, both above and below the water, will also have benefits for wildlife.

Rail contributes a relatively small amount to Aotearoa's transport emissions but there are opportunities to reduce rail emissions

Today, the national rail network consists of 3,700 kilometres of track. Emissions from rail account for one percent of the transport sector emissions.

In the 2019 financial year, KiwiRail reported that the carbon footprint for direct emissions for its activities was 240,068 tonnes of CO_2-e emissions.[93] We note this likely includes both rail and ferries.

Electrifying our rail networks could reduce emissions but requires significant capital investment

Currently, only the central part of Aotearoa's North Island Main Trunk line is electrified. The high capital investment required to further electrify the rail network lines (for freight), build supporting infrastructure, and procure more electric locomotives may be prohibitive for it to be further electrified. KiwiRail has estimated that it would cost $2.5 million to electrify one kilometre of a single track.[94] For the high initial costs of electrification to be justified, modal

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93 KiwiRail. (2019). *Kiwirail's 2019 Annual Integrated Report*. Retrieved:https://www.kiwirail.co.nz/assets/Uploads/documents/Annual-reports/2019/b563b44217/KiwiRail-Integrated-Report-2019-FINAL.pdf

94 KiwiRail. (2016). *Media release: Kiwirail announces fleet decision on North Island Line.* Retrieved from: https://www.scoop.co.nz/stories/BU1612/S00810/kiwirail-announces-fleet-decision-on-north-island-line.htm

shift of freight from road to rail would need to be intensified to yield higher levels of rail traffic, and therefore greater gains from lower operational costs. Battery-powered trains able to travel on non-electrified routes could be explored. These could bridge gaps between electrified sections of the rail network and potentially reduce the proportion (and costs) of the network that needs to be electrified.

Biofuels could be a more cost-effective solution for decarbonising the rail network

As an alternative to electrification, we should consider the benefits of using biofuels for rail. Biofuels would be suitable for transport modes that are difficult to electrify such as heavy long-haul road and rail transport. Ethanol and biodiesel, added as blends in petrol and diesel respectively could offer immediate options to reduce emissions and increase Aotearoa biofuels use. For example, KiwiRail is testing biodiesel in some diesel trains and also the Interislander ferry.[95]

A cleaner rail system could support co-benefits, including reducing operational costs

Electric motors can act as power generators, where they recover the energy spent in braking to feed back into the national electrical grid. Given the much higher energy efficiency of electric engines and the need for less maintenance, electric locomotive operating costs could be much lower than a diesel train.

The economic benefits from implementing electric trains include lower fuel costs, and because they are marginally lighter than diesel trains there is less wear on tracks, which may reduce maintenance costs. Additionally, the costs of overhead lines maintenance would be reduced.

Improving the design of existing infrastructure and vehicles can reduce emissions

Improving the design of road and rail vehicles to improve fuel efficiency would contribute to reducing emissions. These could include adaptations to improve transmission efficiency and to reduce aerodynamic drag, vehicle weight and rolling resistance.[96]

There are barriers to adoption including high upfront costs of equipment, which may make these efficiency gains particularly prohibitive and risky for smaller companies. The competitive nature of the market also leads to a lack of incentive to invest in the absence of external pressures (e.g. stricter fuel and emission standards, or government subsidies for using these adaptations). The long lifetime of assets (both trucks and train locomotives) further complicates the uptake of these adaptations, although some can be retrofitted onto existing fleets. Government could explore working with the industry to investigate the extent to which the fuel efficiency in freight vehicles could be further improved, as well as what levers could be used to encourage change and help smaller companies manage risks. This could include examining the current rules around vehicle dimensions that prevent the use of aftermarket aerodynamic devices.

95 'Kiwirail firms up plans for biodiesel trials despite supply doubts' retrieved from: https://www.rnz.co.nz/news/national/392180/kiwirail-firms-up-plans-for-biodiesel-trials-despite-supply-doubts

96 As cited in International Transport Forum. (2018). *Towards Road Freight Decarbonisation Trends Measures and Policies.*

There is some evidence that better design and maintenance of roads could reduce GHG emissions.[97] There may be benefits in reviewing the design of roads to reduce fuel consumption, e.g. deducing the optimal mix of materials used, reducing the number of curves, surface roughness (including sealing rural roads) or gradient of the road. There may also be scope to improve the maintenance of road conditions in Aotearoa, which also has safety implications. A July 2020 report by the Office of the Auditor General found that since 2009/2010 less has been spent on renewing state highways than the rate of depreciation for the state highway network, which poses some risk to Waka Kotahi's long-term ability to maintain its condition.[98] Adequately maintaining the condition of roads would be important especially if Aotearoa explored further expanding the weight limits of HPMVs, as mentioned earlier.

Decarbonising aviation is important to Aotearoa's trade and social connections

Aviation will play a role in Aotearoa's decarbonisation of the transport system. Aviation contributes to our freight system through the fast movement of people and goods to destinations domestically and internationally. It is a mode that is generally relied upon to quickly shift high value and/or perishable products to our trade markets, such as medicines. Substituting alternative modes to shift high value/perishable products is not generally feasible because of the need to meet tight timeframes and/or to travel to places that can only be readily accessed by aviation.

Aviation is a high emitter and efforts will need to be made to reduce aviation's contribution to our emissions profile. Our participation in CORSIA begins to address international aviation emissions, however more is required both domestically and internationally. Efforts to decarbonise our long-haul flights, given their trade contribution, Pacific and social connection will be important given our distance from markets.

Decarbonising freight modes: possible key actions

Cleaner trucks:

- Introduce vehicle CO_2 standards.
- Implement EURO 6 to improve air pollutants from trucks.
- Consider if the current RUC exemption for heavy electric trucks should be expanded to other low emission fuels used by heavy trucks. **(Under consideration)**
- Consider expanding the scope of the existing low emissions vehicles technology funding to accelerate the uptake of proven low emissions vehicle technology.
- Investigate the viability of introducing a penalty or financial disincentives system for high GHG emitting heavy trucks.
- Investigate the viability of providing upfront grants or other incentives (such as changing depreciation rates) for low and zero emissions trucks.
- Investigate and introduce Green freight procurement through third party contractor rules for government activities.

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97 A 2019 study found that preventative maintenance of road pavements could reduce GHG emissions by up to 2%, even after adopting a life-cycle perspective and taking into account pollution generated during road construction.

98 Controller and Auditor General. (2020). *New Zealand Transport Agency: Maintaining state highways through Network Outcomes Contracts*. Retrieved from: https://oag.parliament.nz/2020/nzta-contracts/docs/nzta-contracts.pdf

- Phase out the registration of diesel heavy vehicles beyond a certain date, e.g. from 2035 or banning diesel trucks in certain cities or zones
- Invest in domestic industry to refurbish diesel trucks with zero emissions options
- Implement a biofuels mandate

Cleaner rail:
- Investigate the use of biofuels for rail. **(Included in biofuels mandate, which is under development)**
- Explore the feasibility of future electrification of rail (i.e. non-metro rail) or other low-emission alternatives.

Cleaner ships and ports and associated activities:
- Introduce targets, rewards, incentives for energy efficient ships using Aotearoa ports.
- Apply MARPOL Annex VI energy efficiency requirements to the Aotearoa domestic fleet. **(Aotearoa is acceding to MARPOL Annex VI)**
- Introduce a target /mandate for renewable fuel (biofuels, hydrogen, ammonia) for ships that applies to the domestic fleet. **(underway)**
- Consider introducing a mandatory speed limit (i.e. impose slow steaming) for ships transiting around Aotearoa.
- Electrify Aotearoa’s fleet (ferries, tugs, cement carriers and fuel tankers). **(Some private electric ferries already built/procured)**
- Improve the ship/port interface by implementing Just-in-Time arrival guidance.
- Incentivise or invest in renewable shore-side power supply for ships.
- Incentivise or invest in renewable energy for port operations.
- Consideration of a large dry dock in Aotearoa.
- Invest in future technologies (e.g. autonomous shipping that provide low carbon alternatives to road freight).
- Introduce decarbonisation as a criterion in government procurement of ships and shipping services.

Improving existing infrastructure and vehicles:
- Investigate potential for adoption of more efficient vehicle design.
- Investigate the impacts of better road design and maintenance.

Decarbonising fuels:
- Consider implementing a carbon intensity standard for all transport fuels.
- Incentivise and/or provide financial support to expedite the uptake of renewable fuels.
- Investigate and implement renewable fuel targets.
- Incentivise or invest in infrastructure for alternative fuels and/or electrification, including ultra fast charge. **(Some Government investment has already taken place e.g. for hydrogen production)**

Exploring opportunities for the domestic production of sustainable alternative fuel

Biofuels and green hydrogen both offer potential for reducing Aotearoa's transport emissions. There is an opportunity for Aotearoa to scale up production of these fuels, and in doing so be able to meet Aotearoa's collective transport demands. Investment is required, and to encourage this certainty is required by investors – certainty of the pathway that Aotearoa will be taking to reduce emissions. Clear government policy direction will enable investors, businesses and consumers to consider how they participate in the market.

In September 2020, the Ministry for Primary Industries (MPI) released its stage one report Aotearoa wood fibre futures. The report identifies wood processing technologies that could help Aotearoa move to being a high value and low carbon economy. It focused on how Aotearoa could build on the forestry industry's current strengths to create a low-carbon future. The report identified possible alternatives to concrete and steel, and biofuels made from woody biomass. The report identified 15 technologies found globally that Aotearoa could prioritise and laid out ways to attract investors.

MPI has released a request for proposal (RFP) for Stage 2 of the project, which will focus on building the investment case and provision of a detailed feasibility study for the priority technologies. This work will involve discussions with key industry partners, including those in forestry, transport, construction, and energy. MPI will work closely with other agencies, including the Ministry of Transport and MBIE, to identify policy tools to incentivise investment.

The four priority product candidates in scope of the RFP are:

- Wood-based products: that will provide a large source of 'residues' that could be the feedstock for the making of the priority product candidates below;
- Biocrude oil;
- Liquid biofuels, including Safer Aviation Fuel and Biodiesel; and
- Solid fuels (e.g. Wood Pellets, Dried Wood Chip or equivalent).

Consultation question 11

Decarbonising our freight modes and fuels will be essential for our net zero future. Are there any actions you consider we have not included in the key actions for freight modes and fuels?

Chapter 9: Supporting a Just Transition

Key points

- Government has committed to taking a 'Just Transition' approach to becoming carbon free – this means making the transition fair, equitable and inclusive.
- The transition to a low carbon economy will create significant economic opportunities for businesses, and job creation in the transport and energy sectors.
- Some parts within the transport sector may be more affected by the transition than others, especially if they face rising transport costs, and/or find it difficult to adapt. Government could assist the sector to adopt new technologies to encourage an earlier transition, and support education and upskilling.
- Many people will benefit from the transition to a zero carbon transport system. For example, many New Zealanders will benefit from better transport options, better health, and lower and more stable transport costs over time.
- People who already experience social/economic disadvantages are likely to be disproportionately affected by any rise in transport costs (as already occurs when fuel prices rise). To make a Just Transition, Government needs to mitigate the impacts of interventions that could increase transport disadvantage. There are also opportunities for the Government to improve transport equity during the transition.
- The speed of change is an important consideration for a Just Transition. We urgently need to transition to a zero carbon system, so Government needs to clearly signal changes to give businesses and consumers time to prepare and make the necessary changes. Government also needs to work collaboratively with industries to ensure the transport sector can adapt and overcome challenges associated with the transition.

What is a Just Transition?

When passing the CCRA, Government committed to taking a Just Transition approach to becoming carbon free. A Just Transition is fair, equitable and inclusive and makes sure that Government carefully plans with iwi, communities, regions and sectors to manage the impacts and maximise the opportunities of the changes brought about by the transition to a low emissions economy.

A Just Transition approach ensures that people affected by changes are considered by those making decisions. Early action on a Just Transition can minimise the negative impacts and maximise positive opportunities. The Paris Agreement on climate change includes Just Transition as an important principle.

The government's Transition Hub provides advice to the Government on how we transition to a low emissions economy. It also supports government sectors such as the energy, transport, built environment and waste sectors to make the transition. This includes making sure policies of the various sectors align. The hub is made up of people from government agencies in the natural resources sector.[99]

Government needs to work with industries and workforces that will find it difficult to transition quickly

As transport in Aotearoa is decarbonised, impacts will fall differently on the various industries and workforces in the transport sector. For example, there could be disproportional impacts on large versus small freight operators. Smaller operators may not have the capacity to transition to new technologies or change business models, or they may not have the finances to buy a new electric truck. Mechanics whose businesses are based on servicing ICE vehicles may also face challenges.

At the same time, there is significant potential for economic opportunity and job creation as we shift towards a low emission transport system. This includes through the uptake of new transport technologies, active modes, and increased domestic production and use of biofuels. Training and upskilling the sector to shift into these new areas will be important. There is potentially a significant positive opportunity for Aotearoa to make its own biofuels from agricultural and forestry resources, replacing some imported fossil fuels. This will also contribute to energy security and resilience as we become less dependent on importing oil from international oil markets which fluctuate (and are sometimes volatile).

The Freight Sector

The freight sector is a highly competitive industry in Aotearoa. Currently low and zero-emission heavy trucks cost substantially more than their diesel equivalents, and will take longer to reach price parity than their light vehicle counterparts. Electric trucks will weigh significantly more, and take significantly longer to recharge/refuel, compared to current diesel trucks. They will also require charging infrastructure, which will require additional investments. High investment costs for trucks and charging may delay the road freight sector transitioning to cleaner vehicles. However, as the cost of fossil fuels rise, the sector should look towards the overall costs of their fleet and begin to decarbonise. Support to assist with the higher costs associated with the transition to lower carbon modes, like electric trucks, hydrogen and biofuels may encourage earlier transition. As noted in Theme 3, the Ministry is starting work on a National Supply Chain Strategy to provide strategic direction and prioritise the objectives for the supply chain, one of which is reducing emissions.

Vehicle CO_2 emission standards could also result in some trucks becoming obsolete, and the cost of newer, fuel-efficient trucks may be out of reach for some operators. To mitigate the impacts of this, Government could consider assisting the freight sector to transition. Possible actions include offering support to the freight sector; bulk purchasing arrangements for zero emissions trucks, sharing best practice around GHG emissions reduction approaches, and agreements around setting freight industry wide GHG emissions targets. The current RUC exemption for heavy vehicles also provides an incentive to encourage uptake.

Early adoption of new vehicle technologies can be high risk; if technologies fail it can result in a wasted investment, stranded assets or safety issues. Government financing to allow

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[99] Ministry for the Environment. (2020). *The transition to a low-emissions and climate resilient Aotearoa New Zealand.* Retrieved from: https://www.mfe.govt.nz/climate-change/climate-change-and-government/climate-change-programme.

trialling of electric heavy vehicles, or funding to support infrastructure like low/zero emission freight vehicles charging infrastructure could be a good way to assist the freight sector in adopting new technologies, as it ensures any limitations of new electric heavy vehicles could be tested before purchasing.

The $27 million allocated to the National New Energy Development Centre in 2019 is an example of government and industry working together to implement a Just Transition – and the kind of investment and collaboration needed for a cleaner freight sector.

Vehicle servicing industry

Decarbonising the light and heavy vehicle fleet may see skill redundancies in the vehicle-servicing industry. Aotearoa has over 15,000 motor mechanics who will be affected by the shift away from internal combustion engine (ICE) vehicles towards low emission vehicles, and this sector has a skills shortage as it is. Electric vehicles have no need for oil changes, spark plug replacement, less wear on brakes and fewer parts to maintain, so less need for servicing. This could mean that relatively new and different skills may be required of mechanics. Mechanics would need training to become more electrically skilled, rather than mechanically skilled, in order to service electric vehicles safely and efficiently.

Education and upskilling is a significant opportunity here. Retraining and upskilling mechanics can ensure we retain a skilled workforce who can service the anticipated influx of electric vehicles coming into Aotearoa, alongside minimal skill redundancies in a sector which is already struggling to obtain adequate staffing.

We need to keep industries and businesses informed and stay consistent in our approach

Government signalling is a significant part of ensuring the transition to a low emissions transport sector goes smoothly. Major changes in requirements to our transport systems need to be signalled far enough in advance to allow the industry to prepare and plan. Consistency with any new policies will also be essential. Bipartisan support and industry acceptance of new policies would also help to ensure consistency through changes in Government.

We need to work collaboratively with industry to ensure the transport sector can adapt and overcome any challenges associated with the zero economy transition.

Government also needs to consider the distributional impacts in society to enable a Just Transition

As part of Aotearoa's commitment to a Just Transition, we need to consider how the transition to a zero carbon transport system will impact different groups of New Zealanders. Everyone will experience changes during this transition. Many people will benefit, but these benefits will not be evenly spread. Some people could also face higher transport costs. We must recognise the rights of iwi/Māori under Te Tiriti o Waitangi and build a strong Crown-Māori partnership as part of a Just Transition.

There are already major inequities in the transport system

Extensive international research demonstrates the important role of transport in creating an inclusive society.[100] The research shows that people who lack affordable access to transport have difficulty accessing goods, services and opportunities that are available to others as a fundamental part of belonging to society. This includes access to education, employment, health services, healthy food choices, and sporting, leisure, and cultural activities. From an equity perspective, there are two aspects that need to be considered to enable a fair and inclusive transition:

- *transport disadvantages*: some people have a lack of transport choices, which limits their options to participate in everyday activities
- *transport poverty*: some people overcome a lack of choices by paying more than they can reasonably afford for mobility, typically by buying and operating a car.

To make a Just Transition, government needs to mitigate the impacts of interventions that could increase transport disadvantages and/or transport poverty. Beyond this, government can also make interventions that improve transport equity.

Low-income households are more likely to face transport disadvantages and transport poverty than others in the population because they often live in car-dependent areas (e.g. on the edges of cities and in rural/remote areas), and face higher daily travel costs. Housing costs are usually cheaper in these areas relative to places with many jobs and amenities, but daily travel costs are often higher due to the need to travel long distances, usually by private car. This can perpetuate cycles of inequality, where low-income people living in areas with limited access to jobs, education, health care, and social services face high transport/living costs to participate in society.

Disabled people experience more transport disadvantages than others in the population. For example, they may find it difficult to use public transport (where available) if vehicles and services are not accessible, and many streets/footpaths have not been well-constructed and maintained for people in wheelchairs and with physical impairments. Disabled people also tend to have lower incomes than average.

Māori also tend to experience more transport inequities than other New Zealanders because they have lower incomes on average. They are also more likely to have an impairment at younger ages than other ethnicities. Many Māori people live and work in areas that are not well served by public transport.

Other groups of people who often experience transport disadvantages include children, solo mothers, and elderly people.[101]

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100 See for example Social Exclusion Unit. (2003). *Making the connections: final report on transport and social exclusion.* http://www.socialexclusionunit.gov.uk/publications/reports/html/transportfinal/summary and Mackett, R, & Thoreau, R (2015), *Transport, social exclusion and health*. Journal of Transport & Health 2 (2015) 610–617.

101 Rosier, K, McDonald, M. (2011). *The relationship between transport and disadvantage in Australia*. Australia: Australian Institute of Family Studies.

There are opportunities to reduce transport disadvantages during the transition, particularly in urban areas

Initiatives to provide people with better transport options, and to increase affordable housing close to jobs and amenities, will help to reduce transport disadvantages while also reducing emissions.

Public transport can play a particularly valuable role in reducing transport disadvantages. Improvements to the reach and frequency of public transport services (along with changes in urban form that support this) could make our transport system more accessible and inclusive, especially if services are significantly improved in socially deprived areas (where suitable). It is not always possible for people to use public transport to get to where they want to go, when they want to travel, even where frequent services exist. However, public transport services can provide a useful substitute for many trips, particularly for getting to and from work in some urban areas. In addition to improving public transport services, Government could also consider targeting public transport concessions at a wider-range of New Zealanders so that people on low-incomes and/or with an impairment can travel on public transport for less.

Urban cycle networks could also help to reduce transport disadvantages, by providing people with another low-cost travel option. Improvements to footpaths and intersections to give more priority to people walking and wheeling would also benefit a wide range of people, including disabled people, children, and elderly people.

A shift to low carbon transport modes will also help to reduce air and noise pollutants, and encourage more active travel. This will deliver better health outcomes, including for many low income households.

Under the Housing portfolio there is a significant amount of work to enable Māori to deliver on their own housing aspirations and to work in partnership to do this. Iwi and Māori aspirations include development on whenua, ability to develop papakāinga and the need for infrastructure to support this, often in areas that are rural. The transport sector will need to consider how it can support these aspirations in a way that enables communities to thrive and is consistent with Aotearoa's low emissions goals.

People living in outer-urban and rural/remote areas are less likely to benefit during the initial phases of the transition

The benefits outlined above are most likely to be experienced in urban areas, particularly places close to urban centres, where it is easier to provide people with access to a good range of travel options. People living in remote/rural areas, or on a city's fringe, usually have poor travel options other than using a car. Many low-income households live in these areas, where housing costs are cheaper compared to urban centres. It is usually not viable to provide frequent public transport services in these areas due to the low population densities. It can also be difficult for people to walk or bike to places for work, healthcare, education, amenities, and places of cultural importance due to the long travel distances involved.

In some urban areas where frequent public transport services are not viable, integrated walking and cycling networks could help to put public transport within reach of neighbourhoods. In more dispersed areas, it could be possible to improve shared mobility options such as on-demand shuttles. Some communities already run shared shuttles to transport members of their communities to and from health services, marae, and local amenities. There could be opportunities for Government to support more of these services. It may also be possible to improve access to goods and services remotely, or via deliveries and/or mobile services, so that transport is not a barrier to affordable goods and services.

This discussion also reinforces the importance of creating quality compact mixed-use urban developments that includes options for affordable housing. Currently, many low-income households are forced to live in car-dependent areas with poor transport options. This can perpetuate inequities over time, as high transport costs reduce overall household incomes and savings.

There are risks that transport poverty could rise with some initiatives, unless government addresses the needs of disadvantaged groups during policy development

Government interventions that increase the cost of using vehicles, such as road pricing mechanisms, could have a disproportionate impact on low-income households who rely heavily on using a car. Government is already considering potential ways to mitigate the impacts of road pricing through its *Congestion Question* project.

Interventions that increase the cost of using fossil fuels could also increase transport poverty. This dynamic already occurs when fuel prices rise at the pump (due to government levies and/or rising international oil prices).

Low-income households will face higher travel costs if it costs more for them to purchase a vehicle. However, there will still be plenty of affordable used ICE vehicles available in Aotearoa over the next decade at least (and likely well beyond this). Even if imports of ICE vehicles are phased out in the 2030s, there will still be many ICE vehicles available domestically over the following decade – especially as more households, businesses, and government agencies shift to cleaner vehicles, or decide that they do not need to own so many cars due to better alternatives, and sell their previous vehicles.

While low-income groups will not necessarily face higher costs to purchase ICE vehicles, they do currently face financial barriers for shifting to cleaner vehicles. Government should consider ways to support more affordable access to cleaner vehicles for lower-income groups so that more people can benefit from the transition, especially in the short-term. Potential options include social leasing schemes, vehicle sharing schemes, and low-interest finance schemes.

As the supply of new and used electric vehicles in Aotearoa increases over time, cleaner vehicles will become more affordable. Initiatives to accelerate the uptake of EVs in Aotearoa over the next few years will therefore help to grow the market for more affordable used EVs in the future.

The shift to cleaner vehicles will reduce transport poverty longer-term

Low-income households in car-dependent areas are vulnerable to the impacts of fluctuating oil prices and higher petrol prices. Unexpected break-downs and maintenance of vehicles can also put severe strain on household budgets.

EVs, in comparison to ICE vehicles, are cheaper to operate. They have lower maintenance requirements. Charging costs are also more stable and predictable than petrol costs, as retail electricity prices in Aotearoa tend to change slowly over time. Aotearoa also has an abundance of renewable energy sources to generate more electricity as demand increases.

Eventually, the shift from ICE vehicles to electric vehicles will therefore lead to lower and more stable transport costs for most households and communities, including low-income groups.

Transport levers alone will not be able to mitigate all of the inequities in the transport system

While there are many opportunities to reduce transport disadvantages by providing people with better transport options, and to avoid increasing transport poverty by mitigating the impacts of some interventions, it is also important to look beyond the transport system to make a Just Transition.

Broader interventions (e.g. in the social welfare/education/health sectors) that could also be considered to reduce transport disadvantages and transport poverty include:

- locating social housing in urban areas within walking and cycling distance of jobs, shops, and schools, and in areas well-served by frequent public transport services
- making school bus services (procured by the Ministry of Education) available for more students in remote/rural areas
- broader initiatives to reduce poverty and increase household income for low-income people.

Consultation question 12
A Just Transition for all of Aotearoa will be important as we transition to net zero. Are there other impacts that we have not identified?

Chapter 10: Four potential pathways – What could it take to meet a zero carbon by 2050 target for transport?

In Chapters 5 to 8, we discussed a broad range of opportunities to reduce GHG emissions from the transport system. We grouped these opportunities into three themes: 'Changing the way we travel', 'Improving our passenger vehicles', and 'Supporting a more efficient freight system'. In this chapter, we explore what it could take to meet a zero carbon target for the transport system by 2050.

Pathways to zero carbon by 2050

We have modelled four pathways for reducing transport emissions

All four 'pathways' outline how a combination of initiatives (Table 2) could reduce transport GHG emissions to almost zero by 2050. We have drawn these initiatives from across the three themes covered in the previous chapters, as it will not be possible to reach a zero carbon target without progress across the whole system. The estimated outcomes of these pathways are compared with the Ministry's base case[102] (see Chapter 2).

Table 2. Pathway initiatives by theme

The model includes the following initiatives	
Theme 1	Land-user changes; public transport improvements and pricing (including parking, congestion and distance-based pricing).
Theme 2	Phasing out the importation of ICE light vehicles by 2035; banning the use of all ICE light vehicles in 2050; adoption of biofuels in light vehicles and buses and electrifying the PT bus fleet by 2035.
Theme 3	Energy saving and logistic improvements (such as freight routes optimisation; freight consolidation and improved last mile efficiency); mode-shift from road freight to rail and to coastal shipping; adoption of biofuels for road freight and accelerating uptake of electric medium trucks.

Pathway 4 was developed following the release of the Climate Change Commission's draft advice. It seeks to achieve the Climate Change Commission's draft recommendation of a 47 percent reduction (relative to 2018) in transport emissions by 2035.

[102] The Ministry's base case includes the Clean Car Standard and Clean Car Discount.

Why do these pathways aim for zero carbon, rather than *net* zero carbon?

While the Government has committed to reducing all GHG emissions (excluding biogenic methane) to net zero by 2050, it is still unclear to what extent carbon offsetting will help to achieve this target. This means that we do not know the extent to which we may or may not be able to offset Aotearoa's transport emissions going forward. Other sectors in Aotearoa may find it harder or take longer to reduce emissions in comparison to transport, and therefore may be prioritised over transport when it comes to carbon offsetting. Given this uncertainty, these pathways explore what could be required to take us as close to zero transport GHG emissions as possible. We acknowledge that absolute zero would be very difficult to achieve by 2050.

The pathways place a different weight on avoid, shift and improve initiatives

In all pathways, electrification of the vehicle fleet is important to achieve as close to zero carbon as possible by 2050. Where these pathways differ is the relative weight given to 'avoid', 'shift' and 'improve' initiatives within each theme (see Figure 8).

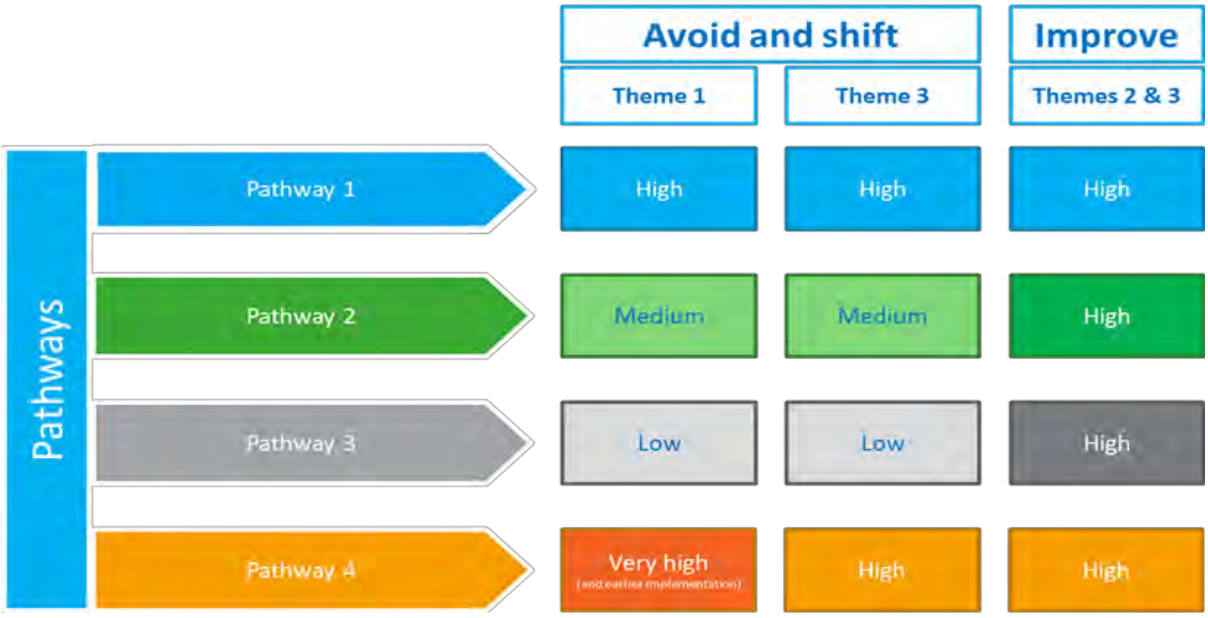

Figure 8. Relative weight given to avoid, shift, and improve interventions in each pathway

- **Pathway 1** assumes 'avoid' and 'shift' initiatives (Theme 1) play a significant role in reducing transport GHG emissions. This pathway requires reducing nearly 30 percent of the light vehicle kilometres travelled by 2050 through reducing trip distances and encouraging mode shift to public transport, walking and cycling. It also requires higher mode-shift from road to rail and coastal shipping.

- **Pathway 2** assumes 'improve' initiatives (Theme 2) play a significant role in reducing emissions than Pathway 1. This pathway requires a larger number of electric vehicles with greater use of biofuels in the short to medium terms. There is also emphasis on 'improve' initiatives for freight.

- **Pathway 3** assumes 'improve' initiatives (Theme 2) play a more significant role in reducing emissions than the other pathways. In this pathway, bringing more EVs into New Zealand transport system compensates for the limited avoid and shift changes. There is also much more emphasis on 'improve' initiatives in freight.

- **Pathway 4** gives even stronger weight to 'avoid' and 'shift' initiatives (Theme 1) than all other pathways. This includes assuming that 'avoid' and 'shift' interventions happen more swiftly, bringing forward their impact on emissions and that the clean car policies will be very successful in accelerating the uptake of electric vehicles. This pathway requires reducing nearly 40 percent of the light vehicle kilometres travelled by 2035 and over 55 percent by 2050. In the long term, the greater impact of 'avoid' and 'shift' initiatives reduces the number of vehicles that need to be electrified.

The pathways with more emphasis on 'avoid' and 'shift', such as Pathway 1 and 4 are more effective at reducing emissions (Figure 9). Avoiding activities that produce emissions is, on balance, a more effective strategy than minimising the emissions from those activities.

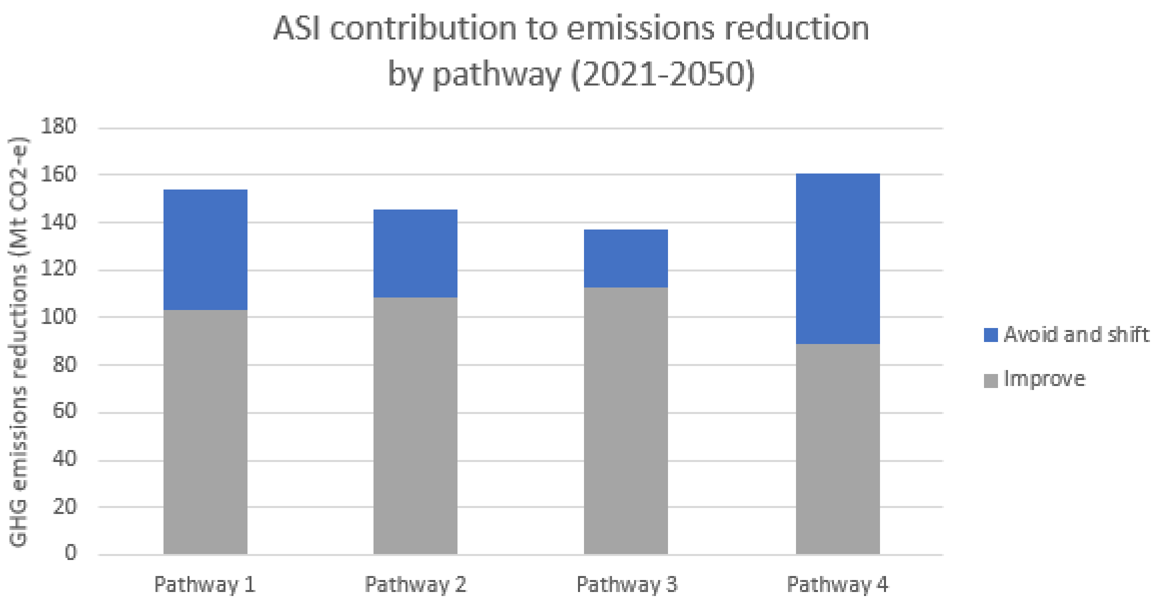

Figure 9. Avoid, shift, and improve contribution to emission reduction by pathway

Compared to the Commission's draft pathway to 2035, the level of reduction in distance travel in Pathway 4 is a lot higher (39 percent versus 14 percent) due to a much higher level of electrification in the Commission's estimates (1.9 million light vehicles and around 22,000 heavy vehicles compared to less than 0.8 million light and heavy vehicles combined in Pathway 4).

Appendix B outlines the assumptions behind the modelling of these pathways.

Potential impact of pathways on transport GHG emissions

Figure 10 shows the impact of each pathway on emissions out to 2050. Table 3 outlines how each pathway impacts on different aspects of the transport system by theme.

The baseline projections for Pathway 4 are different from the other pathways because it assumed the clean car policies are very effective in accelerating the uptake of low emissions vehicles due to relaxing the supply constraint assumption in this pathway.

There are multiple pathways Aotearoa could take to achieve a zero carbon transport system by 2050

The four pathways illustrate that there are different strategies we can take to reduce transport GHG emissions, which include changing the relative weight given to initiatives within each theme. However, given the scale of the challenge, and the limited time available, we need to take advantage of the opportunities to reduce emissions across the whole transport system. Meeting a zero carbon target by 2050 requires a major transformation of the transport system. Currently, our modelling suggests Pathway 1 would come the closest to **realistically** meeting the level of GHG emissions required. In contrast, Pathway 4 comes closest to the target set down in the Commission’s draft advice, but makes bold assumptions to get there.

These pathways are not limited to current Government policies or commitments

The Government has not considered all of the potential interventions covered by *Hīkina te Kohupara*, which go beyond current policy commitments and initiatives.

These pathways therefore aim to provoke thinking about what it ***could*** take to transition to a zero carbon transport system. They do not capture the only paths that we could take. They simply illustrate the scale of changes to reach the target, and the need to lean more heavily on some options for reducing emissions if we do not make progress in other areas.

Our actual pathway will look different

Our pathway to a zero carbon transport system will be shaped by the actions of government, civil society, businesses, and consumers over the next three decades. Actions in the next five years will significantly shape this future pathway, and determine how close we get to, or stray away from, a zero carbon target.

The pathways in this chapter are based on current available evidence, and assumptions about the future. As the future is uncertain, our ability to reduce transport GHG emissions could become harder or easier depending on how it unfolds. Critical uncertainties which could affect our ability to reduce transport GHG emissions are discussed towards the end of this chapter

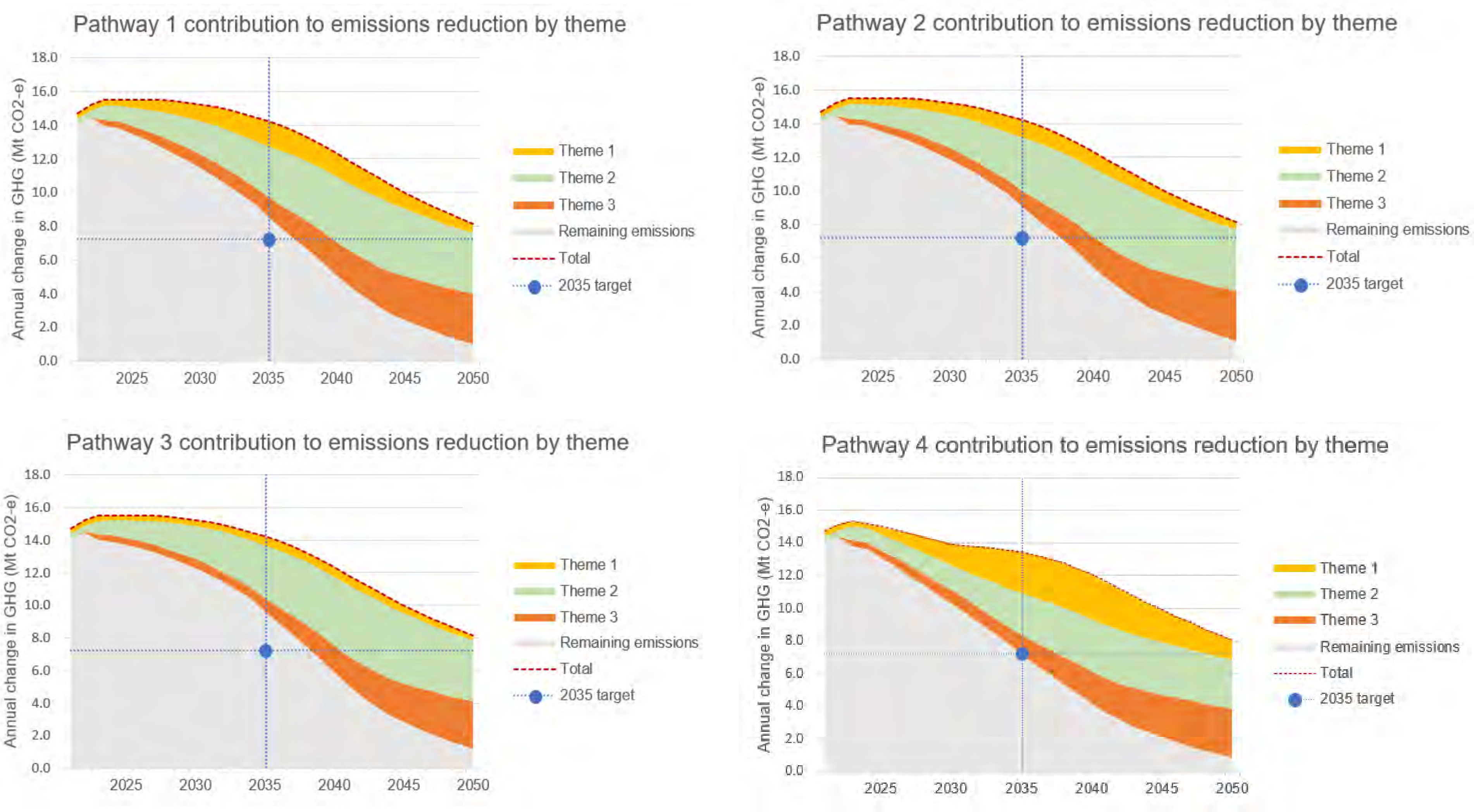

Figure 10. Pathways - Contribution to transport emissions reduction by theme

Hīkina te Kohupara Pathways – Key summary

Table 3. Summary of impact of each pathway on different themes

<table>
<tr><th></th><th>Measure</th><th colspan="2">Pathway 1</th><th colspan="2">Pathway 2</th><th colspan="2">Pathway 3</th><th colspan="2">Pathway 4</th><th colspan="2">CCC's pathway 2035</th></tr>
<tr><td colspan="12">Percentage reduction in transport GHG emission achieved (relative to 2018)</td></tr>
<tr><td></td><td>By 2035</td><td colspan="2">41%</td><td colspan="2">37%</td><td colspan="2">34%</td><td colspan="2">47%</td><td colspan="2">47%</td></tr>
<tr><td colspan="12">Percentage reduction in road transport GHG emission achieved (relative to HtK baseline) (rounded to nearest 5%)</td></tr>
<tr><td rowspan="2"></td><td>By 2035</td><td colspan="2">Approx. 40%</td><td colspan="2">Approx. 35%</td><td colspan="2">Approx. 30%</td><td colspan="2">Approx. 45%</td><td colspan="2" rowspan="2">n/a</td></tr>
<tr><td>By 2050</td><td colspan="2">Approx. 90%</td><td colspan="2">Approx. 85%</td><td colspan="2">Approx. 85%</td><td colspan="2">Approx. 90%</td></tr>
<tr><td rowspan="2">Theme 1</td><td colspan="11">Reduction in light vehicle distance travel (combined effects)</td></tr>
<tr><td>By 2035
By 2050</td><td colspan="2">Approx. 20%
Approx. 29%</td><td colspan="2">Approx. 13%
Approx. 17%</td><td colspan="2">Approx. 6%
Approx. 8%</td><td colspan="2">Approx. 39%
Approx. 57%</td><td colspan="2">14%
n/a</td></tr>
<tr><td rowspan="9">Theme 2</td><td colspan="11">Number and share of the light vehicle fleet transitioned to electric</td></tr>
<tr><td>By 2035
By 2050</td><td>670,000
3.2 m</td><td>20%
90%</td><td>730,000
3.7m</td><td>20%
90%</td><td>790,000
4.1 m</td><td>20%
90%</td><td>758,000
2 m</td><td>27%
94%</td><td>1.9 m
n/a</td><td>41%
n/a</td></tr>
<tr><td colspan="9">Increase in public transport bus fleet</td><td colspan="2">All buses</td></tr>
<tr><td>By 2035
By 2050</td><td colspan="2">+10,300
+16,900</td><td colspan="2">+6,900
+10,000</td><td colspan="2">+3,100
+4,600</td><td colspan="2">+17,200
+28,300</td><td colspan="2">+3,800
n/a</td></tr>
<tr><td colspan="9">Share of public transport buses that are electric</td><td colspan="2">All buses</td></tr>
<tr><td>By 2035
By 2050</td><td colspan="2">97%
100%</td><td colspan="2">97%
100%</td><td colspan="2">97%
100%</td><td colspan="2">97%
100%</td><td colspan="2">80%
n/a</td></tr>
<tr><td colspan="11">Number of vehicles using biofuels (up to 100% by 2050)</td></tr>
<tr><td>Light vehicles in 2035
Light vehicles in 2050</td><td colspan="2">3.1 m
290,000</td><td colspan="2">3.3 m
340,000</td><td colspan="2">3.6 m
370,000</td><td colspan="2">2.1 m
126,000</td><td colspan="2">n/a
n/a</td></tr>
<tr><td>Buses in 2034
Buses In 2050</td><td colspan="2">400
0</td><td colspan="2">300
0</td><td colspan="2">200
0</td><td colspan="2">600
0</td><td colspan="2">n/a
n/a</td></tr>
<tr><td rowspan="2">Theme 3</td><td colspan="9">Medium trucks transitioned to electric (share of fleet in brackets)</td><td colspan="2"></td></tr>
<tr><td>By 2035
By 2050</td><td>3,200
22,000</td><td>4%
25%</td><td>3,200
22,000</td><td>4%
25%</td><td>3,200
22,000</td><td>4%
25%</td><td>3,200
22,000</td><td>4%
25%</td><td>21,500
n/a</td><td>16%
n/a</td></tr>
</table>

	Number and share of medium and heavy trucks using biofuels (up to 100% by 2050)										
	Medium trucks in 2050	66,000		66,000		66,000		66,000		n/a	
	Heavy trucks in 2050	47,000		54,000		61,000		47,000		n/a	
	Assumed modal shift from heavy trucks to rail and coastal shipping										
		Rail	Ship	Rail	Ship	Rail	Ship	Rail	Ship	Rail	Ship
	By 2035	12.5%	7.5%	7.5%	3.5%	3.5%	10%	12.5%	7.5%	7.5%	7%
	By 2050	20%	15%	15%	10%	3.5%	5%	20%	15%	n/a	n/a

- n/a – not available

Policy implications from the pathways chosen in Hīkina te Kohupara

The pathways in this chapter clearly illustrate that deep and widespread changes will be required to reach a zero carbon target for the transport sector by 2050.

To inform thinking on which opportunities the government should pursue, this section highlights policy implications that became evident while modelling the different pathways and through research for *Hīkina te Kohupara*. It identifies implications for the **short-term** (up to five years), **medium-term** (five to 15 years), and **long-term** (15 years plus).

Policy implications from Theme 1 ‘Changing the way we travel’

Quality compact, mixed use urban development and placemaking

- The government should pursue urban development and land use changes that support emissions reductions from transport as soon as possible. Our cities and towns will only realise the full benefits of changes to urban development and land-use planning over the long term (see appendix B for more details on how land use contributes to VKT increases over time). An early start will bring the bigger benefits forward and avoid locking in further transport GHG emissions from unnecessary urban sprawl and car dependency.

- Government needs to deliberately shape urban form for low emissions options. This means prioritising investments in public transport, walking, and cycling over urban state highway/road expansion. The opposite would continue to encourage travel and emissions from private motorised vehicles. This also means that central and local government have to reconsider planned investments in major urban highway and roadway expansion projects if they would induce more vehicle travel.

- Government needs to build on recent policy initiatives, such as the National Policy Statement on Urban Development (NPS-UD), to support quality compact, mixed use urban development. In the short term, the planned reforms to the Resource Management Act 1991 (RMA) offer a critical opportunity to further support this, through stronger integration of urban development, land-use and transport planning.

- Street changes will be crucial to support higher-density living and transport by way of walking, wheeling, cycling, shared mobility and public transport. The Government should explore whether institutional changes are required to accelerate street changes.

Public transport, walking, cycling and shared mobility

- The pathways that make the most difference to emissions reduction involve significant policy interventions and infrastructure investments in public transport, walking, and cycling in both the short and medium term.

- A 'quick win' for mode shift would be to prioritise implementing Waka Kotahi and local government's mode-shift plans for New Zealand's high-growth areas.[103] Although these mode-shift plans were developed primarily to improve access outcomes, they are likely to also reduce emissions resulting from mode-shift. Revisiting these plans to ensure they are designed to also target transport GHG emission reductions will help maximise results.

- As discussed in earlier chapters, it is necessary to consider other changes to increase the uptake of public transport, walking and cycling.

- We did not model the potential for shared mobility incentives (e.g. car sharing, bike sharing, and scooter sharing schemes) to reduce transport emissions.

Transport pricing

- Pricing mechanisms can help us to make the most out of land-use changes and public transport investments. They can encourage mode-shift and address any rebound effects that result from investing in public transport, walking and cycling (such as induced car travel from reduced congestion). The pathways in this chapter all modelled the introduction of congestion pricing, parking pricing, and VKT distance pricing in 2025 (see appendix B for more details).

- Distance and congestion pricing both require substantial changes to the transport revenue and funding system – but could piggyback on upcoming changes. The government has the opportunity to consider what our land transport revenue system needs to be for the future. Further investigation is needed to understand whether his new system could be used as a way to apply distance and congestion pricing.

- Although pricing mechanisms can be a powerful lever for change, the Government needs to consider the distributional impacts of these mechanisms. Pricing mechanisms can make driving more expensive relative to other transport options and this is likely to be more burdensome for low income households. Investigation will be needed to assess how the benefits and burdens of pricing schemes, alongside the land use and public transport improvements affect different groups. Some of this work is already available for the potential impacts of introducing congestion pricing in Auckland.[104]

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[103] Waka Kotahi *Keeping Cities Moving* https://www.nzta.govt.nz/assets/resources/keeping-cities-moving/Keeping-cities-moving.pdf

[104] The Ministry of Transport. The Congestion Question. Retrieved from: https://www.transport.govt.nz/area-of-interest/auckland/the-congestion-question/

Policy implications of Theme 2 'Improving our passenger vehicles'

Decarbonising light vehicles

- A much larger number of zero emissions vehicles will be needed if we do not avoid/shift emissions by changing the way we travel. For example, Pathway 3 requires 2.3 million more electric vehicles compared to Pathway 4 by 2050.
- In all four pathways, decarbonising the light vehicle fleet will be critical for reaching a zero carbon target by 2050. This requires a rapid transition that will not be achievable without significant government intervention. Policies and actions are needed in the short-term to accelerate the uptake of low emission vehicles, and provide clear signals to individuals and businesses, allowing them more time to transition.
- In the short term, the Government is planning to introduce a fuel efficiency standard (the Clean Car Standard) to increase the supply of cleaner vehicles. This standard will need to become progressively more stringent, leading to an eventual phase out of fossil fuel vehicle imports in the medium term.
- In the short and medium term, the Government can encourage the uptake of low emission vehicles by helping to address their high upfront costs. For example, a 'fee-bate' scheme (a Clean Car Discount) could make low emission vehicles more affordable, and provide a disincentive to purchase high emitting vehicles at the same time. The Government could also increase investments in infrastructure such as electric vehicle charging stations.
- Additional measures and incentives to accelerate the uptake of electric vehicles should also be considered. The model assumes there will be an increase in vehicle imports from 2040, resulting in an extra 100 thousand EV imports each year until 2050. This is unlikely to occur without any measures or incentives.
- Imports of ICE vehicles would need to be phased out between 2030 and 2035 to meet a zero carbon transport target in 2050. This is because New Zealanders hold on to their cars for a long time, on average 19-20 years. Alternatively, we would need measures to exit ICE vehicles from the fleet. Our model was based on phasing out ICE imports by 2035. As with many other opportunities identified in *Hīkina te Kohupara*, these are not currently government policy.
- The Government can also support the uptake of electric vehicles through its own procurement practices. The Government is already planning to transition the government fleet to zero emissions vehicles.
- To address emissions in the existing fleet, the Government needs to consider increasing the uptake of bioethanol. For all the pathways in this chapter, the model was based on running the existing ICE light vehicle fleet on a 10 percent bioethanol blend from 2023. This would require government intervention in the short term to ensure this level of uptake (for example, through a biofuel mandate). We would also need to ensure adequate bioethanol supply in Aotearoa.

Decarbonising public transport

- Public transport bus fleets account for about one percent of our total transport GHG emissions. Government has already committed to decarbonise bus fleets, which will reduce these emissions.

Decarbonising aviation

- Domestic aviation emissions are not included in the model, and international aviation emissions are not specifically within the scope of *Hīkina te Kohupara*. Domestic aviation emissions account for just over six percent of our total transport GHG emissions.
- Sustainable aviation fuel has the most potential to reduce aviation emissions in the short to medium term. The Government needs to keep working with the aviation industry to investigate its potential in Aotearoa.
- Electric planes may be viable for reducing short-haul air travel emissions.

Policy implications of Theme 3 'Supporting a more efficient freight system'

Optimising freight routes, equipment and vehicles

- The freight sector already has financial incentives to move freight in an economically efficient way. However, there may be some opportunity to further improve freight efficiency and further reduce emissions. This could be through rerouting, consolidation, last mile efficiency, logistics improvements, driving training etc.
- It is unclear how much potential there is for the Government to support 'avoid' type initiatives (other than measures that increase fuel or transport costs), but the Government could investigate these opportunities further in the medium term.

Shifting road freight to rail and coastal shipping

- There is a clear opportunity for the Government to support shifts from road freight to rail and coastal shipping.
- Our pathways modelled how much emissions would fall if 10 to 20 percent of road freight shifted to rail, and five to 15 percent shifted to coastal shipping, by 2050. Further work is needed to explore whether mode shifts of this scale could be practically achievable.
- The New Zealand Rail Plan sets out the Government's vision and priorities for rail until 2030, and the level of investment needed to achieve a reliable, resilient and safe rail network.
- In the short term, the Government can implement the New Zealand Rail Plan and the coastal shipping activity class in the GPS to support freight mode shift. These initiatives will support mode shifts, but not of the magnitude of 15-20 percent. Further work would be needed to identify opportunities for supporting a larger scale of mode shift.

Cleaner trucks

- Decarbonising trucks will be critical for achieving a zero carbon transport system, and would have the largest impact on reducing emissions from freight.
- Our pathways modelled the potential to reduce transport GHG emissions from biofuels for both medium and heavy trucks, and electrification for medium trucks. Hydrogen-fuelled and additional electric trucks could potentially play an important role in the future.
- Biofuels could potentially play a major role in decarbonising trucks. Our pathways modelled the truck fleet running on a 10 percent biofuel blend from 2023, and renewable

diesel being added to the fuel supply from 2035. By 2050, road freight could be decarbonised if all diesel trucks ran on a blend of 10 percent conventional biofuel and 90 percent drop-in renewable diesel. As with light vehicles, this transition would require significant government intervention.

- In the short term, the best opportunity for the Government to reduce emission from trucks is to introduce a fuel efficiency standard for trucks and a biofuel mandate. As with light vehicles, these standards will need to ramp up over time. There is currently a limited amount of biofuel available in New Zealand, so the Government may want to investigate supporting a domestic biofuel industry.
- In the medium term, the Government could introduce a carbon intensity standard, which is fuel agnostic (e.g. it could also apply to hydrogen fuel) and would require more time to implement than a biofuel mandate.
- Alongside these policies, the Government could also increase the funding available to accelerate the uptake of zero and low emission (electric/hydrogen) trucks. It could also consider targeted investments in infrastructure for green fuels and for fast-charging heavy vehicles. In addition, it could consider setting fuel economy standards and minimum entry requirements for trucks.

Cleaner rail

- We did not explicitly model rail GHG emissions in our pathways, but accounted for increases in rail emissions due to mode shift. Rail emissions account for just over one percent of our total transport emissions, and could rise with increased freight movements.
- Electrification of our rail system or the use of biofuels could potentially reduce rail emissions in the longer term.

Cleaner ships

- Emissions from domestic maritime activities were not modelled in our pathways. (International maritime emissions are not within the scope of *Hīkina te Kohupara*).
- Domestic maritime emissions account for just over three percent of our total transport GHG emissions, and could rise with increased freight movements. In the medium to long term, the Government could work with the maritime industry to investigate options to decarbonise shipping fleets.

Investment costs

Decarbonising our transport system through influencing energy and travel choices and demand would require substantial and sustained investment but, more importantly, such investment will need to commence soon.

We can classify the investment required into four broad categories:

- *Growth enabling* – this includes basic infrastructure expansion to manage population and economic growth and additional investment to change demand.
- *Mode choice provision* – this includes investment in sustainable transport choices to manage demand.

- *Pricing systems* – this includes parking pricing and a distance based charging system to replace the current system that is tied to petrol use and other additional pricing strategies to manage demand during specific times and locations or by different vehicle types.

- *Energy infrastructure* – this includes electricity system and grid upgrade, additional renewable energy production plants and alternate energy refilling/charging infrastructure (including biofuel, electricity and hydrogen).

Growth enabling

As the population grows, the level of transport and non-transport infrastructure investment needed would also increase simply to maintain and manage demand. Existing regional mode shift plans that are sought to be delivered through GPS2021 is unlikely to deliver the level of mode shift required to decarbonise road transport. In addition, the need to address other transport outcomes means the scope for re-prioritisation of the National Land Transport Fund may be somewhat constrained. The size of the additional investment required can vary depending on the pathway chosen. For example:

- Pathway 1 would require investment in high density residential areas and development of liveable cityscapes
- Pathway 2 would require similar but a lower level of investment as for Pathway 1
- Pathway 3 would require additional roading investment to manage traffic growth
- Pathway 4 would require significant investment in transport infrastructure and medium to high-density residential areas, as well as swift policy action in these areas.

The cost of urban and residential housing development depends on location and the size of the development. Although the one-off investment is high, the average cost per unit in a dense residential housing build is likely to be lower than a townhouse or low-rise apartment. Increasing the density of residential areas can result in a higher reduction in carbon emissions due to reduced travel needs. However, such investment tends to take a longer time to plan and develop and the emissions savings are not immediately recognised.

Mode choice provision

Roading improvements alone cannot achieve meaningful change in travel demand because improved conditions tend to attract new traffic and are likely to increase carbon emissions. Achieving the level of modal shift to decarbonise transport demand requires increasing mode choice provision and influencing demand with supporting policies (e.g. pricing). Pathway 4 would require the most investment in public transit, shared mobility and active modes, followed by pathway 1, 2 and the least for pathway 3.

Land use and urban development investment varies significantly between regions, project and investment types. For example, according to the National Land Transport Programme and New Zealand Upgrade Programme, road corridor improvements on State highway 20B to add bus and high occupancy vehicle lanes and bus interchange cost around $70 million, whereas adding two new railway stations, park and ride facilities at Drury cost $247 million. On the other hand, early information from Auckland and Canterbury indicates switching the diesel bus fleet to electric could cost an additional $120,000 to $240,000 per medium and large bus, after considering energy cost savings and charging infrastructure, electricity system and grid upgrade cost.[105]

Pricing system

To influence modal shift behaviour, car users need to consider the true costs of travel in accordance with the level of use.

There would be minimal difference in the level of investment between pathways for distance-based pricing. Irrespective of the pathway chosen and as the vehicle fleet electrifies, the government needs to explore an alternate road use pricing regime (e.g. distance based pricing) to replace the current fuel excise duty that raises revenue for transport infrastructure investment, maintenance and operation purposes.

An initial investigation of switching to basic electronic distance-based charging would cost $50 million for system design and setting up appropriate enforcement infrastructure and equipment plus $800 million for equipping the vehicle fleet with Global Navigation Satellite System enabled on-board units. These costs are highly indicative and exclude on-going costs associated with data analytics, maintenance and operation.

For managing congestion and peak demand, the pricing system would need to be capable of applying time and place-based pricing. It may be possible to incorporate this in a distance-based pricing system.

Smart parking pricing could be considered to manage demand for car travel before and in addition to the implementation of road use pricing regime. A Ministry study[106] shows that the majority of all car trips are not charged for parking at destinations (e.g. at shopping malls and other on-street parking). Such a pricing mechanism would require minimal infrastructure investment.

Energy infrastructure

Renewable energy generation will need to increase to meet transport needs in all pathways. The level of investment would be the lowest for Pathway 4, which achieves a high level of behavioural changes that reduce or meet travel needs through better land use and transport planning or more energy efficient modes. Pathway 3, on the other hand, would incur the highest level of energy generation and system costs to meet growing car-dependent transport demand.

Energy generation infrastructure includes biofuel production plants, renewable electricity generations and grid upgrade and, the potential production and distribution system of hydrogen. According to a 2018 report by Scion, total capital investment to achieve a 30 percent substitution of biofuels use in transport was estimated at between $6 and $6.8 billion. On the other hand, increasing the production of renewable electricity could cost

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[105] There are currently around 13,000 public and private buses in operation in New Zealand, including some 2,600 public buses. By 2030, the total bus fleet could increase to over 16,700. With the current cost premium estimates, electrifying the entire bus fleet by 2030 could cost $3 billion. This is equivalent to around 7 percent of the total expenditure target of the National Land Transport Programme or one-tenth of the expenditure of the Auckland Transport Alignment Project, over the same time period. However, this cost premium is likely to reduce over time as technology develops.

[106] Draft Domestic Transport Costs and Charges report on Car Parking, Ministry of Transport, 2021

between $8 and $12 billion.[107] In addition, private and public investment in infrastructure and equipment for charging electric vehicles could cost between $5 and $9 billion.

In addition to the public sector investment cost discussed above, there would also be additional capital expenditure to private vehicle owners from switching to electric vehicles as they currently attract a price premium. This cost is likely to reduce over time as the price for electric vehicles and ICE vehicles reach parity in the next decade. However, there will be substantial savings to vehicle owners in energy cost.

Total investment costs for the pathways

The following table provides a high-level indication of potential investment costs for the four pathways. While additional data collection and research is needed to put a number on these potential costs, the investment cost will be substantial irrespective of the pathway chosen. Given the kind of infrastructure investment needed has a long lead time to plan, develop and build, it is necessary to commence related planning activities in the near term to ensure infrastructure is ready for the shift or transformation needed.

Table 4. Indicative relative investment requirements

	Pathway 1	Pathway 2	Pathway 3	Pathway 4
Urban design and development *Better land use and transport planning*	Vary with interventions and locations	Vary with interventions and locations	Vary with interventions and locations	Vary with interventions and locations. Early implementation needed
Transport infrastructure *Manage growth and investment in sustainable transport choices*	$$	$$$	$$$	$$
Transport pricing systems *To achieve mode shift, dis-incentivise discretionary travel and manage rebound effects from improvements*	$	$	$	$ Early implementation needed
Energy infrastructure *Electricity system, grid update and charging infrastructure*	$	$$	$$	$
Electric vehicle and private charging equipment	$	$$	$$	$
Alternative energy source *Infrastructure investment*	$$	$$	$$$	$$

Indicative scale (comparison investment between pathways): $ = lowest; $$ = moderate; $$$ = highest

107 Source: Concept Consulting (2018), Driving change – Issues and options to maximise the opportunities from large-scale electric vehicle uptake in New Zealand, Prepared for Orion, Unison, and Powerco.

Critical uncertainties

Future pathways are always based on assumptions about what could happen in the future, and how effective our actions could be in making changes. Modelling is always limited by the availability of current knowledge. Aotearoa will not neatly follow any of the pathways discussed above. The value of these pathways is that they highlight the long-term implications of forging different pathways, and the scale of challenges and opportunities that we face.

The pace and scale of transport GHG emissions reductions will be affected by a range of drivers within, and beyond, the transport sector. This section highlights critical uncertainties that could slow us down and hinder our ability to achieve a zero carbon transport system, as well as speed up, and help us to achieve this quicker than projected in the pathways above.

These headwinds and tailwinds are summarised in seven categories: technologies; availability and cost of alternative fuels; the social mandate for change; economic shocks; global dynamics; unanticipated changes in travel demand; and population growth.

Vehicle technologies

New and adapted technologies have always driven major changes in the transport sector. Over the next thirty years, the transport technology that is most likely to drive emissions reductions is the electrification of vehicles. In our pathways, we assumed that the purchase price of electric vehicles will continue to decrease, battery ranges will keep growing, and more vehicle models will quickly become available in Aotearoa.

If the purchase price parity point for electric vehicles (relative to ICE vehicles) happens before the mid-2020s, this would help to accelerate emissions reductions in Aotearoa. On the other hand, if the price of electric vehicles does not come down as quickly as anticipated, or if the variety of electric vehicle models does not expand quickly enough to meet consumer demands, this may slow down the uptake of electric vehicles.

The price of electric vehicles is significantly affected by battery costs. Vehicle costs may not decrease quickly if battery advances primarily lead to higher capacity batteries that enable greater range (rather than simply lower costs). Battery costs could also be affected by supply constraints in the materials used to manufacture batteries, and global manufacturing capacity, as global demand for electric vehicles increases.

We also anticipate increasing automation of vehicles in coming decades. This will initially involve vehicles becoming ‘smarter’ and safer, rather than becoming completely driverless (although driverless vehicles are already used for public transport globally). We have not modelled the potential impact of fully automated vehicles in our pathways. Previous work by the government has explored the potential impacts of fully automated vehicles on urban form and vehicle travel.[108] Fleets of fully automated vehicles could help to accelerate emissions reductions if they are fully electric, and if they help to drive lower vehicle ownership. However, fully automated vehicles could also encourage urban sprawl and higher vehicle travel. This would work against emissions reductions.

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108 Ministry of Transport. Investigating the future of public transport. Retrieved from: https://www.transport.govt.nz/area-of-interest/strategy-and-direction/public-transport-2045/

Availability and cost of alternative fuels, particularly for freight

In addition to electric vehicles, biofuels and hydrogen both offer potential for decarbonising the transport system, particularly for freight. Biofuel is commonly used internationally, while hydrogen is at an earlier stage of development.

If major advances are made in drop-in renewable biofuel, or green (low/zero carbon) hydrogen, then this could help us to decarbonise the transport system more quickly. However, if alternative fuels do not develop as quickly as expected, or Aotearoa is unable to establish an effective domestic industry or distribution network for biofuels/hydrogen, then this would be a headwind. This would make us reliant on fossil fuel vehicles for longer, or require more emphasis on mode shifts or electrifying vehicles where viable.

The social mandate for shifting to a low emissions economy

Most New Zealanders are concerned about climate change, and support emissions reductions. We assume that this sentiment will grow over time, as the impacts of climate change grow and become more obvious, and younger generations who have grown up with the threat of climate change become more influential in decision-making.

To achieve a zero carbon transport system, major changes will be needed in the way that people and products travel, and the vehicles and fuels used. The scale and pace of changes will depend on, and affect, the social appetite for changes.

If the social mandate grows more quickly than expected, we could achieve a zero carbon transport system swiftly. This could be reflected in both the personal actions that people take to reduce transport GHG emissions, and collective support and demand for institutional changes (e.g. policies, pricing, and incentives). Alternatively, emissions reductions could be hampered if there is insufficient will or mandate for changes.

Economic shocks

Aotearoa has faced major economic shocks over the last couple of decades, including the global financial crisis, Canterbury earthquakes, and the impacts of COVID-19. We will face more shocks over the next thirty years. These could affect Government finances, borrowing, and debt levels. They will also affect employment levels and consumer/business confidence, and potentially the social mandate for further change.

Economic shocks are likely to have a detrimental impact on initiatives to reduce emissions, even if they cause short-term emissions reductions due to lower economic activity and travel. However, shocks can also create opportunities for change. For example, Governments often focus on the transport sector to stimulate economic activity and employment. These investments could prioritise infrastructure and services that reduce transport GHG emissions.

Global dynamics

International changes will affect emissions reductions in Aotearoa. For example, if other countries enact ambitious policies quickly (such as the United Kingdom’s plan to ban the sale of new petrol and diesel cars from 2030), this could create a bigger international market for cleaner vehicles and fuels. Aotearoa could benefit from this, if mass production of electric vehicles leads to lower purchase costs. In the short term, Aotearoa is likely to compete with other countries as buyers of electric vehicles. Without any policy intervention, we could see an influx of cheap cars with internal combustion engines as the demand for these vehicles reduce in other countries.

Global dynamics will also affect the commitments that countries make to reduce GHG emissions, and their accountability for these reductions. Over the last 20 years, the global consensus to reduce emissions has grown significantly, even though there is often flux in the commitments made by individual countries due to domestic political changes. We expect global commitments and pressures to reduce emissions to grow this century, rather than diminish.

Changes in travel demand

How much, and how far, people and products travel is affected by many factors. In our pathways, we assumed for simplicity that the overall structure of New Zealand's economy remains relatively similar to 2050. We have not considered major changes in what people consume, or what businesses produce.

If people consume less in the future, and/or if Aotearoa shifts more towards a service-based high-value economy, with less emphasis on producing and transporting high-volumes of commodities, our carbon footprint could be smaller. Alternatively, if consumption grows more than expected, and/or if services play a relatively less important role in our economic future, then this would be a headwind.

Population growth

Our population growth rate will mostly be affected by immigration levels. This is because our birth rate is currently 1.63 children per woman, which is below the replacement rate. Aotearoa is a country built on immigration, and we are an attractive place for people from around the world to settle. Immigration settings will affect how large our population will become between now and 2050.

If our population grows more quickly than expected, this could become a headwind for emissions reductions due to increases in domestic travel demand. If immigration settings lead to slower population growth than expected, overall travel demand (and transport GHG emissions) might be lower. Ultimately, however, population growth needs to be decoupled from emissions by decarbonising the transport system and changing the ways that people and products travel.

Consultation question 13
Given the four potential pathways identified in Hīkina te Kohupara, each of which require many levers and policies to be achieved, which pathway to you think Aotearoa should follow to reduce transport emissions?

Chapter 11: What opportunities should the Government progress over the first three emissions budget periods?

In Chapter 10, we identified four possible pathways for how Aotearoa could reduce transport emissions towards zero carbon. Each pathway shows the choices and combinations of policies that will be needed to move towards zero. Most importantly, the pathways show that the effort required to reach the net zero target by 2050 will be significant.

Given this context, decisions on policies that will contribute to future emissions reductions for the transport system must be made now to ensure Aotearoa has a credible chance to achieve the changes required. This includes decisions about new policies that can be implemented during the first emissions budget period, and policies that are required in the future.

In doing this, we must also consider the systemic changes needed for the transport sector to effectivley reduce GHG emissions from the transport system by 2050. Future interventions must consider how Aotearoa transitions from the legacy practices:

a) of ‘trading-off transport outcomes against each other’ towards a new practice of ‘designing interventions to reduce GHG emission reduction that also achieve multiple transport outcomes, such as access, safety and resilience’.

b) that is largely based on ‘predicting and providing transport infrastructure to move light passenger vehicles’ towards a new practice of ‘optimising and managing travel demand across all transport modes’ (based on an agreed transport intervention hierarchy).

c) that emphasises ‘delivery of large road transport infrastructure projects’ towards a new practice that enables ‘the delivery of integrated multi-modal transport system programmes and activities’.

Overarching policies are already being implemented that support emissions reductions

A number of overarching policies have already been implemented to support Aotearoa’s efforts to reduce transport emissions – these are set out in the table below. For some of these policies the level of abatement that might be achieved from their implementation are yet to be actively measured and/or evaluated, although generally it is considered that they do contribute to mitigating transport emissions.

Table 5. Overarching policies that contribute to reducing emissions across the transport system

Title	Description
Government Policy Statements on land transport	Assessing how the Government Policy Statements on land transport can better focus on mode shift and climate change outcomes (both through implementation and monitoring).
Arataki 2021/31	Presents Waka Kotahi NZ Transport Agency's 10-year view of what is needed to deliver on the government's current priorities (as outlined in GPS 21) and long-term outcomes for the land transport system (as outlined in the Transport Outcomes Framework). Arataki 2021/31 outlines areas of focus to support key step changes needed to deliver on these priorities, including; tackling climate change and transforming urban mobility. It confirms that Waka Kotahi will use the Avoid-Shift-Improve framework and a complementary intervention hierarchy; (i) integrated planning, ii) demand management, iii) optimisation, iv) new infrastructure to reduce land transport greenhouse gas emissions.
Toitu Te Taiao – Sustainability Action Plan	Waka Kotahi is embedding its primary direction setting document which describes actions being taken to enable greenhouse gas reductions across the land transport system.
Investment Decision Making Framework	Waka Kotahi is reviewing its investment system that now factors in climate change considerations with further work underway to refine relevant processes, tools and resources.
Infrastructure Projects and Climate Change Policy	Establishing Waka Kotahi's new policy for infrastructure project applications to ensure they are compliant with COVID-19 'Fast-Track' legislation.
Infrastructure Sustainability Council of Australia Rating Tool	Applying this procurement requirement to specified infrastructure projects that require consideration of greenhouse gases – in particular as it relates to the design and construction of major infrastructure projects.
Provincial Growth Fund (PGF) projects	Implementing PGF projects with the aims of creating sustainable jobs; enabling Māori to reach their full potential; boosting social inclusion; building resilient communities; and help meet Aotearoa's climate change targets.
Innovation work programme	Investigating how innovation can better support transport outcomes in New Zealand, including how climate-focused innovation and technology can help us achieve our targets.
Carbon Neutral Public Service	The Ministry of Transport and Waka Kotahi are working to build on our existing efforts to reduce our corporate greenhouse gas emission footprint.
Regional Land Transport Plans (RLTP)	RLTPs document a regions' land transport objectives, policies and measures and sets the direction for the region. It provides a statement of the transport priorities for the region - climate change considerations are included in these plans.

A range of policies will be required to achieve the transport sector contribution to achieving the emissions budgets

Based on the Climate Change Commission's draft advice and modelling, the transport system will need to halve its emissions from 16.8 mega tonnes[109] of CO_2-e to 8.9 mega tonnes of CO_2-e in 2035. This ambition requires Aotearoa to implement a large number of policies to have a feasible chance of us getting close to it. This will require early and significant effort from all of us.

A strategic delivery of transport outcomes will be required for future policy developments

The Ministry uses the Transport Outcomes Framework to give government a way to set priorities for the transport system, and to measure progress. It connects the transport system with other systems, such as the wider economic system, and has been adopted by all transport agencies. The individual outcomes also help to better understand transport's contribution to the economy and society. The outcomes are inter-related, and need to be met through a range of interventions to improve intergenerational wellbeing.

As reflected in the Ministry's 2020 Briefing to the Incoming Minister[110] the strategic delivery of transport outcomes is structured through the use of long-term generational planning (using the Generational Investment Approach which sets out investment choices 10-50 years from now); medium-term mezzanine strategies, and short-term delivery through five key policy levers.

Mezzanine strategies drive outcomes for 10-15 years into the future by packaging suites of measures to address specific issues or problems. An example of this is the Road to Zero strategy. As noted earlier Hīkina te Kohupara will be used to develop a 10-15 year time horizon strategy on how the transport system can reduce its emissions.

Transport outcomes and government priorities are delivered through five key policy levers: Investment, Regulation, Economic and Education tools, Monitoring and Oversight and Influencing the international environment. Delivery relies on a combination of the five levers being used together, in a coordinated way, over time.

It should be noted, that dependent on the Government's objectives, the GPS and NLTF may not play a key role in meeting the objectives of a mezzanine strategy for reducing transport emissions. The NLTF funds maintenance, and enables some growth, while the GPS may be able to direct some investment so these things are aligned with a low emissions system. However, together these may not have a significant impact on the emissions profile, especially in the short term.

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[109] Based on 2018 transport emissions.

[110] [Transport - Strategic.pdf (beehive.govt.nz)]

Policies that should be considered for inclusion in the emissions budgets

The following table sets out the policies that are underway that contribute to reducing transport emissions. It also provides details of proposed policies or specific areas that require further analysis before specific policies will be identified for the first three emissions budgets. These proposals will still need to be discussed and agreed with Ministers, including confirmation of which policies will be locked into the first emissions budget through the Emissions Reduction Plan.

Table 6. Policies underway and that should be considered for inclusion in emissions budgets

Theme 1 – Changing the way we travel			
Shaping our towns and cities			
Current work underway	**Budget period 1: 2022-2025**	**Budget period 2: 2025-2030**	**Budget period 3: 2030-2035**
	Note: The responsibility for reducing transport emissions does not rest with transport decision-makers alone. The following opportunities require a coordinated approach by different agencies involved in land use, urban development and transport policy.		
Urban Growth Partnerships • The Urban Growth Partnerships programme provides a long-term and integrated approach to land use and infrastructure planning. The current approach to spatial planning under Urban Growth Partnerships identifies climate change as a key challenge, alongside other big challenges relating to integrated land use and transport. Several Urban Growth Partnerships are considering how to respond to climate change in the development of spatial plans. Transport projects, including future rapid transit systems and frequent public transport networks, feature heavily in all of these evolving partnerships and spatial plans. However, most of these transport projects do not currently have funding allocated to deliver them.	• Continue to progress the Urban Growth Partnerships programme. These partnerships, and the spatial plans that are integral to them, could play a valuable role in reducing emissions. The Government should ensure that emission reductions are central to this approach to land use and infrastructure planning, and prioritise transport projects that contribute to emission reductions. • Government could enable Waka Kotahi, Local Government, KiwiRail and Kāinga Ora to take more active roles in developing sites around frequent public transport services. This would help to unlock compact development (and give more certainty of the outcome) and ensure growth takes place around key transport nodes. • Work with local government to establish how major transport projects agreed to in spatial plans could be funded in the future.		
Resource Management Act (RMA) reforms • The current Government has committed to reform the RMA. Proposed reforms to the RMA include a new Strategic Planning Act, which would improve long-term integrated planning. Regional spatial planning, which could become mandatory under this Act, is a useful tool to integrate transport planning/investments with land use planning. This could support the development of town and cities where housing is concentrated close to jobs, schools, amenities, and rapid transit nodes – making it easier for people to access places by walking, cycling, or using public transport.	• The RMA reform is a crucial opportunity for the Government to embed spatial planning. Central government also needs to work with local government to improve capabilities for spatial planning. By mandating spatial plans that integrate land use, urban development and transport planning to achieve quality, compact, mixed-use urban development, the RMA reform could have a significant impact on emissions over the long term. Councils could be required to demonstrate how spatial plans will deliver long-term emission reductions. • Begin implementing RMA reforms, including guidance to councils.	• Continue implementing RMA reforms.	
National Policy Statement on Urban Development (NPS-UD) and Government Policy Statement on Housing and Urban Development (GPS HUD) • Councils are currently implementing the NPS-UD, which requires them to plan well for growth and ensure a well-functioning urban environment for all people, communities and future generations. Reducing GHGs from urban development is one of its objectives. This will	• To build off the NPS-UD, the Government may need to undertake work that supports councils to accelerate widespread street changes to support walking, cycling, public transport and placemaking – all of which are critical for mode shift and supporting higher density living. The project the Ministry is currently scoping called 'Reshaping Streets' will help to understand the opportunities in this area.		

drive existing and future urban development including transport needs. • The Ministry of Housing and Urban Development is currently developing the GPS HUD which must be finalised by 1 October 2021. This will set out the Government's overall direction and priorities for housing and urban development, to provide direction to Kāinga Ora and to guide the actions of other actors in the housing and urban development system. It is required to provide expectations for how Kāinga Ora recognises the need to mitigate and adapt to the impacts of climate change but there is an opportunity to set broader expectations about how the housing and urban development system mitigates and adapts to climate change.	• Develop design guidance and expectations for quality high-density environments (including streets, public spaces, buildings, and green space).		
Making streets more sustainable, healthier, and inclusive • The Ministry of Transport is scoping a project called Reshaping Streets to determine whether transport system settings need changing to accelerate the uptake of widespread street changes in Aotearoa that support public transport, active travel, and placemaking. • Waka Kotahi is developing the One Network Framework, which will provide consistent classification system for streets and roads to support greater collaboration across planning sectors, and help improve urban form and mobility outcomes. • Waka Kotahi is developing the Aotearoa Urban Street Guide to provide a national framework and high-level principles for excellence in multimodal street design in urban contexts.	• Remove barriers and improve funding for tactical urbanism and innovative approaches to street design (e.g. expand on Waka Kotahi's Innovating Streets for People Programme). • Invest in placemaking and urban design capability and capacity of transport agencies and transport functions within local government. • Clarify the principles of living infrastructure, and set expectations that living infrastructure is incorporated into transport plans and projects. • Review street design standards and develop nationally applicable consistent sets of standards for Aotearoa. • Investigate if regulatory changes are needed to empower Road Controlling Authorities to more easily consult on and make street changes to support active travel, public transport, and placemaking. • Make changes to policy and funding settings to ensure Waka Kotahi and Road Controlling Authorities maximise opportunities to 'build back better' when doing street renewals (to improve streets for people walk, cycling, and using public transport).		
Linking funding more closely with requirements to reduce emissions • The Government Policy Statement on land transport 2021 (GPS 2021) includes a strategic priority on climate change.	• Government could make transport investments conditional on having appropriate land use and urban development plans. This is a strong transport lever, which could help to ensure that transport investments are effective through better integration of land use and urban development planning. This could include reconsidering and/or reprioritising projects included in current plans. • Government could consider how to encourage transport investments (including National Land Transport Fund and Crown investments) towards packages and programmes (as opposed to projects) that are purposefully designed to reduce long-term land transport GHG emissions as well as deliver wider benefits. • Government could require transport GHG emission impact assessments for proposed urban developments (including the transport GHG emissions of residents and business owners that would be located in the development). Developments that are inconsistent with		

	emission reduction objectives could potentially be required to undergo redesign and/or an acceptable form of durable mitigation. • Government could set targets for councils to deliver public transport and active travel networks (e.g. dedicated/priority bus lanes on some routes; connected cycling networks) by a specific date. There could be funding consequences if Road Controlling Authorities do not deliver these changes within these timeframes.		
Providing Better Travel Options			
Current work underway	**Budget period 1: 2022-2025**	**Budget period 2: 2025-2030**	**Budget period 3: 2030-2035**
Government Policy Statement on land transport 2021 (GPS 2021) • GPS 2021 invests in infrastructure and support for walking, cycling and public transport (including rapid transit, such as in Drury, Hamilton to Auckland passenger rail, and City Rail Link). *Crown investment in public transport, walking and cycling* • There is also investment from the Crown (e.g. NZ Upgrade Programme, Provincial Growth Fund) into public transport, walking and cycling infrastructure.	• Support mode-shift to public transport, walking, and cycling – prioritising New Zealand's largest urban areas. • Significantly increase investments by central Government in public transport (including public transport infrastructure, services and operations), walking and cycling (including improving footpaths and walking infrastructure, and quality connected urban cycling networks). • Prioritise the need to reallocate street space and to create connected networks for delivering transport mode shifts in the next GPS on land transport, and/or for any additional funding for active modes and public transport. • Set higher Funding Assistance Rates for walking and cycling investments and dedicated/priority bus lanes to strongly incentivise Road Controlling Authorities to prioritise and accelerate street changes. • Investigate the opportunity to incentivise mode shift by introducing nationally consistent public transport fare concessions.	• Consider mode-shift opportunities in remaining urban areas – whilst continuing to prioritise investment in New Zealand's main urban centres. • Continue significant investments in public transport, walking and cycling.	• Continue significant investments in public transport, walking and cycling.
Keeping Cities Moving (Waka Kotahi) • Waka Kotahi's plan for enabling mode shift in urban areas. This includes a wide range of actions, including the development of specific mode shift plans for all high-growth urban areas as well as initiatives, such as Innovating Streets. *Auckland Transport Alignment Project* • A strategic approach for transport in Auckland between central and local government, supported by a confirmed investment package. Modelling for the 2021-2031 package shows an increase in emissions of 6 per cent. The package by itself reduces emissions by 13 per cent but this is outstripped by population growth. Modelling out to 2051 shows an emissions reduction potential of around 50 per cent.	• Support mode-shift by implementing Waka Kotahi and local government's mode shift plans for New Zealand's high-growth (and emerging high-growth) urban areas. However, these plans should be revisited to ensure they are designed to maximise transport GHG emission reductions. • Consider other barriers facing mode-shift to public transport, walking and cycling. In particular, the Government may need to undertake further work to: o clarify the roles of agencies to deliver large frequent public transport systems and ensure that there are legislative settings in place to enable them (e.g. land acquisition, consenting) o accelerate wide spread street changes, remove regulatory and investment barriers, require greater network planning, and develop guidance and standards. • Consider whether further support is warranted for shared mobility schemes – such as car share, car-pooling, shared micromobility and Mobility as a Service.		

Let's Get Wellington Moving (LGWM) • To 'future-proof' Wellington city's transport network to get ahead of growing demand by maintaining and developing Wellington's liveability, economic growth and productivity by reducing reliance on private vehicles and developing a multi-modal transport approach. Some initiatives may contribute to emission reductions and others may increase emissions.			
Accessible Streets – package of regulatory changes • Accessible Streets is a package of regulatory changes to increase the safety and attractiveness of walking and cycling. Accessible Streets has been publicly consulted on. Officials are now preparing advice for the Minister of Transport on how to progress the package, including whether changes to the proposals are necessary based on consultation. *Investment in integrated ticketing for public transport* • Waka Kotahi is developing an integrated ticketing system for public transport, which is likely to support public transport uptake. *Continued funding of SuperGold Card scheme* • The SuperGold Card scheme subsidises public transport use for those over the age of 65 and veterans.	• Implement Accessible Streets proposals. • Deliver integrated ticketing for public transport. • Consider extending public transport fare concessions to other low-income groups.		

Transport Pricing and Demand Management

Current work underway	Budget period 1: 2022-2025	Budget period 2: 2025-2030	Budget period 3: 2030-2035
Investigation into congestion pricing for Auckland (called the Congestion Question) • Investigation into whether congestion pricing could work for Auckland. No decisions have been made about implementing congestion pricing.	• Aim to introduce pricing mechanisms alongside land use changes and public transport investments. In the first budget period, this could involve implementing congestion pricing in Aotearoa's main urban centres, in particular Auckland. Congestion pricing could have more or less impact on emissions depending on its set up. The Government could also consider introducing incentives (subsidies and/or rewards) that encourage people to use public transport, walk or cycle.	• Introduce further pricing mechanisms, where appropriate in other urban areas.	
Future of the Revenue System project • This project looks at the future purpose and objectives of the land transport revenue system (was narrowed to focus on electronic distance-based charging in 2019, but scope has expanded again).	• Continue to investigate opportunities to innovate distance based charging, as more motorists switch from petrol powered vehicles to vehicles powered by other sources that will be subject to road user charges. This includes considering how all motorists can fairly contribute to funding the land transport system, including EV owners.		
	• Parking management can significantly influence demand for parking and encourage mode shift. The Government could require councils to continue to develop and implement parking pricing strategies, introduce maximum		

	parking standards for some areas, and consider workplace/private property/commuter parking levies.		
	• Government could investigate increasing rates of fuel excise duty and implementing a transport fuels only carbon tax.	• Consider increasing fuel excise duty / transport fuels only carbon tax.	

Theme 2 – Improving our passenger vehicles

Decarbonising the light vehicle fleet

Current work underway	Budget period 1: 2022-2025	Budget period 2: 2025-2030	Budget period 3: 2030-2035
Clean Car Standard • The Government has agreed to implement the Clean Car Standard, which will come into effect from 2022, to improve the fuel efficiency of new and used light vehicles imported into Aotearoa.	• Implement the Clean Car Standard • The Government should also clearly signal the phase out of light ICE vehicles – such as a commitment to phase out fossil fuel vehicle imports by 2030-2035.	• Strengthen the Clean Car Standard. • Consider policies that remove ICE vehicles from the fleet more quickly.	• The Government should phase out ICE light vehicle imports by 2030-2035.
Road User Charge exemption and rates • There is a Road User Charge (RUC) exemption in place for low emission light vehicles to increase the speed of their uptake. The Ministry is also investigating enabling RUC rates taking into account a vehicles' emissions. *Vehicle fuel economy labelling* • There is a vehicle fuel economy labelling (VFEL) system in place which allows buyers to compare the fuel economy of one vehicle against another (not emissions). Work is underway to expand the role of the VFEL so that it can support the purchase of low emission vehicles. *The Low Emission Vehicle Contestable Fund* • The Energy Efficiency and Conservation Authority (EECA) is reviewing the scope of its Low Emissions Vehicle Contestable Fund to accelerate LEV uptake through encouraging innovation. *Road to Zero strategy* • The strategy includes the aim of removing the most unsafe vehicles on the roads, which are generally also the highest emitting. *Government procurement* • All government departments have a 2025 target to be carbon neutral for all of their operations including transport. Government investment is available to facilitate this. A procurement rule is in place that requires government agencies to buy electric vehicles, unless there is a strong business reason not to. MBIE runs all-of-government procurement.	• Increase demand for cleaner vehicles by addressing their high upfront cost through introducing incentives. This could include a feebate scheme (e.g. the Clean Car Discount) and/or other subsidies. • The Government may need to ramp up its investment in electric charging infrastructure to support the increasing numbers of EVs in the fleet • Investigate the potential for tax incentives to stimulate the demand for low emission vehicles (including Fringe Benefit Tax, Depreciation and Tax Grants) and implement changes to the system if necessary. • Government departments must take steps to achieve the 2025 target to be carbon neutral.	• Continue to incentivise uptake of EVs. • Final decisions by government departments to complete their fleet transition to being zero emissions.	

Electric Vehicle Infrastructure – scoping project • The Ministry, with MBIE, EECA and Waka Kotahi, is scoping national guidance on electric vehicle public charging infrastructure to determine the best way to be ready for the uptake in low emission vehicles required to meet our targets.	• Consider scaling up investment in low emission vehicle infrastructure to support the uptake of low emission vehicles. The Ministry, with MBIE, EECA and Waka Kotahi, is currently scoping what might be required.		
Reviewing the 2008 Biofuel Sales Obligation for reinstatement • To support the development of a sustainable transport biofuels mandate.	• Implement a biofuel mandate to help address emissions from existing vehicle fleet.	• The Government may need to strengthen the biofuel mandate to increase biofuel use in existing fleet.	

Decarbonising the public transport fleet

Current work underway	Budget period 1: 2022-2025	Budget period 2: 2025-2030	Budget period 3: 2030-2035
Decarbonising buses • The Government has committed to a target of decarbonising the public transport bus fleet by 2035. • The Government will require only zero emissions buses to be purchased by 2025. • The Government has announced that it will provide $50m over four years to help councils achieve the targets. *Review of the Public Transport Operating Model* • This review will consider how changes could enable accelerated decarbonisation of public transport and support local government to reach the targets set by Government.	• Engage with the sector to identify what support is required to accelerate the decarbonisation of the bus and ferry fleet. • Implement zero emissions buses by 2025 mandate. • Consider extending the RUC exemption for electric buses. • Consider if legislative change is necessary to enable the acceleration decarbonisation of the public transport fleet. • Implement monitoring and reporting of funding to inform future decision-making. • Investigate options to decarbonise existing diesel buses, e.g. greater use of biofuels or synthetic diesel. • Consider future investment needs to ensure existing rail networks are fit for purpose.	• Ongoing engagement with the sector to identify whether continued support is required to accelerate decarbonisation of the bus and ferry fleet.	

Decarbonising aviation

Current work underway	Budget period 1: 2022-2025	Budget period 2: 2025-2030	Budget period 3: 2030-2035
Decarbonising aviation • Implementing the International Civil Aviation Authority's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) into domestic legislation. *Reviewing the 2008 Biofuel Sales Obligation for reinstatement* • To support the development of a sustainable transport biofuels mandate. This is intended to apply to all modes including aviation. *Operational improvements* • New Southern Sky (NSS) and Performance Based Navigation (PBN) have been implemented to implement emerging aviation technologies and improve air traffic flow and efficiency.	• Sustainable aviation fuel has the most potential to reduce aviation emissions in the short to medium term. The Government should keep working with the aviation industry to investigate its potential in New Zealand. • Implement a biofuel mandate to help address emissions from aviation. • Consider subsidies to support domestic biofuel production. • Continue implementation of operational improvements through NSS and PBN.	• Strengthen biofuels mandate. • Consider continuing subsidies to support domestic biofuel production. • Continue implementation of operational improvements through NSS and PBN.	• Strengthen biofuels mandate. • Consider continuing subsidies to support domestic biofuel production. • Continue implementation of operational improvements through NSS and PBN.

Theme 3 – Supporting a more efficient freight system			
Improving the efficiency of our overall freight supply chain			
Current work underway	**Budget period 1: 2022-2025**	**Budget period 2: 2025-2030**	**Budget period 3: 2030-2035**
National Supply Chain Strategy • Scoping work has begun on a National Supply Chain Strategy that will provide strategic direction and set out priorities amongst the various objectives for the supply chain, one of which is the reduction of emissions.	• Identify opportunities to improve the overall efficiency of the freight supply chain to avoid/reduce freight emissions. This is a focus of the National Supply Chain Strategy.	Implement opportunities agreed to improve the overall efficiency of the freight supply chain.	Implement opportunities agreed to improve the overall efficiency of the freight supply chain.
Enabling modal-choice in freight through the use of low emissions modes			
Current work underway	**Budget period 1: 2022-2025**	**Budget period 2: 2025-2030**	**Budget period 3: 2030-2035**
Future of Rail • A range of decisions have been taken by the Government over the past 2 to 3 years with the aim of improving the viability of rail as an alternative freight choice in order to reduce the negative externalities of road freight, in particular GHG reduction. *Coastal Shipping* • Opportunities to improve the uptake of coastal shipping will be explored through the National Freight Strategy. A key driver is emissions reduction given coastal shipping has lower GHG than road transport. • The Ministry is working with Waka Kotahi to see how the newly created Coastal Shipping allocation in the National Land Transport Fund may contribute towards the aim of increasing coastal shipping.	• Identify opportunities for supporting mode shift. This is a focus of the National Freight Strategy.		

Decarbonising freight modes			
Current work underway	**Budget period 1: 2022-2025**	**Budget period 2: 2025-2030**	**Budget period 3: 2030-2035**
The Low Emission Vehicle Contestable Fund • The Energy Efficiency and Conservation Authority (EECA) is reviewing the scope of its Low Emissions Vehicle Contestable Fund to accelerate LEV uptake through demonstrating low-emissions technologies and fuels, supporting the development of vehicle charging and refuelling infrastructure. *Reviewing the 2008 Biofuel Sales Obligation for reinstatement* • To support the development of a sustainable transport biofuels mandate. *Extending the Road User Charge (RUC) exemption for heavy vehicles* • To increase the speed of heavy low emission vehicle uptake.	• Government should investigate the best opportunities for decarbonising trucks (building on the Ministry's Green Freight strategic working paper), including: o introducing CO2 standards for trucks o increasing funding available to accelerate the uptake of zero and low emission trucks. • Implement a biofuels mandate to help reduce emissions from trucks (in addition to light vehicles). • Consider subsidies to support domestic biofuel production. • Consider targeted investments in infrastructure for green fuels and for fast charging heavy vehicles. • Investigate and introduce Green freight procurement through third party contactor rules for government activities.	• Consider strengthening CO2 standard. • Strengthen biofuel mandate. • Consider continuing subsidies to support domestic biofuel production. • Consider continuing targeted investments in infrastructure for green fuels and for fast charging heavy vehicles. • Investigate disincentives for high emitting trucks. • Consider refurbishing used diesel trucks with zero emission options.	• Phase out the registration of diesel heavy vehicles beyond a certain date, e.g. from 2035 or banning diesel trucks in certain cities or zones. • Strengthen biofuel mandate. • Introduce disincentives for high emitting trucks. • Consider continuing subsidies to support domestic biofuel production.
The Future of Rail Review has recognised the importance of investment in core asset replacement to provide a resilient and reliable rail network and to facilitate mode shift. NZ's Rail Plan of investment priorities , which will also facilitate emissions reductions through: • Replacement of old assets with modern equivalents (i.e. assets which are more energy efficient) • Encouraging mode shift to rail as a result of greater resilience and reliability	• KiwiRail will progress its procurement of a new South Island mainline locomotive fleet. A key consideration will be improved engine performance. • KiwiRail progressively replaces lighter duty mainline locomotives and shunt locomotives across Aotearoa with new units with more modern technology. • The Government's investment in Auckland Metro rail network which involves several packages of work progresses. This includes the Wiri to Quay Park (Third Main) and extending electrification from Papakura to Pukekohe.	• Three ferries are replaced with two new rail-enabled ferries that are diesel-electric hybrids. • Ongoing exploration of the potential for further network electrification and its impact on the national grid. • Continued investigation of alternative propulsion technologies and adapting KiwiRail's rolling stock strategy as this evolves.	• Continued investigation of alternative propulsion technologies and adapting KiwiRail's rolling stock strategy as this evolves
MARPOL VI • MARPOL Annex VI is the international regulatory mechanism for addressing the climate change impacts from shipping and Aotearoa is in the process of aligning domestic legislation and regulations to accede to MARPOL Annex VI by early 2022.	• Work with the maritime industry to investigate options to decarbonise shipping fleets.		

Consultation question 14

Do you have any views on the policies that we propose should be considered for the first emissions budget?

Chapter 12: Where to next?

Hīkina te Kohupara was produced to help inform the Government's strategic approach to reducing GHG emissions from transport. It is the first step towards fully understanding how the transport sector can reduce its GHG emissions. It will be used to facilitate discussions with Ministers, Iwi/Māori, stakeholders and our wider communities on potential policies that we will carry forward in 2021 through to the first ERP under the CCRA.

Leadership and stewardship will be critical to achieving our goal

To credibly reduce transport emissions Aotearoa will require ongoing leadership and stewardship to ensure we are on a pathway to net zero by 2050. It will necessitate significant effort to ensure all New Zealanders play their part to reduce emissions from our transport system.

The people of Aotearoa must be kept informed about when we will progress policies to reduce transport GHG emissions, including which policies will be given priority. Doing so will provide certainty to iwi/Maori, businesses, investors and our wider communities on how we intend to reduce transport emissions.

Hīkina te Kohupara has highlighted that actions designed to reduce transport GHG emissions can also deliver wider benefits. Win-win approaches delivering multiple outcomes are sought ahead of trade-offs and single outcome actions. This includes ensuring that a Just Transition is supported and inequitable impacts from policies are mitigated.

Hīkina te Kohupara is underpinned by the principles of partnership, protection and reciprocity in Te Tiriti o Waitangi. It enables partnership for shared outcomes, protection for people, the environment and the planet, and recognition of multiple benefits for all people of Aotearoa.

There are many parties that have a part to play to reduce transport emissions

The Ministry will need to work with others to deliver the policy changes needed. This will include working with other central government organisations, local government, Iwi/Māori, key stakeholders and businesses across a range of industries.

Some of the policies proposed are not lead by the Ministry, but the Ministry will play a significant role in assisting the transport sector to decarbonise. Additionally, decarbonising the transport system will require effort from a cross sector of government agencies, local government, businesses, and all peoples of Aotearoa.

Hīkina te Kohupara is shaped by a commitment to a sustainable transport system that serves the needs of current and future generations.

Hīkina te Kohupara will help to inform the transport policies included in the ERP

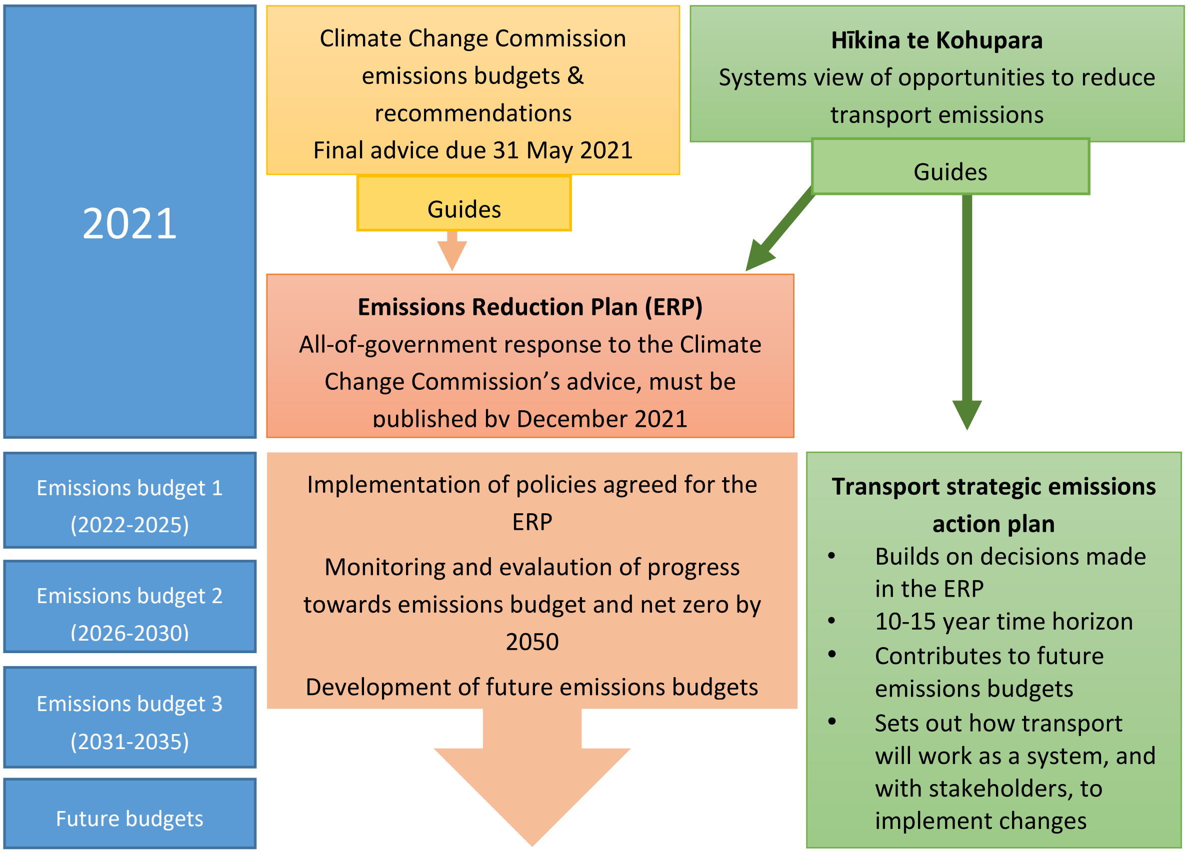
Government obligations under the CCRA includes a requirement to prepare a plan to set out the policies and strategies to meet the next emissions budget, and it may include policies and strategies for meeting other emissions budgets. The plan must include:

- sector specific policies to reduce emissions (and increase removals)
- multi-sector strategies to meet emissions budgets and improve the ability of sectors to adapt to the effects of climate change, and
- a strategy to mitigate the impacts that reducing emissions (and increasing removals) will have on employees and employers, regions, Iwi/Māori and wider communities, including the funding for any mitigation action.

Discussions with Ministers on Hīkina te Kohupara will inform the transport policies included in the ERP. Transport policies agreed with Ministers will need to be scoped and developed in further detail, including cost benefit analyses and more detailed analysis of the potential level of investment required for their implementation.

The transport policies agreed for the first ERP will **only** be the starting point for the transport system to reduce its GHG emissions. We anticipate that the transport chapter of the ERP will include policies that have already been agreed to by Government, new policies and indicative work that is required to understand how aspects of the transport system will contribute to the emissions budgets. Further effort will be required to identify additional policies that will need to be implemented in the future to support the whole of government response to the Climate Change Commissions' GHG emissions budgets.

The diagram below illustrates the relationship of Hīkina te Kohupara with the Climate Change Commission's advice, the development of an all-of-government Emissions Reduction Plan and a transport strategic action plan.



Hīkina te Kohupara will underpin a 10-15 year strategy and action plan

Hīkina te Kohupara has highlighted that Aotearoa must implement a broad range of policies to achieve meaningful change and reductions in our GHG emissions from the whole transport system. Aotearoa cannot afford to cherry pick policies, nor are there policies that are silver bullets. In addition to informing the policies for the first ERP, Hīkina te Kohupara will be the foundation document from which a 10-15 year time horizon strategy and action plan will be developed. A strategy and action plan will be agreed with Government and used to inform future ERPs and future investment and resource needs.

How can you help?

Thank you for taking the time to read this paper. The Ministry invites your views on the opportunities outlined in this paper to reduce transport emissions and put us on a pathway to zero carbon emissions by 2050. Your views will help us to shape the advice we put forward to Ministers for the ERP, and for the development of transport strategic action plan for the next 10 to 15 years.

Fourteen questions have been asked in this document. These can be found on pages: 11, 27, 31, 44, 56, 64, 72, 76, 79, 86, 97, 104, 108, 122 and 134.

If you would like to submit your views, please email:
transportemissions@transport.govt.nz

Key terminology used throughout this report

Alternative fuels – include low carbon fuels or energy sources that offer an alternative to conventional fossil fuels (e.g. petrol and diesel) to power motor vehicles. Low carbon fuel options include: electricity, green hydrogen and biofuels.

Avoid-Shift-Improve Framework – this is the framework the Transport Emissions: Pathways to Net Zero by 20500 report - Hīkina te Kohupara has used to structure the possible interventions to reduce transport emissions. It is described in detail in Chapter 4.

Battery electric vehicles (BEVs) – are purely electric vehicles that are only powered by batteries, which are charged by connecting to an external electricity source.

Biodiesel – is a form of diesel derived from plants or animals and consisting of long-chain fatty acid esters.

Carbon Dioxide (CO_2) – is a long lived greenhouse gas, which makes up 45 percent of Aotearoa's gross greenhouse gas emissions.

Climate Change Response (Zero Carbon) Amendment Act 2019 – legislates our emissions reductions targets and 5-yearly Emissions Reduction Plans, which will contain carbon budgets. The Act also set up the Climate Change Commissions to provide expert advice and monitoring to ensure we are on track to meet our targets. It is formally known as the Climate Change Response Act 2002.

CO_2-e – stands for "carbon dioxide equivalent" and is a standard unit for expressing the impact of different greenhouse gases, in terms of the amount of CO2 that would create the same amount of warming. CO_2 is the baseline greenhouse gas that is used as a benchmark for other gasses.

Co-benefits – additional outcomes associated with a strategic priority. The Transport Outcomes Framework also acts as a guide to identify key co-benefits that transport policies and measures should aim for.

Conventional biofuels – or 'first generation' biofuels, are produced from a range of feedstocks, including oil crops (such as canola), used cooking oils, and animal fats like tallow (an inedible meat by-product from meat processing). They are produced through well-understood technologies and processes, and are generally blended with diesel to make them compatible with standard diesel engines.

Decarbonisation – is the process by which countries, individuals or other entities aim to achieve zero fossil carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry and transport.

Electric Vehicles (EV) Programme – The EV Programme was launched in March 2016 to help address barriers to EV uptake.

Emissions Reduction Plan (ERP) – The ERP, led by the Ministry for the Environment, will set out how we respond to the Climate Change Commissions' advice and emissions budgets, and how we will make progress towards meeting our 2050 target.

The Aotearoa Emissions Trading Scheme (NZ ETS) – One of the Government's key levers in the transition to a zero carbon economy. The NZ ETS puts a price on our greenhouse gas emissions, and creates a financial incentive for businesses to reduce their emissions and landowners to earn money by planting forests that absorb carbon dioxide as the trees grow. It is described in detail in Chapter 3.

Fuel Cell Electric Vehicles (FCEVs) – a FCEV uses hydrogen gas to power an electric drivetrain. These vehicles combine hydrogen and oxygen to produce electricity, which runs the vehicle's electric motor.

Feebate scheme (Clean Car Discount) – The feebate scheme is a demand-side policy. It is designed with the intention of stimulating consumer demand for low emission vehicles.

Fuel efficiency – is the relationship between the amount of fuel a vehicle uses over the distance it travels.

Freight industry – includes all freight companies and those reliant on freight delivery for their business

Greenhouse gas (GHG) emissions – those gases that emit radiant energy, trapping heat in the atmosphere, and warming the planet above what it would be without these gasses.

Green hydrogen – hydrogen produced using renewable energy resources so that it is low-carbon. Blue hydrogen is produced from natural gas, and brown hydrogen is produced from coal. Around 95 percent of the world's hydrogen production is blue or brown hydrogen.

Harmful vehicle emissions - pollutants of concern to human health including nitrogen oxides and particulate matter. These have multiple negative health effects, especially for children. Particulates are known to be carcinogenic, and nitrogen oxides cause respiratory and cardiovascular damage, and can contribute to smog.

Heavy vehicle fleet – the heavy vehicle fleet consists of vans, buses and trucks with a 3.5 tonnes gross vehicle mass or more.

Just Transition – Aotearoa has committed to taking a 'Just Transition' approach to becoming carbon free. A Just Transition is fair, equitable and inclusive. It is described in detail in Chapter 9.

Long-haul road freight – long distance transport, performed mainly on state highways or main roads, typically over 300-400km one-way in distance.

Low-emissions vehicle – refers to an engine, motor, process, or other energy source producing relatively low levels of atmospheric pollutants, such as carbon.

Light vehicle fleet – all vehicles weighing up to 3.5 tonnes (3,500 kg) GVM. Medium trucks – those weighing between 3.5 and 10 tonnes (3,500 kg-10,000 kg) GVM.

Micro-mobility – light, short haul modes of transport such as electric scooters, skateboards, share-bicycles.

Mode Shift – increasing the share of people's travel by public transport, walking and cycling.

Paris Agreement – a global agreement on climate change that was adopted by Parties under the United Nations Framework Convention on Climate Change (UNFCCC) in 2015. It commits all countries to take action on climate change and aims to keep the global average temperature well below 2° C above pre-industrial levels, while pursuing efforts to limit the temperature increase to 1.5° C.

Public transport (PT) – passenger transport infrastructure and services contracted by local and central government which may include shared on-demand services identified in Regional Public Transport Plans as integral to the public transport network. Interregional passenger transport by means of a rail vehicle.

Rapid transit – a quick, frequent, reliable and high-capacity public transport service that operates on a permanent route (road or rail) that is largely separated from other traffic.

Renewable diesel – is a direct substitute for diesel, which is refined from lower carbon and renewable source materials such as used cooking oil and animal fats.

Renewable fuels – include advanced biofuels, recycled carbon fuels, and renewable liquid and gaseous transport fuels of non-biological origin (e.g. green hydrogen).

Road freight – is the transportation of commodities and goods by road between two or more points. Short-haul road freight – short to medium distance transport, primarily within regions or across urban areas.

Road User Charges (RUC) – distance based charges based on weight and axle configuration. They are paid by operators of diesel and heavy vehicles ti fund land transport activities.

Transport Outcomes Framework - The Transport Outcomes Framework is intended to help the Ministry of Transport and Government set priorities for the transport system and measure progress.

Transport sector – the sector of the economy that deals with the movement of people and products. It includes organisations across aviation, maritime and land transport.

Urban Environment – any area of land (regardless of size, and irrespective of local authority or statistical boundaries) that is, or is intended to be, predominantly urban in character; and is, or is intended to be, part of a housing and labour market of at least 10,000 people.

Vehicle kilometres travelled (VKT) – is the total kilometres travelled by motor vehicles during a given period.

Waka Kotahi, the NZ Transport Agency (Waka Kotahi) – The government agency with statutory functions to manage the funding of the land transport system and manage the state highwaynetwork.

Zero-emissions vehicle – refers to an engine, motor, process, or other energy source, that at the point of operation emits no atmospheric pollutants.

Appendix A: How Hīkina te Kohupara was developed

In early 2020 the Ministry commenced work on Hīkina te Kohupara.

This has been both a cross-Ministry and cross-agency project.

The following central government agencies were involved in discussions that have shaped the development of Hīkina te Kohupara: Waka Kotahi the New Zealand Transport Agency, the Ministry for the Environment, the Ministry for Business, Innovation and Employment, the Ministry for Housing and Urban Development and the Energy Efficiency and Conservation Authoirty.

The following sets out a high level overview of the steps taken to develop this report:

Workshop 1 - virtual	Cross agency request to provide list of potential levers and opportunities that could be used to reduce transport emissions. Agencies were also asked to identify data sources and past/current/new work that had commenced. The levers/opportunities were collated into outcome groups – themed. More than 100 opportunities were identified.
Background papers	Information papers were written for each of the outcomes, including on each of the levers/opportunities that were identified. This was an iterative process, and the list of levers/opportunities expanded as more research was completed. The papers were shared with agencies for comment. They were also shared with other groups/sectors as relevant to the paper, for example the paper on public transport was shared with local government in Auckland, Wellington and Christchurch.
Sprint Sessions	To support the development of the background papers the Ministry held a series of 2 hour sprint sessions on many of the papers. Representation at these sessions reflected the audience who were asked to comment on the paper. Discussions at the sprint session and through written submissions were used to revise the background papers as appropriate.
Generational Investment Assessment	The Ministry ran an internal Generational Investment Assessment process which required an assessment of the more than 100 levers/opportunities to reduce emissions from the transport system.

	This process assessed and ranked the levers including assessing how/what contribution they might make against the Ministry of Transport's transport outcomes framework.
Workshop 2 - virtual & in person (restricted numbers due to Covid-19 requirements)	A full day workshop was held with representatives from central and local government to discuss the development of the pathways for the report. This workshop was to gather information on what are identified as priority levers/opportunities, how fast these should be implemented, and discuss what advice we should provide to Government to assist with the task ahead.
Steering Group oversight	A Steering Group of Ministry and Waka Kotahi managers was set up for the 2nd half of the process to maintain oversight of the direction and content of the paper.

Appendix B: Modelling Assumptions for Hīkina te Kohupara

The model calculates Theme 1, 2 and 3 impacts in terms of GHG emission reductions

For each theme, the model calculates the change in transport GHG emissions relative to a reference case of emissions from the road fleet from 2021 to 2050. This projection assumes some uptake of electric vehicles over time – particularly in the light vehicle fleet. The reference case is the Ministry's base case from the 2021 update of the Vehicle Fuel Emissions Model (VFEM) (see Chapter 2).

The four themes change either the total amount of vehicle kilometres travelled (through reducing distances or number of vehicles) or the fuel used by the remaining fleet. The model reflects this by first applying all the factors that reduce vehicle kilometres travelled, then by changing the fuel used by the remaining fleet. Where integrating VKT and fuel changes was not possible, we applied the changes in terms of a percentage change in emissions.

Pathways differ in the model based on assumption settings for avoid and shift

The model has different settings (very high, high, medium and low) for how much we reduce VKT or change fuel. We have used these settings to develop the four pathways. The figure below illustrates the different settings between for each pathway.

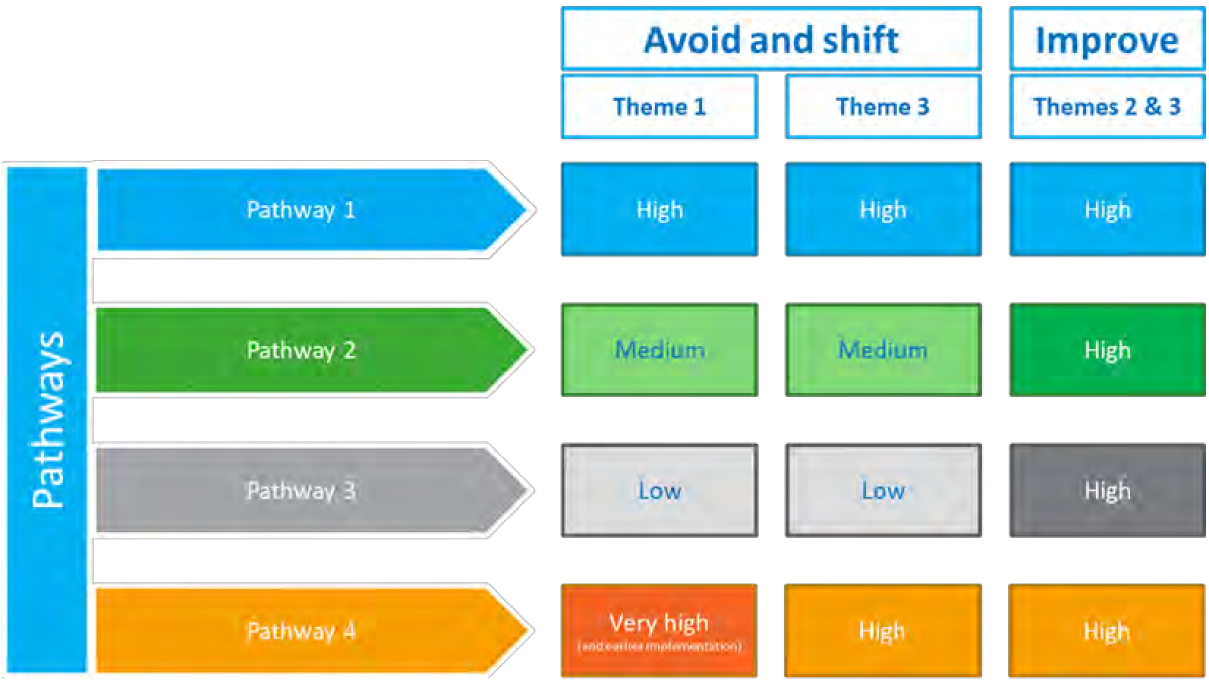


Figure 11 Pathway assumption settings

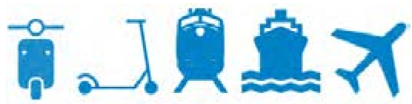
For each of the pathways, we have applied highly optimistic settings for most themes. This reflects the commitment and level of actions required to achieve as close to zero transport GHG emissions as possible.

Pathways 1 to 3 have the same ‘high’ settings for improve initiatives covered in Theme 2 and Theme 3. This setting reflects strong EV and biofuel uptake and is to reduce as much emissions as possible from all remaining vehicles in each pathway. Even though ‘improve’ initiatives convert remaining vehicles to low emissions options at the same ‘high’ setting, more weight on avoid and shift initiatives reduces this task burden.

Pathway 4 has the same high settings as Pathways 1 to 3 but it assumes less of a supply constraint on incoming electric vehicles. Japan remains Aotearoa’s primary source of vehicles and has limited EV availability. Relaxing the supply constraint implicitly assumes Japan will achieve much higher EV production and car sales (a turn around from current trends) or that Aotearoa is able to set up substantially more alternative supply from other right-hand drive countries such as Korea, UK and India.

The model does not cover everything

The table below highlights at a high level what is included and excluded in the model by theme:

		In the model		Not in the model
Modes				
		Walking, cycling, working from home, cars, SUVs, vans, utes, buses, passenger rail (excluding fuel changes), trucks		Motorcycles, micromobility, freight rail, aviation, ships and boats
Fuels				
		Petrol, diesel, hybrid-electric, electric, conventional ethanol (up to 10% blend), conventional biodiesel (up to 7%), ‘ drop-in’ renewable diesel (up to 100%)		Heavy fuel oils and sustainable fuels used in shipping, aviation fuels – including sustainable alternatives, hydrogen
Initiatives (categorised	1	Land-use changes Public transport improvements Congestion, parking, and VKT pricing	1	Placemaking/urban design Shared mobility and MaaS Parking management (except pricing) Low emission zones Working from home / flexible working policies
	2	Fuel efficiency standard for light vehicles Feebate scheme for light vehicles Phase out of ICE light vehicle imports by 2035 Ban on all ICE vehicles in 2050 Biofuels in light vehicles and buses All PT buses electric by end of 2035	2	Rolling age ban for light ICE vehicles Other subsidies or tax incentives for light vehicles Government procurement of electric vehicles Vehicle scrappage schemes Decarbonising passenger rail initiatives Aviation policies

3	Freight routes optimisation, freight consolidation, improved last mile efficiency Energy saving and logistic improvements[111] Mode-shift from road freight to rail Mode shift from road to coastal shipping Biofuels for road freight More electric medium trucks	3	Hydrogen truck initiatives Heavy electric truck initiatives Decarbonising maritime initiatives

There are some key assumptions underpinning the model

Theme 1: Changing the way we travel

- For Theme 1, the model includes the combined impacts of land-use changes (including increased densification), public transport improvements, and transport pricing (including congestion pricing, parking pricing and distance pricing) on GHG emissions from the light vehicle fleet and buses.

- Land use and public transport impacts amplify one another. The model reflects this by using the evidence for the combined effect land use and public transport changes which is larger. In contrast, pricing mechanisms may partially offset one another. To adjust for this offsetting, the model incorporates congestion, parking, and distance pricing multiplicatively which slightly erodes the combined effect.

- Pricing is often supportive of land use and public transport changes. However, we are cautious about overstating the combined change of all these types of initiatives without further analysis so have also incorporated pricing multiplicatively (which reduces the overall effect).

- These public transport, pricing, and land use changes drive and increase in car sharing, walking, cycling, and working from home in the model.

- The model draws on information compiled from studies of VKT changes in response to these types of initiatives in the United States and Europe.[112]

Theme 2: Improving our passenger vehicles

- For Theme 2, we considered what it could take to transition all of New Zealand's light vehicle fleet to cleaner vehicles/fuels by 2050. To reach that target in the model, we have included initiatives that increase the fuel efficiency of vehicle imports, phase out ICE vehicle imports by 2035, increase the use of bioethanol, and introduce a complete ICE vehicle ban in 2050.

- The model takes into account the impact of Theme 1 on Theme 2 for all pathways, which provide a cumulative impact on emissions. The initiatives outlined in Theme 1 help to reduce car ownership and VKT (through improved access, better transport options, and mode shifts), in turn reducing the number of vehicles and the amount of energy/fuel that needs to be decarbonised by 2050.

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111 e.g. driver training, load sharing, retiming urban delivery for medium trucks

112 The model does not account for the impact of these policies on trucks, buses, rail or ferries.

Theme 3: Supporting a more efficient freight system

- For Theme 3, the model includes policies that support the optimisation of freight, shifting road freight to rail and coastal shipping, and increasing the uptake of biofuels and electrifying medium trucks.

- We have taken into account the impact that optimisation will have on the number of vehicles and vehicle kilometres travelled that needs to be decarbonised.

- While we have not modelled the impact of electrifying large trucks or using hydrogen to fuel trucks, we acknowledge that both of these technologies could play a significant role in reducing GHG emissions.[113] We discuss this in more detail in the policy implications section of Chapter 10.

It must be stressed that many of the policies would either be extremely difficult or expensive to implement within the timeframes. They would also require a number of supporting and complementary measures to support individuals, businesses and transport industry players in transitioning to reduce transport GHG emissions.

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[113] The use of renewable diesel in the model (which reduces GHG emissions by 80 percent for every litre it replaces) gives some indication of the impact that electrification or hydrogen could also have on reducing emissions from road freight.

Pathway 1					
2035			**2050**		
Theme 1					
VKT reduction		**Emissions impact**	**VKT reduction**		**Emissions impact**
Combined theme 1 effects	19.7%	1.5Mt reduction (10% of 2035 emissions)	Combined theme 1 effects	28.9%	0.5Mt reduction (7% of 2050 emissions)
Land use and public transport	3.9%		Land use and public transport	8.1%	
Combined pricing effects	16.4%		Combined pricing effects	22.6%	
Parking pricing	*1.5%*		*Parking pricing*	*1.4%*	
Congestion pricing	*2.6%*		*Congestion pricing*	*3.0%*	
Distance pricing	*14.2%*		*Distance pricing*	*20.4%*	
Fleet snapshot			**Fleet snapshot**		
• 3.8m vehicles (VKT reduction is equivalent to removing 20% of the light fleet) • 10,300 additional PT buses (260% increase)			• 3.5m vehicles (VKT reduction is equivalent to removing 29% of the light fleet) • 16,900 additional PT buses (291% increase)		
Theme 2					
Fleet snapshot		**Emissions impact**	**Fleet snapshot**		**Emissions impact**
• 670,000 EVs • 3.0m petrol, diesel, and hybrid vehicles • Light fleet is 18% electric • 13,800 EV PT buses • 400 non-EV PT buses • PT bus fleet is 97% electric • All petrol and diesel vehicles running on 10% ethanol or 16% biodiesel blends respectively		3.0Mt (21% of 2035 emissions)	• 3.2m EVs • 290,000 petrol, diesel, and hybrid vehicles • Light fleet is 92% electric • 22,700 EV PT buses • Zero non-EV PT buses • PT Bus fleet is 100% electric • All petrol and diesel vehicles running on 10% ethanol or 100% biodiesel blends respectively		3.6Mt (44% of 2050 emissions)

Notes

1) We combined all VKT reductions for Theme 1 multiplicatively, resulting in the total VKT change being less than the sum of all the VKT changes
2) Theme 1 effects account for different initiatives applying in different parts of the country. Congestion pricing applies to only Auckland and Wellington. Parking pricing, land use, and public transport applies to main centres. Distance pricing applies to all of New Zealand.

<table>
<tr><th colspan="10">Pathway 1</th></tr>
<tr><th></th><th colspan="4">2035</th><th colspan="5">2050</th></tr>
<tr><th colspan="10">Theme 3</th></tr>
<tr><td rowspan="14"></td><td colspan="9">Avoid and shift initiatives</td></tr>
<tr><td colspan="3">VKT reduction</td><td>Emissions impact</td><td colspan="3">VKT reduction</td><td colspan="2">Emissions impact</td></tr>
<tr><td></td><td>Heavy trucks</td><td>Medium trucks</td><td rowspan="7">0.8Mt
(6% of 2035 emissions)</td><td></td><td>Heavy trucks</td><td>Medium trucks</td><td colspan="2" rowspan="7">1.3Mt
(15% of 2050 emissions)</td></tr>
<tr><td>Optimisation of freight routes etc.</td><td>5.8%</td><td>5.8%</td><td>Optimisation of freight routes etc.</td><td>12%</td><td>12%</td></tr>
<tr><td>Energy saving and logistic improvements</td><td>0.6%</td><td>4.8%</td><td>Energy saving and logistic improvements</td><td>1.2%</td><td>10%</td></tr>
<tr><td>Mode-shift to rail</td><td>12.5%</td><td>NA</td><td>Mode-shift to rail</td><td>20%</td><td>NA</td></tr>
<tr><td>Mode-shift to coastal shipping</td><td>7.5%</td><td>NA</td><td>Mode-shift to coastal shipping</td><td>15%</td><td>NA</td></tr>
<tr><td colspan="3">Fleet snapshot</td><td colspan="3">Fleet snapshot</td></tr>
<tr><td colspan="3">• Marginal decrease in medium truck fleet
• 61,700 heavy trucks (down 20% from reference case)</td><td colspan="3">• Marginal decrease in medium truck fleet
• 53,700 heavy trucks (down 32% from reference case)</td></tr>
<tr><td colspan="9">Improve initiatives</td></tr>
<tr><td colspan="3">Fleet snapshot</td><td>Emissions impact</td><td colspan="3">Fleet snapshot</td><td colspan="2">Emissions impact</td></tr>
<tr><td colspan="3">• 3,200 EV medium trucks (48% increase)
• Medium truck fleet is 4% electric – no difference between pathways
• Remaining petrol and diesel trucks running on 10% ethanol or 16% biodiesel blends respectively</td><td>0.4Mt
(3% of 2035 emissions)</td><td colspan="3">• 22,000 EV medium trucks (100% increase)
• Medium truck fleet is 25% electric – no difference between pathways
• Remaining petrol and diesel trucks running on 10% ethanol or 100% biodiesel blends respectively</td><td colspan="2">1.8Mt
(22% of 2050 emissions)</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td colspan="9"></td></tr>
<tr><th colspan="10">Total all themes</th></tr>
<tr><td rowspan="2"></td><td colspan="4">Emissions Impact</td><td colspan="5">Emissions Impact</td></tr>
<tr><td colspan="4">5.7Mt (40% of 2035 emissions)</td><td colspan="5">7.2Mt (88% of 2050 emissions)</td></tr>
</table>

<table>
<tr><th colspan="5">Pathway 2</th></tr>
<tr><th colspan="3">2035</th><th colspan="2">2050</th></tr>
<tr><td colspan="5">Theme 1</td></tr>
<tr><td colspan="2">VKT reduction</td><td>Emissions impact</td><td colspan="1">VKT reduction</td><td>Emissions impact</td></tr>
<tr><td>Combined theme 1 effects</td><td>13.3%</td><td rowspan="8">1.0Mt reduction
(7% of 2035 emissions)</td><td>Combined theme 1 effects | 17.1%</td><td rowspan="8">0.4Mt reduction
(5% of 2050 emissions)</td></tr>
<tr><td>Land use and public transport</td><td>2.7%</td><td>Land use and public transport | 5.9%</td></tr>
<tr><td>Combined pricing effects</td><td>10.8%</td><td>Combined pricing effects | 11.9%</td></tr>
<tr><td>Parking pricing</td><td>1.1%</td><td>Parking pricing | 1.1%</td></tr>
<tr><td>Congestion pricing</td><td>0.9%</td><td>Congestion pricing | 1.3%</td></tr>
<tr><td>Distance pricing</td><td>9.9%</td><td>Distance pricing | 10.8%</td></tr>
<tr><td colspan="2">Fleet snapshot</td><td>Fleet snapshot</td></tr>
<tr><td colspan="2">• 4.1m vehicles (VKT reduction is equivalent to removing 13% of the light fleet)
• 6,900 additional PT buses (175% increase)</td><td>• 4.0m vehicles (VKT reduction is equivalent to removing 17% of the light fleet)
• 10,000 additional PT buses (172% increase)</td></tr>
<tr><td colspan="5">Theme 2</td></tr>
<tr><td colspan="2">Fleet snapshot</td><td>Emissions impact</td><td>Fleet snapshot</td><td>Emissions impact</td></tr>
<tr><td colspan="2">• 730,000 EVs
• 3.3m petrol, diesel, and hybrid vehicles
• Light fleet is 18% electric
• 10,500 EV PT buses
• 300 non-EV PT buses
• PT bus fleet is 97% electric
• All petrol and diesel vehicles running on 10% ethanol or 16% biodiesel blends respectively</td><td>3.1Mt
(22% of 2035 emissions)</td><td>• 3.7m EVs
• 340,000 petrol, diesel, and hybrid vehicles
• Light fleet is 92% electric
• 15,800 EV PT buses
• Zero non-EV PT buses
• PT Bus fleet is 100% electric
• All petrol and diesel vehicles running on 10% ethanol or 100% biodiesel blends respectively</td><td>3.7Mt
(45% of 2050 emissions)</td></tr>
</table>

Notes

1) We combined all VKT reductions for Theme 1 multiplicatively, resulting in the total VKT change being less than the sum of all the VKT changes
2) Theme 1 effects account for different initiatives applying in different parts of the country. Congestion pricing applies to only Auckland and Wellington. Parking pricing, land use, and public transport applies to main centres. Distance pricing applies to all of New Zealand.

Pathway 2							
2035				**2050**			
Theme 3							
Avoid and shift initiatives							
VKT reduction			**Emissions impact**	**VKT reduction**			**Emissions impact**
	Heavy trucks	Medium trucks	0.5Mt (4% of 2035 emissions)		Heavy trucks	Medium trucks	1.0Mt (12% of 2050 emissions)
Optimisation of freight routes etc.	4.8%	4.8%		Optimisation of freight routes etc.	10%	10%	
Energy saving and logistic improvements	0.5%	3.6%		Energy saving and logistic improvements	1%	7.5%	
Mode-shift to rail	7.5%	NA		Mode-shift to rail	15%	NA	
Mode-shift to coastal shipping	3.5%	NA		Mode-shift to coastal shipping	10%	NA	
Fleet snapshot				**Fleet snapshot**			
• Marginal decrease in medium truck fleet • 68,500 heavy trucks (down 11% from reference case)				• Marginal decrease in medium truck fleet • 60,900 heavy trucks (down 23% from reference case)			
Improve initiatives							
Fleet snapshot			**Emissions impact**	**Fleet snapshot**			**Emissions impact**
• 3,200 EV medium trucks (48% increase) • Medium truck fleet is 4% electric – no difference between pathways • Remaining petrol and diesel trucks running on 10% ethanol or 16% biodiesel blends respectively			0.4Mt (3% of 2035 emissions)	• 22,000 EV medium trucks (100% increase) • Medium truck fleet is 25% electric – no difference between pathways • Remaining petrol and diesel trucks running on 10% ethanol or 100% biodiesel blends respectively			2.0Mt (24% of 2050 emissions)
Total all themes							
Emissions Impact				**Emissions Impact**			
5.1Mt (36% of 2035 emissions)				7.1Mt (87% of 2050 emissions)			

Pathway 3					
2035			**2050**		
Theme 1					
VKT reduction		**Emissions impact**	**VKT reduction**		**Emissions impact**
Combined theme 1 effects	6.0%	0.5Mt reduction (4% of 2035 emissions)	Combined theme 1 effects	7.8%	0.3Mt reduction (4% of 2050 emissions)
Land use and public transport	1.1%		Land use and public transport	2.5%	
Combined pricing effects	4.9%		Combined pricing effects	5.5%	
Parking pricing	*0.4%*		*Parking pricing*	*0.3%*	
Congestion pricing	*0.6%*		*Congestion pricing*	*1.0%*	
Distance pricing	*4.4%*		*Distance pricing*	*4.8%*	
Fleet snapshot			**Fleet snapshot**		
• 4.4m light vehicles (VKT reduction is equivalent to removing 6% of the light fleet) • 3,100 additional PT buses (80% increase)			• 4.5m light vehicles (VKT reduction is equivalent to removing 8% of the light fleet) • 4,600 additional PT buses (80% increase)		
Theme 2					
Fleet snapshot		**Emissions impact**	**Fleet snapshot**		**Emissions impact**
• 790,000 EVs • 3.6m petrol, diesel, and hybrid vehicles • Light fleet is 18% electric • 6,900 EV PT buses • 200 non-EV PT buses • PT bus fleet is 97% electric • All petrol and diesel vehicles running on 10% ethanol or 16% biodiesel blends respectively		3.2Mt (23% of 2035 emissions)	• 4.1m EVs • 370,000 petrol, diesel, and hybrid vehicles • Light fleet is 92% electric • 10,400 EV PT buses • Zero non-EV PT buses • PT Bus fleet is 100% electric • All petrol and diesel vehicles running on 10% ethanol or 100% biodiesel blends respectively		3.7Mt (46% of 2050 emissions)

Notes

1) We combined all VKT reductions for Theme 1 multiplicatively, resulting in the total VKT change being less than the sum of all the VKT changes
2) Theme 1 effects account for different initiatives applying in different parts of the country. Congestion pricing applies to only Auckland and Wellington. Parking pricing, land use, and public transport applies to main centres. Distance pricing applies to all of New Zealand.

<table>
<tr><th colspan="9">Pathway 3</th></tr>
<tr><th></th><th colspan="4">2035</th><th colspan="4">2050</th></tr>
<tr><td colspan="9">Theme 3</td></tr>
<tr><td></td><td colspan="8">Avoid and shift initiatives</td></tr>
<tr><td></td><td colspan="3">VKT reduction</td><td>Emissions impact</td><td colspan="3">VKT reduction</td><td>Emissions impact</td></tr>
<tr><td></td><td></td><td>Heavy trucks</td><td>Medium trucks</td><td rowspan="6">0.4Mt
(3% of 2035 emissions)</td><td></td><td>Heavy trucks</td><td>Medium trucks</td><td rowspan="6">0.7Mt
(9% of 2050 emissions)</td></tr>
<tr><td></td><td>Optimisation of freight routes etc.</td><td>3.9%</td><td>3.9%</td><td>Optimisation of freight routes etc.</td><td>8%</td><td>8%</td></tr>
<tr><td></td><td>Energy saving and logistic improvements</td><td>0.4%</td><td>2.4%</td><td>Energy saving and logistic improvements</td><td>0.8%</td><td>5%</td></tr>
<tr><td></td><td>Mode-shift to rail</td><td>3.5%</td><td>NA</td><td>Mode-shift to rail</td><td>10%</td><td>NA</td></tr>
<tr><td></td><td>Mode-shift to coastal shipping</td><td>3.5%</td><td>NA</td><td>Mode-shift to coastal shipping</td><td>5%</td><td>NA</td></tr>
<tr><td></td><td colspan="3">Fleet snapshot
• Marginal decrease in medium truck fleet
• 71,600 heavy trucks (down 7% from reference case)</td><td colspan="3">Fleet snapshot
• Marginal decrease in medium truck fleet
• 68,100 heavy trucks (down 14% from reference case)</td></tr>
<tr><td></td><td colspan="8">Improve initiatives</td></tr>
<tr><td></td><td colspan="3">Fleet snapshot</td><td>Emissions impact</td><td colspan="3">Fleet snapshot</td><td>Emissions impact</td></tr>
<tr><td></td><td colspan="3">• 3,200 EV medium trucks (48% increase)
• Medium truck fleet is 4% electric – no difference between pathways
• Remaining petrol and diesel trucks running on 10% ethanol or 16% biodiesel blends respectively</td><td>0.4Mt
(3% of 2035 emissions)</td><td colspan="3">• 22,000 EV medium trucks (100% increase)
• Medium truck fleet is 25% electric – no difference between pathways
• Remaining petrol and diesel trucks running on 10% ethanol or 100% biodiesel blends respectively</td><td>2.2Mt
(27% of 2050 emissions)</td></tr>
<tr><td colspan="9">Total all themes</td></tr>
<tr><td></td><td colspan="4">Emissions Impact</td><td colspan="4">Emissions Impact</td></tr>
<tr><td></td><td colspan="4">4.6Mt (32% of 2035 emissions)</td><td colspan="4">7.0Mt (86% of 2050 emissions)</td></tr>
</table>

Pathway 4					
2035			**2050**		
Theme 1					
VKT reduction		**Emissions impact**	**VKT reduction**		**Emissions impact**
Combined theme 1 effects	38.8%	2.5Mt reduction (19% of 2035 emissions)	Combined theme 1 effects	56.8%	1.2Mt reduction (15% of 2050 emissions)
Land use and public transport	8.6%		Land use and public transport	10.9%	
Combined pricing effects	33%		Combined pricing effects	51.5%	
Parking pricing	*3.4%*		*Parking pricing*	*3.6%*	
Congestion pricing	*2.9%*		*Congestion pricing*	*3.2%*	
Distance pricing	29.5%		*Distance pricing*	48.7%	
Fleet snapshot			**Fleet snapshot**		
• 2.9m vehicles (VKT reduction is equivalent to removing 39% of the light fleet) • 17,200 additional PT buses (436% increase)			• 2.1m vehicles (VKT reduction is equivalent to removing 57% of the light fleet) • 28,300 additional PT buses (487% increase)		
Theme 2					
Fleet snapshot		**Emissions impact**	**Fleet snapshot**		**Emissions impact**
• 758,000 EVs • 2.1m petrol, diesel, and hybrid vehicles • Light fleet is 27% electric • 20,600 EV PT buses • 600 non-EV PT buses • PT bus fleet is 97% electric • All petrol and diesel vehicles running on 10% ethanol or 16% biodiesel blends respectively		2.6Mt (19% of 2035 emissions)	• 2.0m EVs • 126,000 petrol, diesel, and hybrid vehicles • Light fleet is 94% electric • 34,100 EV PT buses • Zero non-EV PT buses • PT Bus fleet is 100% electric • All petrol and diesel vehicles running on 10% ethanol or 100% biodiesel blends respectively		3Mt (37% of 2050 emissions)

Notes

1) We combined all VKT reductions for Theme 1 multiplicatively, resulting in the total VKT change being less than the sum of all the VKT changes
2) Theme 1 effects account for different initiatives applying in different parts of the country. Congestion pricing applies to only Auckland and Wellington. Parking pricing, land use, and public transport applies to main centres. Distance pricing applies to all of New Zealand.
3) Pathway 4 assumes importation of ICE vehicles will phase out in 2032 and has a higher percentage of working from home assumption. In addition, it also assumes the clean car policies (part of the baseline) are very successful in accelerating the uptake of electric vehicles and therefore slightly reduce the mitigation needs. Due to changes in the baseline, the emissions impact expressed in percentages are not directly comparable with other pathways.

Pathway 4							
2035				**2050**			
Theme 3 (same as Pathway 1)							
Avoid and shift initiatives							
VKT reduction			**Emissions impact**	**VKT reduction**			**Emissions impact**
	Heavy trucks	Medium trucks	0.8Mt (6% of 2035 emissions)		Heavy trucks	Medium trucks	1.3Mt (16% of 2050 emissions)
Optimisation of freight routes etc.	5.8%	5.8%		Optimisation of freight routes etc.	12%	12%	
Energy saving and logistic improvements	0.6%	4.8%		Energy saving and logistic improvements	1.2%	10%	
Mode-shift to rail	12.5%	NA		Mode-shift to rail	20%	NA	
Mode-shift to coastal shipping	7.5%	NA		Mode-shift to coastal shipping	15%	NA	
Fleet snapshot				**Fleet snapshot**			
• Marginal decrease in medium truck fleet • 61,700 heavy trucks (down 20% from reference case)				• Marginal decrease in medium truck fleet • 53,700 heavy trucks (down 32% from reference case)			
Improve initiatives							
Fleet snapshot			**Emissions impact**	**Fleet snapshot**			**Emissions impact**
• 3,200 EV medium trucks (48% increase) • Medium truck fleet is 4% electric – no difference between pathways • Remaining petrol and diesel trucks running on 10% ethanol or 16% biodiesel blends respectively			0.4Mt (3% of 2035 emissions)	• 22,000 EV medium trucks (100% increase) • Medium truck fleet is 25% electric – no difference between pathways • Remaining petrol and diesel trucks running on 10% ethanol or 100% biodiesel blends respectively			1.8Mt (22% of 2050 emissions)
Total all themes							
Emissions Impact				**Emissions Impact**			
6.2Mt (46% of 2035 emissions)				7.2Mt (89% of 2050 emissions)			

HB1-288

Auckland Transport Alignment Project

Interim Report: Findings and Conclusions – May 2016

Ministry of Transport
TE MANATŪ WAKA

THE TREASURY

Auckland Council

Auckland Transport

STATE SERVICES COMMISSION

NZ TRANSPORT AGENCY
WAKA KOTAHI

HB1-289
Document Structure

- **Executive Summary**
  - Key learnings
  - Emerging strategic approach
  - Next steps
- **1. Background**
  - Purpose and objectives
  - Auckland's transport challenge
  - Analysis informing this document
- **2. Key Learnings**
  - Revenue and land use assumptions
  - Optimising existing networks
  - Testing alternative investments
  - New opportunities
- **3. Emerging Strategic Approach**
  - Towards a strategic approach
  - Influence travel demand patterns
  - Make better use of existing networks
  - Provide new infrastructure and services
- **4. Next Steps**
  - Steps to the final report
  - How should we prioritise future investments?
  - Feedback sought

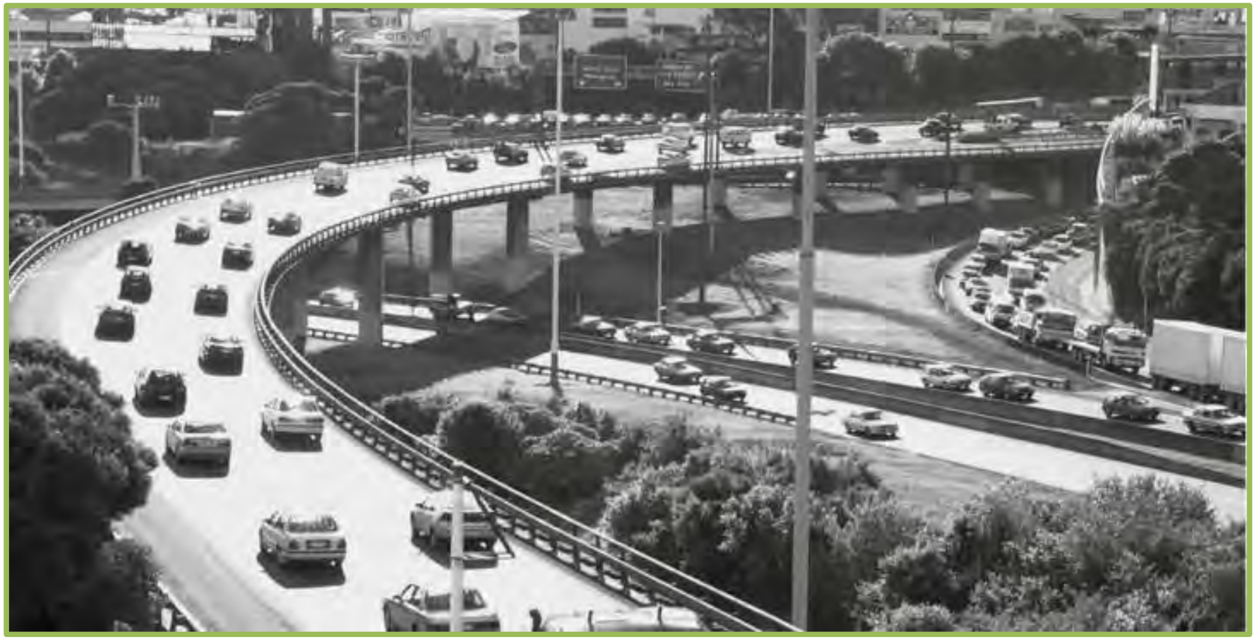
Executive Summary

Key learnings

Emerging strategic approach

Next steps

Executive Summary



Key Learnings

This report is the second ATAP deliverable. It presents interim findings and conclusions from the work undertaken to date and sets out the emerging strategic approach for review and feedback from the project parties.

Short-term funding plans are mostly committed

There is limited forecast discretionary funding available for investment in the short term, as much of the Decade 1 programme is already committed to significant investments including the City Rail Link, East West Connection, Puhoi-Warkworth, and the Accelerated Motorway Package.

Even with these investments in place, there is a projected decline in network performance by 2026. This problem will be exacerbated if, as recent trends suggest, growth is faster than the medium population projection assumed in ATAP.

We have developed two alternative scenarios to estimate future revenue available for transport in Auckland: one based on maintaining current per capita investment, and another maintaining the current share of Auckland's GDP invested in transport. These provide an indication of likely future affordability, but are above currently forecast funding levels.

Changing the investment mix will not achieve a step-change

The vast majority of Auckland's future transport network already exists today. To help accommodate growth, the productivity of this existing network needs to improve. This requires a combination of better network optimisation, continued improvements to asset management, and a greater focus on Intelligent Transport Systems (ITS).

It is possible to deliver better results by changing the mix of investments within existing funding constraints, but this will not deliver a major improvement in regional outcomes over and above the current plan (the Auckland Plan Transport Network, or APTN).

However there are differences in impact at the sub-regional level, and specific interventions can help improve accessibility in the west and south, which were identified as problem areas in the Foundation Report.

A greater focus on influencing demand patterns has benefits

New initiatives, including variable network pricing (directly charging for road use and varying charges by location and time of day), shared mobility and connected vehicle technology, would have a potentially significant positive impact on system performance.

Pricing has major potential to influence travel demand patterns and improve network productivity but would require substantial further investigation. A work programme, which could start this year, would be needed to address a broad range of implementation challenges.

A variety of specific transport challenges need to be addressed

Continued growth in public transport ridership will put pressure on key corridors into the central area. Efficiency improvements can address these challenges in the short term, but beyond that substantial further capacity increases will be required.

The existing Auckland Harbour Bridge has limits on its ability to cater for heavy traffic growth, but a new crossing has very high opportunity costs. Route protection for a new crossing needs to progress. However, a clearer understanding of cost and benefits, and better integration between road and public transport, is needed.

Enabling growth in newly developing areas requires significant transport investment. Early investment in route protection and land acquisition is critical, and an early start is needed on key connections in the north-west, the south and to support Special Housing Areas. In the existing urban area, the location of growth and intensification will affect the timing and priority of transport investments.

Towards a strategic approach: embracing new opportunities

- Historically, our approach to dealing with Auckland's transport issues has focused on investment in roading and public transport infrastructure and services, and optimising where possible to make better use of existing assets.

- Over time, this approach has become increasingly expensive and has struggled to keep pace with the demands that growth is placing on the system. Our analysis has shown that continuing on this path can deliver localised benefits, but will not provide the step change in transport system performance that Auckland needs.

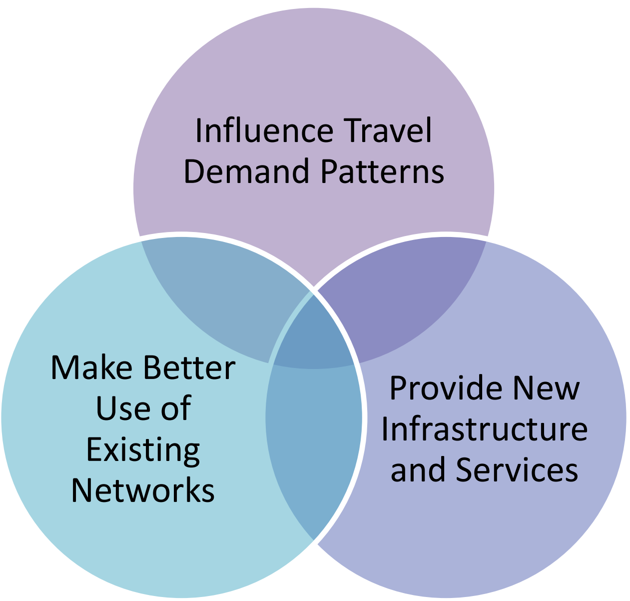
To achieve this, a change in approach is needed. Where should we focus our efforts?

Should we build more?	Or should we address demand?
One path is to focus on greater transport 'supply-side' provision by significantly accelerating the development of new infrastructure and services, to enable supply to get ahead of growth in demand. Although this option has not been specifically tested to date, our analysis suggests that this would be a very expensive approach, with diminishing returns over time. As growing cities around the world are finding, adding new infrastructure in existing urban areas requires increasingly expensive solutions. Only building our way out of the problem does not offer a compelling future.	An alternative path is to take advantage of new demand-side opportunities that have previously not been available. Rapid advances in transport and communications technology provide opportunities to influence the demand for private vehicle travel, through variable road pricing and the emergence of "mobility as a service" technologies. In addition, advances in intelligent transport system (ITS) and vehicle connectivity provide the opportunity for significant gains in network productivity. Our analysis has shown that, in combination, these initiatives have the potential to provide a step change in system performance.

- Auckland's continued growth means there is a need to continue work on optimising the current network, and adding new infrastructure and services. However, these actions will not on their own be sufficient. To make a real difference, we need to also take advantage of new demand-side opportunities, and ensure these are integrated with our investments and optimisation plans.

Emerging strategic approach

The emerging strategic approach involves an integrated combination of three types of intervention



Influence Travel Demand Patterns

- Ensure land-use decisions support an efficient transport network
- Maximise opportunities from new technologies to increase vehicle occupancy and throughput
- Progressively introduce a variable network pricing system to encourage more efficient travel patterns and reduce the long-term need for investment

Provide New Infrastructure and Services

- Tailor solutions to suit different circumstances
- Ensure transport enables and supports growth to address Auckland's housing challenge
- Strengthen strategic road, rail and public transport networks to ensure sufficient capacity, resilience and efficiency

Make Better Use of Existing Networks

- Better prioritise existing networks to more effectively deliver their required tasks
- Continue to improve efficiencies in maintaining, operating and renewing existing networks
- Accelerate the use of intelligent transport systems to provide real-time information and enable the benefits of emerging technologies

Recommended pathway

- The recommended approach requires a strong commitment to influencing travel demand patterns. This brings some implementation challenges, but the potential gains mean that a proactive approach is justified.
- In the short term this means prioritising resources towards making the transport system "technology ready", and laying the groundwork for variable network pricing, to enable a staged implementation.
- Because the benefits from these demand-side interventions may take some time to materialise, we need to ensure that progress is made on investments to improve our strategic networks and support Auckland's growth. Priority should be given to investments that will be required regardless of pricing or technology changes and those that enable and support Auckland's continued growth.

1st decade

- Better optimise use of the existing transport network
- Remove barriers to new technology and provide incentives to encourage uptake
- Pave the way for the staged implementation of variable network pricing
- Prioritise investments that facilitate early implementation of tools to influence demand
- Prioritise route protection, land acquisition and commence delivery of infrastructure in growth areas

2nd & 3rd decades

- Accelerate uptake and implementation of new tools
- Address public transport capacity constraints that may be exacerbated by pricing
- Continue base investment to enable and support growth

Implementing the recommended strategic approach will require the following issues to be addressed:

- How we accelerate a range of complementary interventions to influence future demand: including ride share services, connected vehicles, and pricing
- Whether to change level of investment in the first decade
- Where to focus early investment

HB1-295

Next steps will incorporate feedback with further analysis

Review and feedback on this report from parties (by mid-June) → Third round testing during June-July → Final ATAP report (August)

The next stage of the project will include further modelling and evaluation to supplement the work to date, and provide sufficient evidence to support the recommended approach, and demonstrate its costs and benefits.

A prioritisation framework consistent with the preferred strategic approach will be developed. In delivering value for money, recommended prioritisation criteria should include :

- Address most severe deficiencies against ATAP objectives
- Resilience to a range of different futures (pricing and technology)
- Unlock growth required for Auckland

Feedback on the following issues will be particularly useful to the project team:

- Is the emerging strategic approach supported?
- Do the parties support a move to embrace new technologies and demand management (variable pricing) as part of the preferred approach?
- Are there any differences in approach that should be considered?
- Are the recommended prioritisation criteria appropriate?
- Are there any additional issues that need to be addressed or options tested in the next phase of the project?

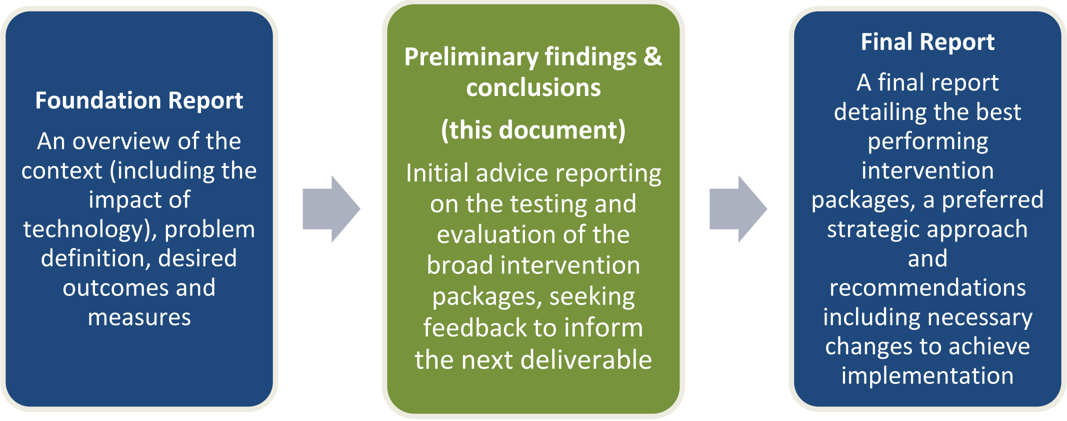
1. Background

1. Background

- Purpose and objectives
- Auckland's transport challenge
- Analysis informing this document

HB1-297
Purpose and objectives

ATAP Purpose and Objectives	Purpose of this Document
The focus of the project is to test whether better returns from transport investment can be achieved in the medium and long-term, particularly in relation to the following objectives: • To support economic growth and increased productivity by ensuring that access to employment/labour improves relative to current levels as Auckland's population grows • To improve congestion results, relative to predicted levels, in particular travel time and reliability, in the peak period and to ensure congestion does not become widespread during working hours • To improve public transport's mode share, relative to predicted results, where it will address congestion • To ensure any increases in the financial costs of using the transport system deliver net benefits to users of the system	• This is the second Auckland Transport Alignment Project (ATAP) deliverable and presents initial findings and conclusions from analysis undertaken to date • The document sets out an emerging strategic approach, based on these findings. It also identifies further work that is planned to inform the Final Report • Feedback from the parties on this report will be used to help shape the Final Report, which is due for completion in August 2016



Auckland's transport challenge

The ATAP Foundation Report (released in February 2016) highlighted opportunites and challenges arising from Auckland's future growth.

Foundation Report Findings	Key Issues for ATAP
• While growth provides opportunities to capitalise on the benefits of a larger and more diverse labour force, driving productivity and prosperity gains, it also places pressure on transport networks leading to congestion, overcrowding and delays. • Some of most significant transport challenges appear to occur over the next 10 years, with projected congestion increasing to 2026 before flattening and eventually slightly decreasing. Growth in demand over this period means that, despite major investments either underway or committed, car accessibility and congestion results show a decline. • Auckland's fast growth since 2013, the base year for analysis, means that much of this early challenge may have already occurred. • Planned investments beyond the next decade appear to result in some improvements in network performance. • Of particular significance is how the opportunities and challenges from growth vary across different parts of Auckland. The Foundation Report indicated that under current plans there is a substantial and growing gap between areas in relation to their access to employment. Due to their distance from where projected employment growth occurs, the western and southern parts of Auckland appear to face the greatest future transport challenges.	The Foundation Report highlighted that subsequent stages of the project needed to focus on addressing the following key issues: ***Access to employment and labour*** • an overall decline in access to employment by car between 2013 and 2036, particularly in the west and south • a low level of improvement in public transport access for people in the south and west, for accessing jobs in the south, and the slowing of public transport access improvements beyond 2026 • the extent to which transport interventions alone can improve access to employment ***Congestion*** • increased levels of congestion between 2013 and 2036, particularly on the motorway network • key bottlenecks on the motorways and local road network which impact on overall accessibility and trip reliability ***Public transport mode share*** • investigation of options to increase public transport mode share, particularly attracting longer trips off the motorway network to reduce congestion • the low level of public transport mode share growth in South Auckland, particularly in the first decade.

Analysis informing this document

The findings described in this report come from a range of technical analysis and assessment

Package development, modelling and evaluation	Specialist workstreams	Project team engagement
• Two rounds of package development, transport modelling and evaluation assessed different mixes of transport interventions • A variety of road pricing options were tested, informing a refined option that was modelled in combination with a supporting set of infrastructure projects • 'What if' technology scenarios looking at connected vehicles and shared mobility were developed and tested	• Specialist reports have been prepared to provide information on the following key topics: • Arterial Roads • Emerging Transport Technologies • Rail Network Development • Freight • Revenue Assumptions	• Ongoing engagement with teams that are undertaking more detailed analysis into major projects, including: • Additional Waitemata Harbour Crossing • Transport for Future Urban Growth • Central Access • North Shore Rapid Transit • Airport Rapid Transit

This work will be fully documented in the Final Report and supporting Working Papers, which are currently in draft

2. Key Learnings

- 2. Key Learnings
  - Revenue and land use assumptions
  - Optimising existing networks
  - Testing alternative investments
  - New opportunities

Revenue Assumptions

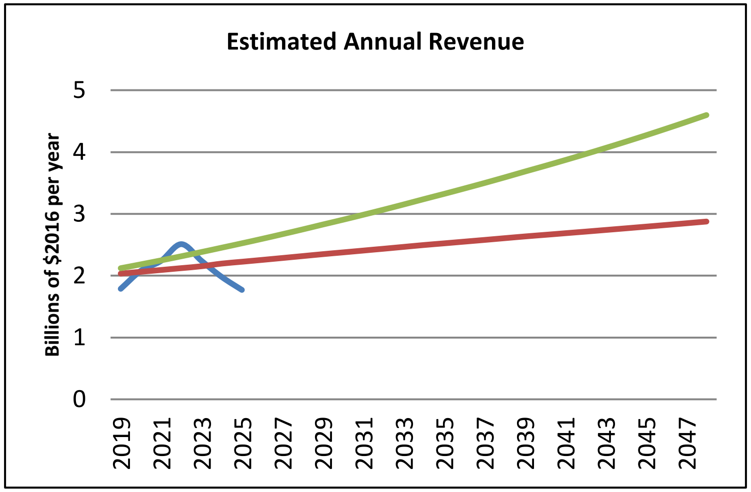
A key part of the project is to determine whether a funding gap exists.
This requires an estimate of likely future revenues.

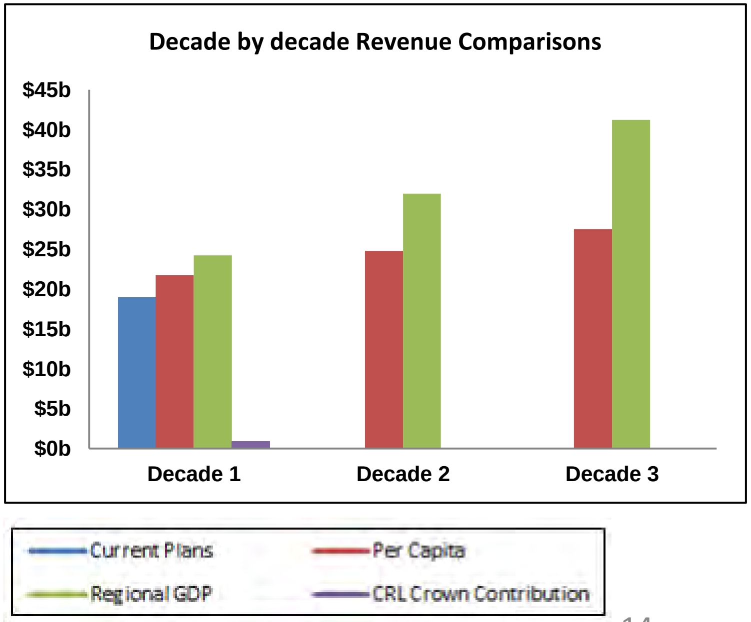
Recent & Planned Investment

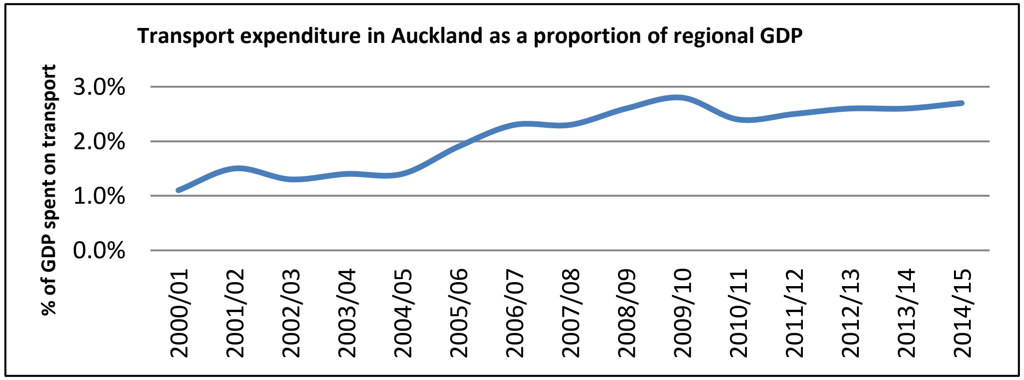
- There has been a five-fold increase in transport investment in Auckland over the past 15 years (in nominal terms).
- This rate of growth has outpaced both population and economic growth, meaning that the share of Auckland's economy being spent on transport has grown from around 1% to above 2.5% since 2000.
- Up to 2022, planned investment continues to grow quickly but subsequently sharply reduces once the City Rail Link is completed.
- Since current plans (Auckland's Regional Land Transport Plan and the National Land Transport Programme) were published in 2015, there have been some new investment commitments (e.g. East West Connections and pending Crown contribution to City Rail Link).

Future Revenue Assumptions

- Current financial plans only extend out 3-10 years so broad revenue assumptions are required beyond these timeframes.
- Two alternative scenarios were developed to estimate future revenue available for transport in Auckland: one based on maintaining current per capita spending, and another maintaining the current share of Auckland's GDP invested in transport. These provide an indication of likely future affordability, but are above currently forecast funding levels.
- Over the 30 year period, revenues would be approx. $74b under the Per Capita scenario and $97b under the Regional GDP scenario. Most of the difference occurs in the second and third decades
- Under both assumptions (and including an assumed Crown contribution to the City Rail Link) there would be a higher level of revenue than in current plans from 2024 onwards.







Land Use Assumptions

HB1-302

Where and when growth occurs has significant impacts on transport but is highly uncertain. Imbalances between the location of household and employment growth will increase pressure on the transport system.

Assumed Growth Pattern

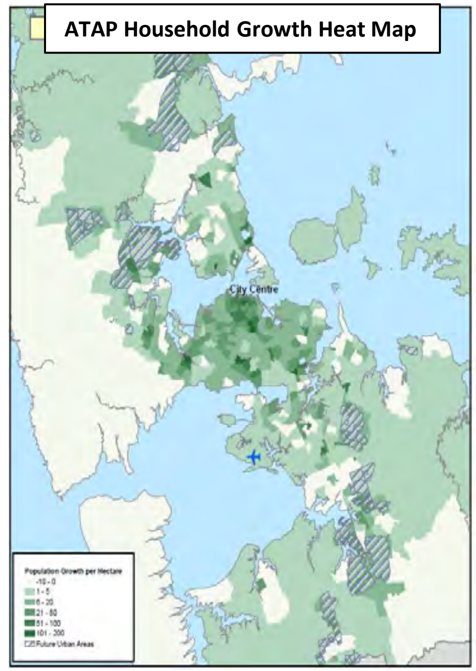
- The assumed pattern of household growth used for this project includes a substantial amount of growth throughout Auckland, including in inner parts of the urban area.
- The assumed pattern of employment growth (which has been peer reviewed) includes a very strong focus of growth in the Central Area and a limited number of other major centres such as the Airport and Westgate/Whenuapai.

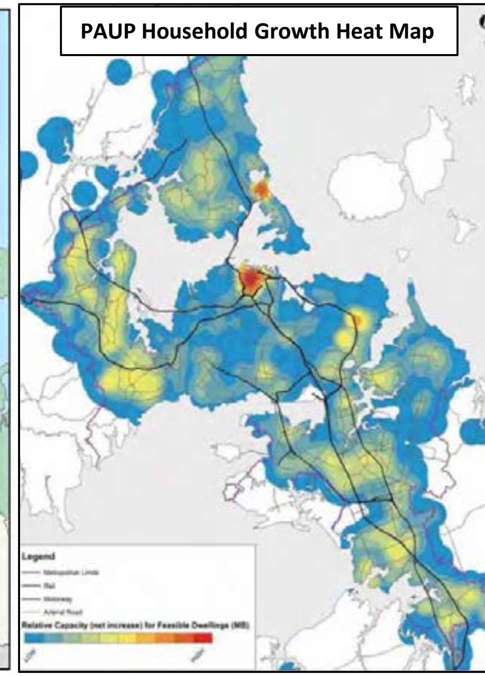
Growth Uncertainty

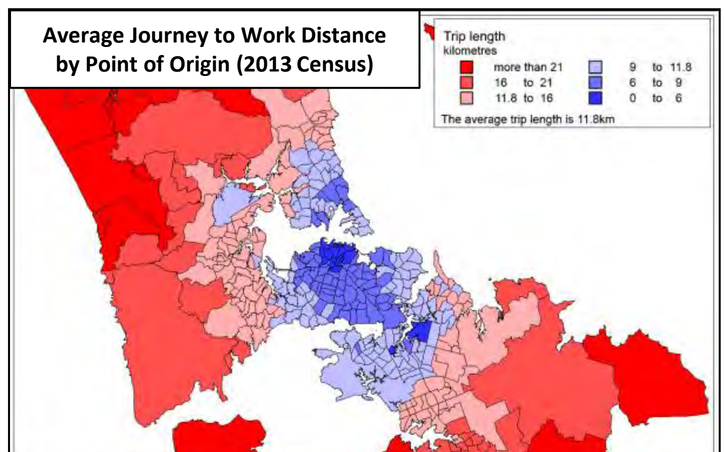
- Where are when growth occurs is subject to a wide variety of factors including the extent to which it is enabled by planning documents, infrastructure provision and market attractiveness. This leads to unavoidable uncertainty about future growth assumptions.
- There are some substantial differences between the growth assumptions used in this project and what is enabled by the Proposed Auckland Unitary Plan (PAUP). This is particularly true in the balance between inner urban and outer urban household growth with the PAUP providing feasible capacity for approximately 50,000 fewer dwellings on the Auckland isthmus than the growth assumptions used in this project.
- Where and when growth occurs affects the timing and priority of transport investments as well as the overall size of the transport challenge faced by Auckland. Depending on the outcome of the Unitary Plan, a greater balance of growth towards outer areas will need to be reflected in the prioritisation of investment.

Effect of Different Growth Patterns

- Average journey distances tend to increase, while the use of public transport, walking and cycling tends to decline, with distance from central Auckland.
- Therefore, the balance between where household and employment growth occurs has important transport implications. Projected trends of widespread household growth and concentrated employment growth contributes to Auckland's growing transport challenge, especially for the West and South which are most distant from where projected employment growth is greatest.
- Increasing household growth in inner areas, or employment growth in outer areas, can help address this imbalance.







HB1-303
Optimising Existing Networks

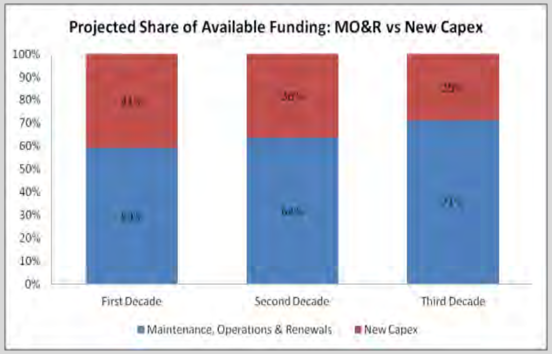
The vast majority of Auckland's future transport network already exists today.
To achieve ATAP objectives, it is critical to get more out of the existing network.
We have looked at opportunities to improve in three key areas:

Network Prioritisation

- Key challenge in providing for many competitive uses in the same corridors. Challenge is most acute on the arterial road network that have traffic, freight, public transport, walking & cycling, property access and place functions.
- No over-arching framework currently exists to guide trade-offs between competing uses for space on the arterial road network.
- To better optimise, greater specialisation of routes (e.g. general traffic, freight, public transport, place-making, cycling etc.) is required that balances network and place requirements.
- Major gains can be made in short-term by removing on-street parking, extending bus lane operating hours and improving pedestrian facilities in high volume areas. Often these changes can be difficult to implement, but they are very important and must be pursued.

Maintenance, Renewals and Operations

- Looking after current assets is crucial but is becoming more expensive as the asset base grows.
- Current projections suggest that the share of transport expenditure going to maintenance, operations and renewals will grow over time. Key drivers of this projected growth are public transport service costs, increased heavy vehicle traffic, and maintaining/renewing new and more complex assets. (e.g. tunnels).
- There appears to be scope for further improving efficiencies in this area through increased use of technology for monitoring assets and new ways of delivering public transport services (e.g. ridesharing or driverless vehicles)



Intelligent Transport Systems

- Intelligent network management encompasses a wide variety of distinct interventions designed to enable a comprehensive real-time understanding of network use, the ability to intervene to manage dynamically travel demand, and the associated data processing capability to perform these functions.
- Better network management can improve the utilisation of existing infrastructure - for example by re-routing traffic in response to congestion or incidents. It can also inform where to target maintenance and renewals expenditure and allow better planning of new infrastructure investment.
- Increasing investment in this area would enable more comprehensive real time information and better traffic information and analytics and better traffic management tools.
- Early investment is also necessary to capture the full benefits of emerging technologies, particularly vehicle-to-infrastructure communication.

Testing Alternative Investments

An important part of the work to date has been the testing of different intervention packages, to determine whether better results can be achieved by changing the mix of investment. Themed packages involving similar levels of investment were tested:

Auckland Plan Transport Network (APTN)

- The baseline package analysed in the ATAP Foundation Report. This mix of investments was developed to inform 2015 transport funding plans.

A mix of roading and public transport investments including Airport Rail, Additional Waitemata Harbour Crossing and substantial third decade motorway widening

Capacity constraints focus

- To test the impact of prioritising interventions that increase speed or capacity where levels of service are poor.

Significant motorway widening in the second and third decades and the Additional Waitemata Harbour Crossing. Also increases public transport services where demand is expected to exceed capacity.

Employment centres focus

- To test the impact of improved access to and between major employment centres.

A mix of public transport and roading investments focussed on improvements in travel times to the main employment growth centres (including the city centre, airport, & major town centres)

The next slides summarise the key findings from these package tests, and the extent to which different investments can address:

- Regional transport challenges: whether better results against ATAP objectives can be delivered at the region-wide level
- Access challenges in the South and West: whether better results can be achieved in areas where deficiencies have been identified

They also include a summary of findings from an assessment of key constraints and challenges that have been identified, including:

- Public transport capacity constraints
- Auckland Harbour Bridge constraints
- Auckland's housing challenge

HBI 305

Addressing Regional Transport Challenges

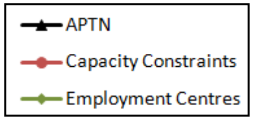
Modelling of different infrastructure programmes indicates broadly similar regional performance against key ATAP objectives, although some early gains can be made.

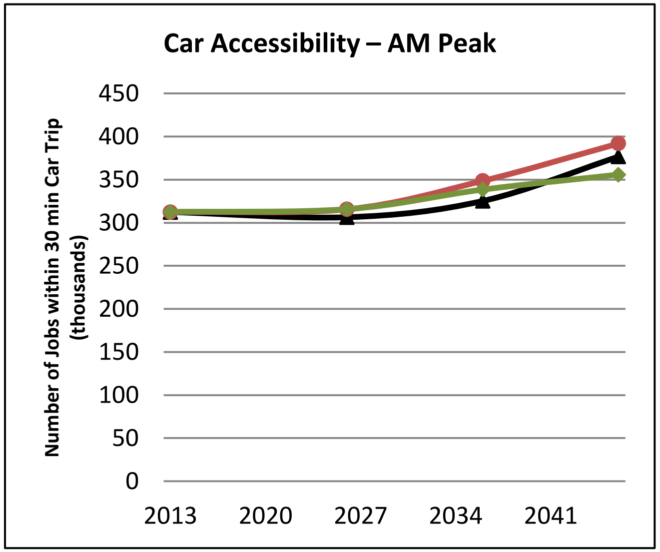
Model results show that it is possible to deliver some improvement in performance against the ATAP objectives, compared to APTN.

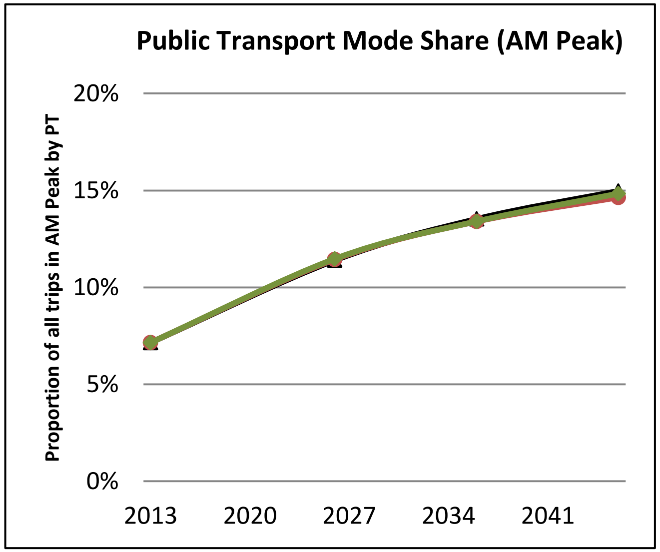
The most significant difference is for congestion levels on the strategic network (largely motorways) due to earlier and different levels of investment in motorway widening.

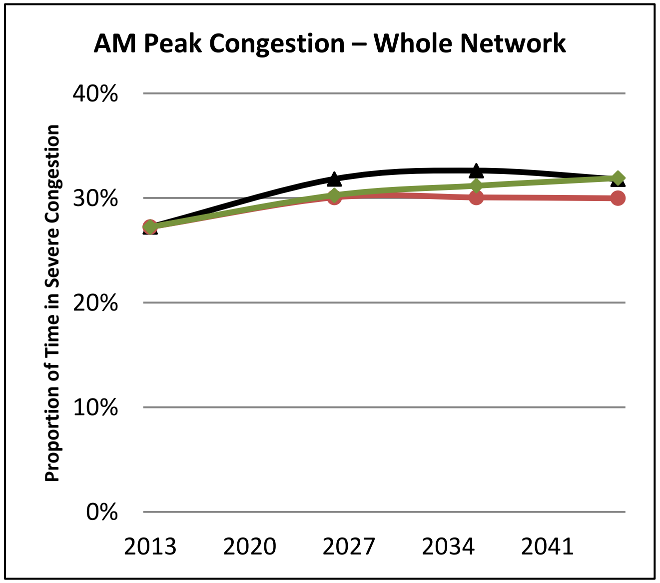
At the regional level, however, there is relatively little difference between the packages for key measures by the end of the third decade. This is because the infrastructure programmes tested only change a small part of the overall transport network

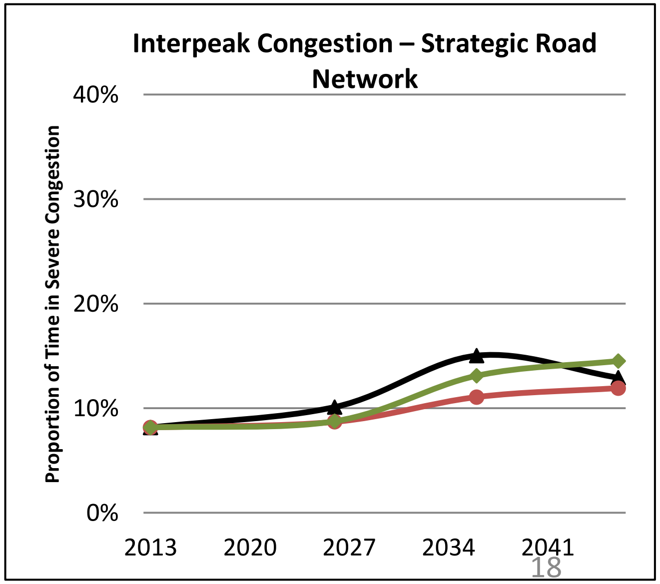
This suggests that changing the mix of investment within current expenditure levels will not achieve a 'step-change' in regionwide performance.











HB1-306

Addressing Access Challenges in the West and South

2. Key Learnings

Specific interventions can help address identified deficiencies in the west and south

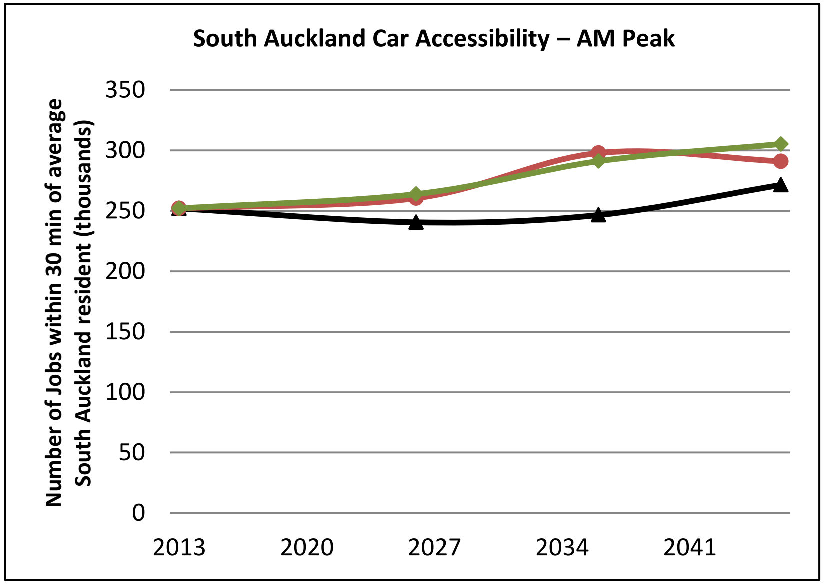
Access challenges in west and south Auckland

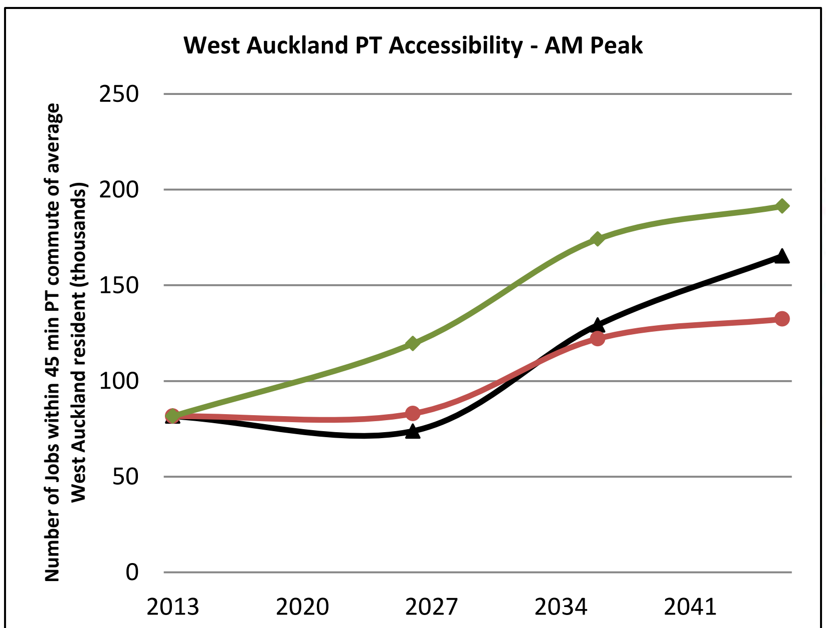
- The Foundation Report highlighted significant accessibility challenges in west and south Auckland.
- These findings were particularly concerning given substantial projected growth and higher levels of deprivation in these parts of Auckland.

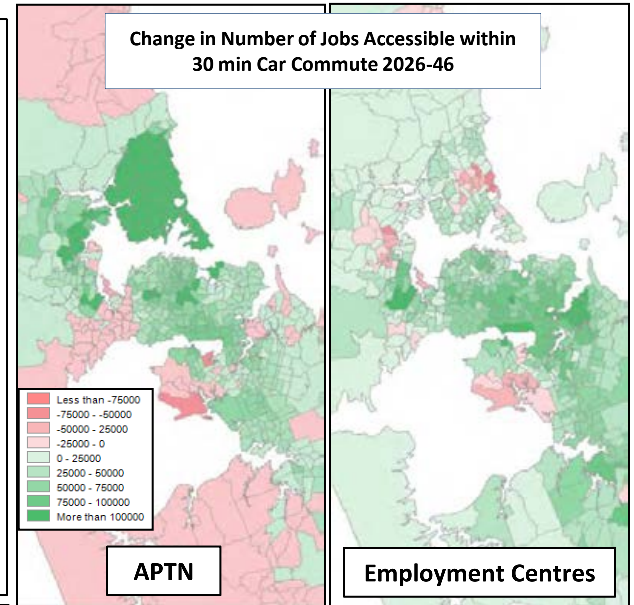
Different investment mixes do have sub-regional impacts

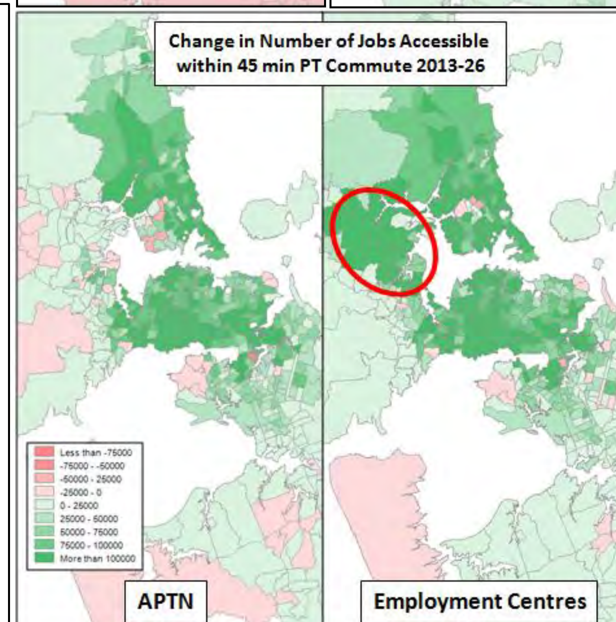
- Reconfigured motorway widening contributes to increasing 2046 South Auckland car accessibility by around 12% (34,000 more jobs within a 30 minute car commute)
- Advancing Northwest Busway contributes to increasing 2026 West Auckland public transport accessibility by around 60% (45,000 more jobs within a 45 min PT commute)

APTN
Capacity Constraints
Employment Centres









Addressing Public Transport Capacity Constraints

Continued growth in public transport ridership will put pressure on key bus corridors into the central area

Strong Projected Public Transport Growth

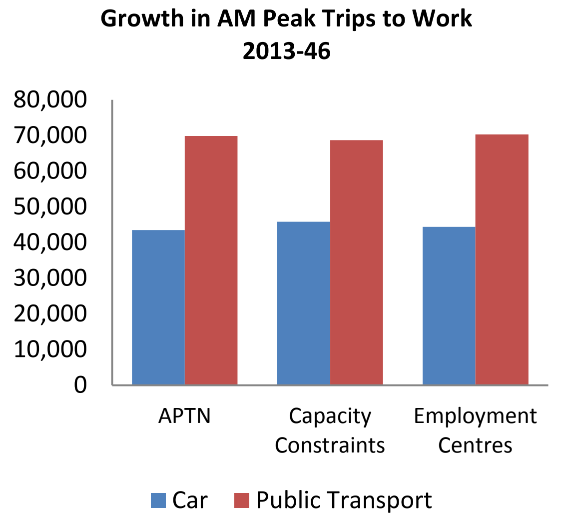
- Public transport ridership is expected to triple by 2046.
- Public transport expected to carry the majority of growth in AM peak trips to work over the next 30 years.

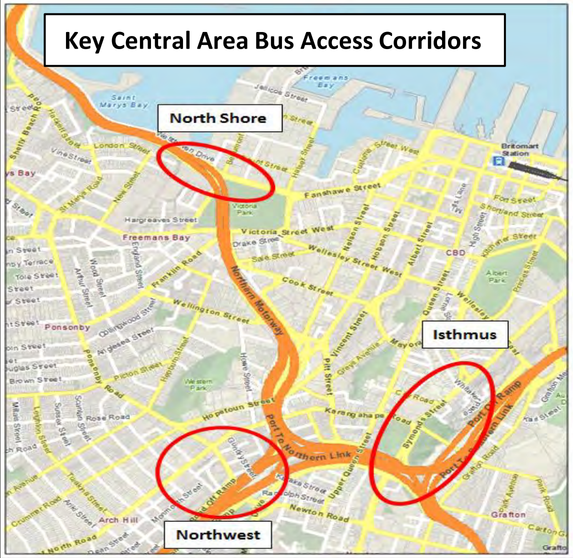
Concentration of Trips in Central Area

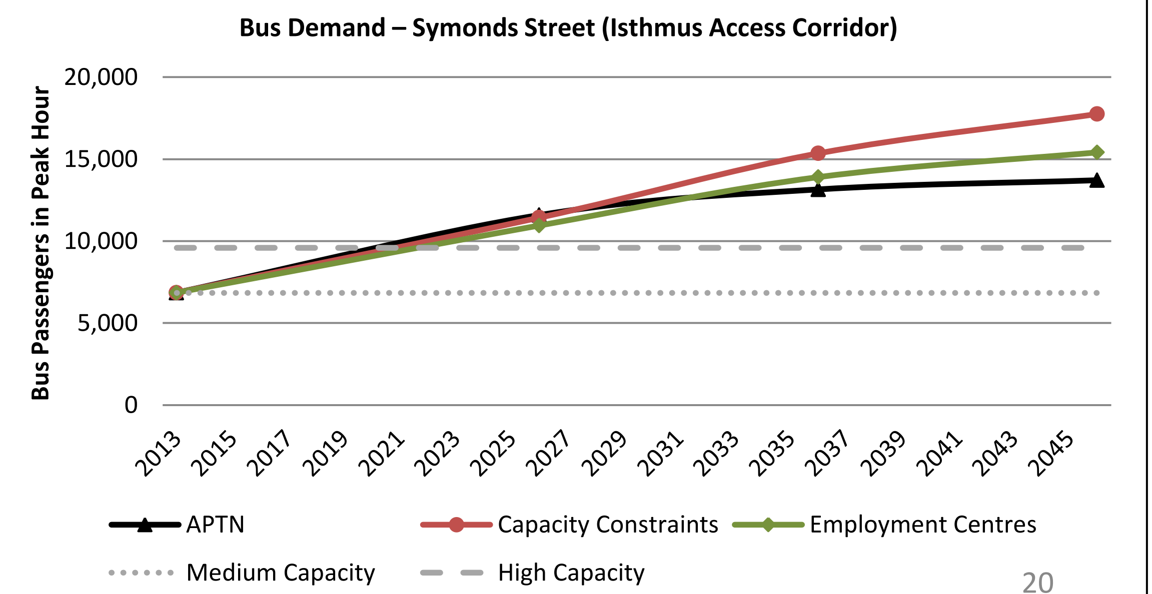
- The greatest concentration of PT trips is related to accessing Auckland's largest and fastest growing employment centre, the central area (city centre & fringe, Newmarket)
- Rail network serves the west, south and eastern parts of Auckland. However, access to central area from much of the isthmus, the North Shore and the northwest currently relies upon buses.

Bus Capacity Constraints

- There is substantial projected growth in bus passenger numbers accessing the central area from the isthmus, North Shore and the northwest.
- The number of buses required to meet this demand is channelled into a few key corridors and is reliant upon limited space within the city centre for passengers to board and alight.
- These constraints will have a widespread impact on the effectiveness of the bus system to meet demand, with widespread overcrowding projected on a variety of routes serving the isthmus, North Shore and the northwest. This will increase delays and decrease reliability.
- In the short term, efficiency improvements to the bus network (completing currently planned bus infrastructure improvements, rerouting services and fully utilising benefits of the City Rail Link project) will help to address these challenges.
- Beyond this, however, it appears that substantial further capacity increases are required to avoid severe overcrowding.







Addressing Auckland Harbour Bridge Constraints

HB1-508

The existing bridge has limits on its ability to cater for growth in heavy vehicles, but any new crossing will require very substantial investment

2. Key Learnings

Preserving the Auckland Harbour Bridge's Lifespan

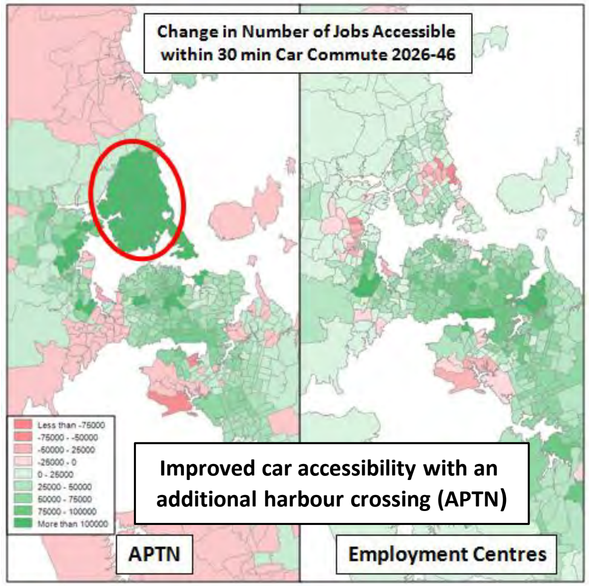
- The Auckland Harbour Bridge is one of the most important pieces of transport infrastructure in New Zealand, being both State Highway 1 and the main connection between the North Shore and the rest of Auckland. Preserving the bridge's lifespan is critical.
- Although strengthened in the past decade, the bridge has limitations in its ability to cater for growth in heavy vehicle traffic. Some level of heavy vehicle management will be necessary in the future to preserve its lifespan.
- Depending on the timing and nature of any restrictions on heavy vehicle traffic, there could be substantial economic costs for Auckland and New Zealand.

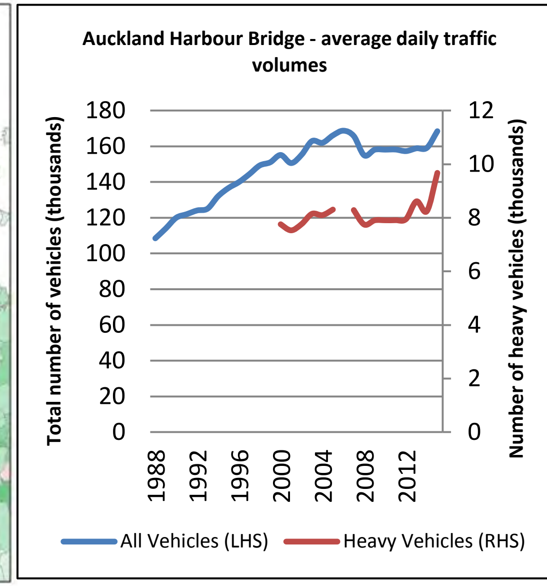
Improving access to and from the North Shore

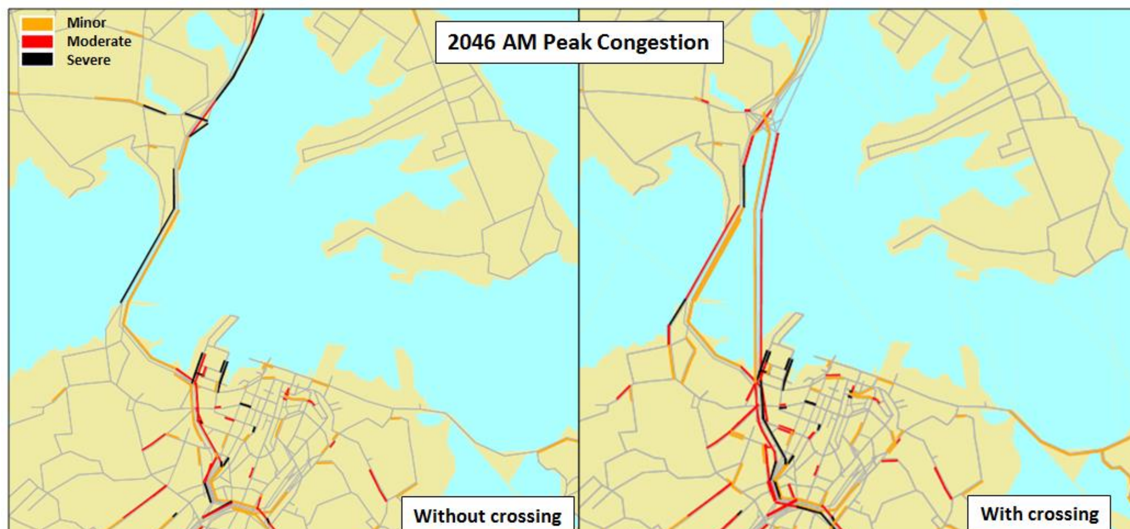
- The bridge and its approaches are a pinch-point on the transport network, particularly during the evening peak in both directions.
- An additional crossing significantly improves accessibility to/from the North Shore but does not appear to substantially improve congestion results.
- Projected growth in public transport demand appears likely to trigger the need for a new crossing within the next 30 years. There is potential for a shared road/PT crossing but the costs and benefits of different options require further analysis.

High cost of potential solutions

- Because any new crossing will be tunnelled, there is a significant opportunity cost arising from this investment. Fully understanding key drivers, alternatives, cost and benefits will be crucial before any investment decisions are made.
- It makes sense to protect the route for a new harbour crossing in a way that integrates potential future roading and public transport requirements.







Addressing Auckland's Housing Challenge

Enabling growth in newly developing areas will require significant transport investment.
Early investment in route protection, land acquisition and investments to support Special Housing Areas is critical

Transport enables growth

- Enabling and supporting a faster rate of housing development in Auckland is a critical element of improving housing affordability.
- Transport investment is a key enabler of growth, particularly in greenfield areas where transport shapes growth patterns and investment is required before growth can occur.

Substantial and ongoing investment to support greenfield growth

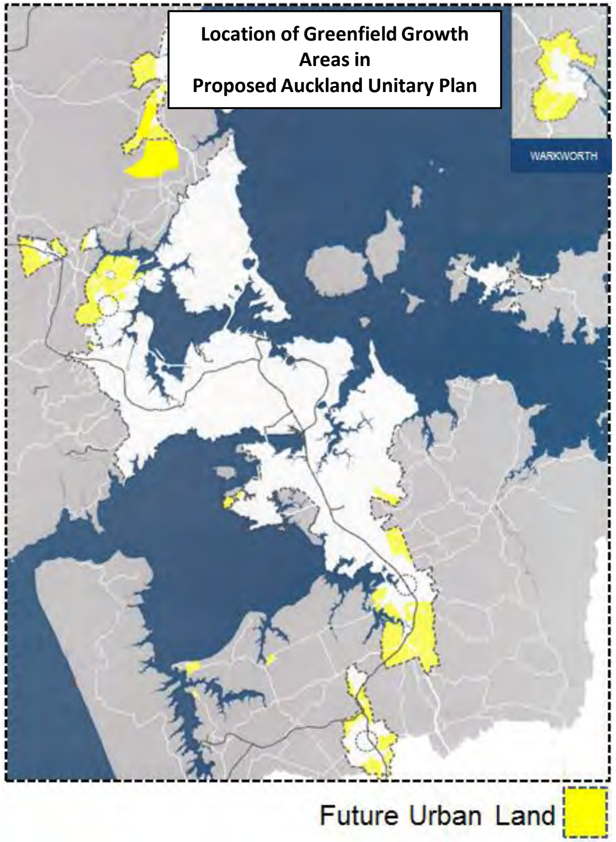
- Over 11,000 hectares of "Future Urban" land is identified in the Proposed Auckland Unitary Plan. New transport (and other) infrastructure is required to make this land ready for development.
- Travel demands generated by growth in these areas will also place pressure on existing networks, particularly as more peripheral areas tend to have longer average trip lengths and a lower use of public transport, walking and cycling.
- There are also substantial ongoing operational costs arising from this growth.

Early Focus

- Substantial early investment in route protection and land acquisition for future transport infrastructure will be required to minimise future costs and protect alignments.
- Early investment is also required to support Special Housing Areas, address current deficiencies and enable a faster rate of development, particularly in the northwest and parts of the south.

Urban redevelopment

- Major new infrastructure to enable greenfield growth will take a number of years to be constructed.
- Ensuring planning rules enable growth in locations with existing transport capacity and good access will have significant transport benefits and reduce investment requirements.



Potential future transport improvements to serve south Auckland growth

New opportunities: Variable Network Pricing

ATAP has explored the potential to use variable road network pricing as a demand management tool to achieve better network performance against ATAP objectives.

- The goal of demand management pricing is to achieve better performance by pricing users to face a greater proportion of the true costs of their travel, including impacts on other users. Over time this can reduce the extent of investment required in the transport system.
- Road pricing can improve transport network performance by changing travel patterns through shifting the mode, route or time of travel in a way that improves the efficiency of the transport system.
- Developing technologies enable more sophisticated pricing systems to be examined than was envisaged by earlier work – including whole of network dynamic pricing schemes.
- Early analysis looked at different options (CBD cordon, motorway access charge & whole of network system). Whole of network system had biggest impact and was merged with the motorway access charge (by applying slightly higher rates on the motorway network) in subsequent analysis.

Hypothetical network-wide pricing system

- Modelling was undertaken to investigate the impact of a hypothetical network-wide pricing system, with varying charges (between 3c and 40c per kilometre) depending on time of day, location and type of network travel occurs within (see table).
- Highest prices targeted to areas with most congestion and where travel alternatives are most available (e.g. the “inner urban” Auckland isthmus).
- Pricing tested with accompanying infrastructure investments focused on providing sufficient public transport capacity was available where possible to meet changing travel patterns. Reported as the “Managing Demand” package

		Peak	Inter-Peak	Off-Peak (night)
Inner Urban	Motorways	Highest Increase	Medium/High Increase	Decrease
	Other Roads	Medium/High Increase	Medium Increase	Decrease
Outer Urban	Motorways	Medium/High Increase	Medium Increase	Decrease
	Other Roads	Medium Increase	Smallest Increase	Decrease
Rural	All Roads	Decrease	Decrease	Decrease

HB1-311

New opportunities: Variable Network Pricing

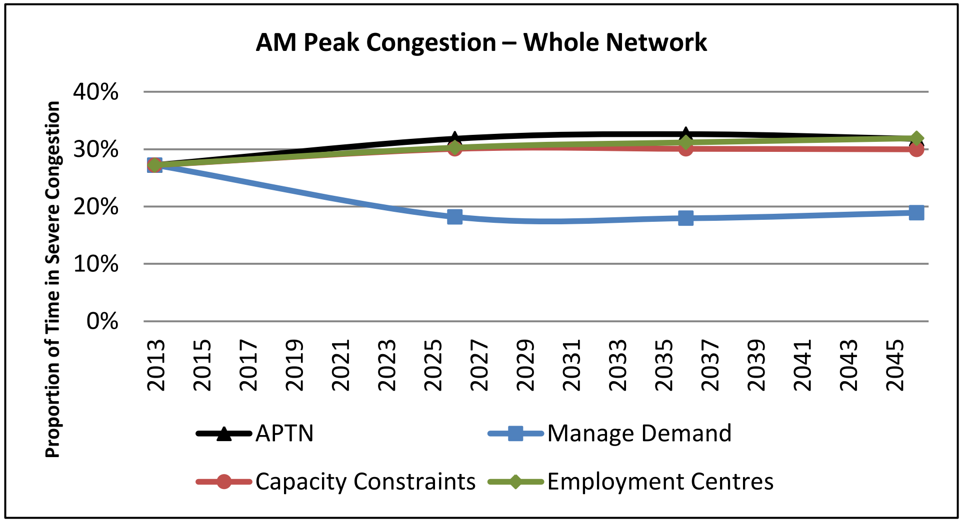
Model results show encouraging impacts on ATAP performance objectives, but further work is needed to assess user impacts

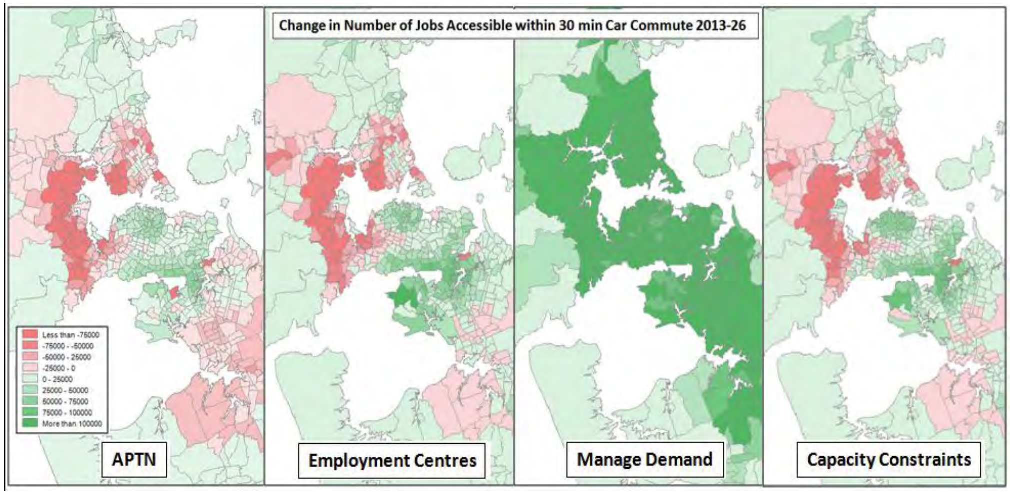
Encouraging impacts on ATAP performance objectives…

- Pricing has a substantial regional impact on congestion, leading to a significant reduction from current levels and well below the other packages tested.
- Pricing also leads to major accessibility improvements (in terms of how many jobs can be reached within certain commute times) due to reduced congestion.
- A substantial growth in public transport mode share was also evident with the introduction of pricing.
- As its impacts are far greater than different mixes of investment, pricing can help to avoid or defer significant infrastructure investment
- Pricing is adaptable, can be phased in over time, and changed to meet changing circumstances or demands. Unlike infrastructure investment, it is also reversible if it fails to meet its objectives.

…but further analysis is required to properly understand net user impacts and overall value for money

- Price levels tested so far indicate a net financial cost to users, based on the analytical tools available. Further refinement of pricing levels is underway to inform the final report.
- The improved congestion performance is a result of some trips being "priced off" the network. Overall value for money assessments need to consider wider benefits to society but also the potential for deferred/reduced transport expenditure that could be very substantial.





New opportunities: Transport Technologies

Emerging transport technologies have the potential to enable much more efficient use of existing transport infrastructure and to achieve better transport outcomes. The timing and impact of new technologies, which will be driven by private sector innovation, remains uncertain, but appear likely to have profound effects within the next 30 years.

Two different scenarios tested:

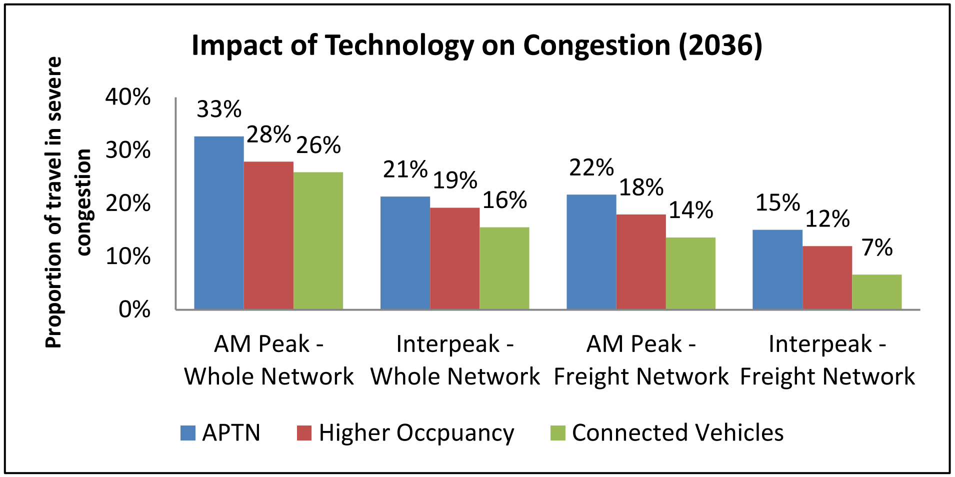
- "What-if" technology scenarios testing the impact of aggressive increases in vehicle occupancy (from more ridesharing enabled by ongoing IT advances) and connected vehicle uptake from current and future improvements in vehicle technology.
- All options were tested with a low-level investment programme to understand the impact of technology alone.

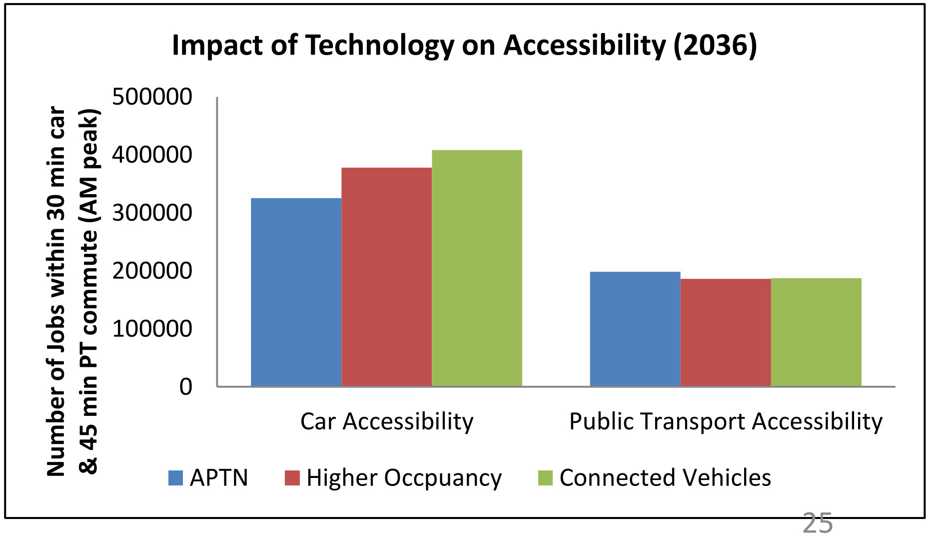
Initial results are encouraging…

- Increased vehicle occupancy delivers positive car accessibility and congestion outcomes.
- Improved vehicle connectivity delivers very positive outcomes – and is potentially easier to implement as it relies on technology rather than human behaviour change.
- The effect of these changes are cumulative, so both shared mobility and connected vehicles appear worth pursuing.
- Timing is important: the scenarios were developed for 2036: need to determine whether this is plausible, and what might occur in the meantime.

… but probably reflect a "best case", and some caution is needed…

- Scenarios assume a reasonably aggressive uptake of shared mobility and connected vehicles: further work needed to identify a level of uptake which is both sufficiently ambitious and plausible.
- Uptake of shared mobility will rely on behavioural change as well as technology – this has proven to be very challenging in the past.
- The results show a strong switch from PT to shared cars: however, this needs further analysis as it may simply reflect the way it is modelled.
- No attempt was made to estimate the impact of new technology on the overall demand for travel.





3. Emerging strategic approach

3. Emerging Strategic Approach

- Towards a strategic approach
- Influence travel demand patterns
- Make better use of existing networks
- Provide new infrastructure and services

Towards a strategic approach: embracing new opportunities

- Historically, our approach to dealing with Auckland's transport issues has focussed on investment in roading and public transport infrastructure and services, and optimising where possible to make better use of existing assets.
- Over time, this approach has become increasingly expensive and has struggled to keep pace with the demands that growth is placing on the system. Our analysis has shown that continuing on this path can deliver localised benefits, but will not provide the step change in transport system performance that Auckland needs.

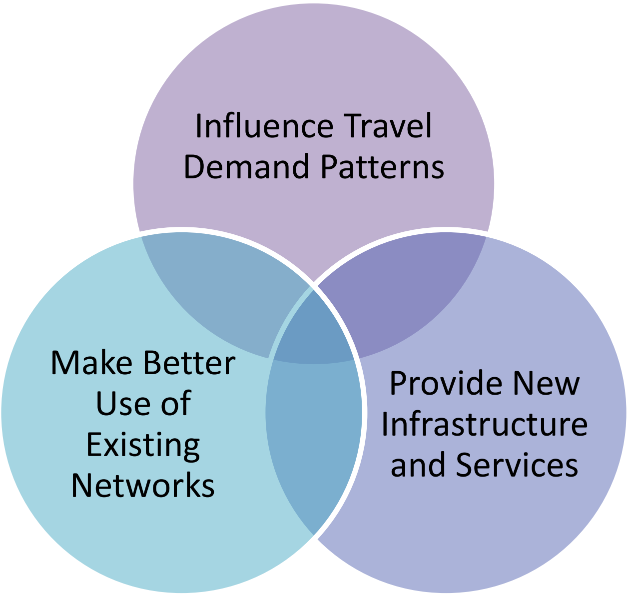
To achieve this, a change in approach is needed. What are our options?

Should we build more?	Or should we address demand?
One path is to focus on greater transport 'supply-side' provision by significantly accelerating the development of new infrastructure and services, to enable supply to get ahead of growth in demand. Although this option has not been specifically tested to date, our analysis suggests that this would be a very expensive approach, with diminishing returns over time. As growing cities around the world are finding, adding new infrastructure in existing urban areas requires increasingly expensive solutions. Only building our way out of the problem does not offer a compelling future.	An alternative path is to take advantage of new demand-side opportunities that have previously not been available. Rapid advances in transport and communications technology provide opportunities to influence the demand for private vehicle travel, through variable road pricing and the emergence of "mobility as a service" technologies. In addition, advances intelligent transport system (ITS) and vehicle connectivity provide the opportunity for significant gains in network productivity. Our analysis has shown that, in combination, these initiatives have the potential to provide a step change in system performance.

- Auckland's continued growth means there is a need to continue work on optimising the current network, and adding new infrastructure and services. However, these actions will not on their own be sufficient. To make a real difference, we need to also take advantage of new demand-side opportunities, which will offer Auckland-wide benefits, and ensure these are integrated with our investments and optimisation plans.

Emerging strategic approach

The emerging strategic approach involves an integrated combination of three types of intervention



Influence Travel Demand Patterns

- Ensure land-use decisions support an efficient transport network
- Maximise opportunities from new technologies to increase vehicle occupancy and throughput
- Progressively introduce a variable network pricing system to encourage more efficient travel patterns and reduce the long-term need for investment

Provide New Infrastructure and Services

- Tailor solutions to suit different circumstances
- Ensure transport enables and supports growth to address Auckland's housing challenge
- Strengthen strategic road, rail and public transport networks to ensure sufficient capacity, resilience and efficiency

Make Better Use of Existing Networks

- Better prioritise existing networks to more effectively deliver their required tasks
- Continue to improve efficiencies in maintaining, operating and renewing existing networks
- Accelerate the use of intelligent transport systems to provide real-time information and enable the benefits of emerging technologies

HB1-316

Recommended pathway

- The recommended approach requires a strong commitment to influencing travel demand patterns. This brings some implementation challenges, but the potential gains mean that a proactive approach is justified.
- In the short term this means prioritising resources towards making the transport system "technology ready", and laying the groundwork for variable network pricing, to enable a staged implementation.
- Because the benefits from these demand-side interventions may take some time to materialise, we need to ensure that progress is made on investments to improve our strategic networks and support Auckland's growth. Priority should be given to investments that will be required regardless of pricing or technology changes and investment that enable and support Auckland's continued growth

1st decade

- Better optimise use of the existing transport network
- Remove barriers to new technology and provide incentives to encourage uptake
- Pave the way for the staged implementation of variable network pricing
- Prioritise investments that facilitate early implementation of tools to influence demand
- Prioritise route protection, land acquisition and commence delivery of infrastructure in growth areas

2nd & 3rd decades

- Accelerate uptake and implementation of new tools
- Address public transport capacity constraints that may be exacerbated by pricing
- Continue base investment to enable and support growth

Implementing the recommended strategic approach will require the following issues to be addressed:

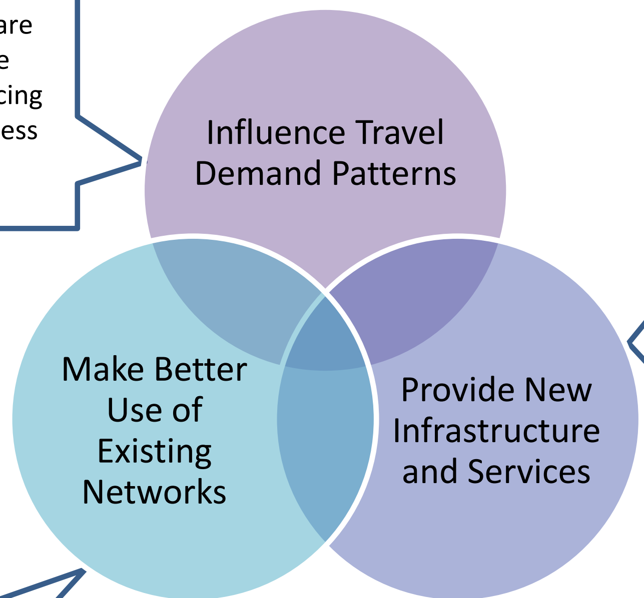
- How we accelerate a range of complementary interventions to influence future demand: including ride share services, connected vehicles, and pricing
- Whether to change level of investment in the first decade
- Where to focus early investment

HB1-317

Key elements of the emerging strategic approach

The following slides provide detail on the key elements of the emerging strategic approach

To take advantage of the significant potential benefits, early actions are needed to pave the way for the adoption of variable network pricing and new technology; and to address implementation issues and uncertainties



Transport investments need to support Auckland's growth. New urban growth areas in the north, north-west and south will need early investment in transport infrastructure before growth can occur.

Targeted investments are required to strengthen the ability of strategic networks to deal with the impacts of growth in travel demand, and to ensure that the strategic road, rail and public transport networks have sufficient capacity and resilience to operate effectively.

Improving the productivity of the existing transport system can be very cost-effective and potentially delay the need for more expensive investments in new infrastructure. In some key parts of the network (e.g. arterials) this will require difficult trade-offs

HB1-318

Influence travel demand patterns

- There is potential for significant benefits from a shift to variable network pricing, and mobility as a service technologies, which can influence travel behaviour, especially for single occupant vehicles. The benefits from these tools appear to be much stronger than traditional supply-side interventions.
- To maximise the opportunities that pricing and technology present, we need to take early actions to facilitate their adoption; and to address the issues and uncertainties that have been identified. Actions in the first decade will have a big influence on our ability to capture the potential benefits of technology in later decades.

<table>
<tr><th>Implementation Path - Pricing</th><th>Implementation Path - Technology</th></tr>
<tr><td>

Progress further work to understand how and when a network-wide pricing system could be introduced in Auckland through a staged implementation pathway (including how national implications of such a system would be addressed).
Undertake work to identify social and economic impacts, and how these should be mitigated
Examine merits of an interim pricing scheme as a step towards implementation of a network-wide approach. Partial schemes may achieve some level of performance improvement but also may generate unintended outcomes (e.g. discouraging growth in some areas, shifting traffic flows) that need to be fully considered.
Identify how variable network pricing might be phased in over time, in a manner that is compatible with any future development of the national charging system. The most likely implementation path for pricing would be a ‘phasing in’ approach, potentially over a fairly long time period. This could include some vehicle-type s (e.g. heavy vehicles) being phased in first. Other ways of phasing in pricing could be to shift to a GPS-based system but initially charge at current levels, with prices moving to variable rates over time
Identify any necessary investments that may be required ahead of implementing a pricing scheme to deal with shifts in travel behaviour.
Refine analytical tools to better understand the detailed effects of pricing. Current tools used to assess impacts of pricing have significant limitations.

</td><td>

In the short term, adopt a proactive approach to making the transport system “technology-ready”, by:

making maximum use of current ITS technologies, e.g. better synchronising traffic lights
investing in ITS improvements that will enable benefits of connected vehicle to be realised at an early stage
ensuring that regulatory settings don’t act as a barrier to technology uptake, and enable the private sector to respond and innovate;
providing incentives to increase vehicle occupancy. (e.g. road pricing)
ensuring that technology helps facilitate a move to variable network pricing
gaining a better understanding of behavioural aspects related to ridesharing, and identifying actions that are most likely to increase uptake

Not able to conclude at this stage which infrastructure investments should be delayed or discarded due to technology changes. It would be risky to do this in the short term, given levels of uncertainty and high growth.

</td></tr>
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Further work required for final report: Better understand the next steps for enabling the use of these tools

Make better use of existing networks

- Investments in new major transport infrastructure can be expensive and disruptive. Therefore, improving the productivity of existing transport networks can be very cost-effective and potentially delay the need for more expensive investments in new infrastructure.
- There appears to be significant potential to increase road network productivity in Auckland, particularly the arterial network. This requires:
  - a stronger focus on network-level strategic planning of arterial roads to provide an effective basis for prioritisation, and addressing the trade-offs between competing activities on the network
  - taking advantage of new ITS technologies to assist with network optimisation
  - a stronger commitment to addressing incompatible activities, such as removal of parking on arterial roads
- The recommended strategic approach identifies opportunities to significantly increase future road productivity through technology improvements, particularly connected vehicles. ITS investments that enable these opportunities to be realised earlier should be prioritised.
- There are also opportunities to improve the productivity of the public transport system. For example, improvements to bus operations on high volume corridors can help to delay the need for large-scale investments in new mass-transit infrastructure.
- International evidence suggests improved asset management processes can also deliver significant benefits, improving efficiencies and informing the optimal timing of intervention. In the long-term this could lead to substantial savings in maintenance and renewals.

Further work required for final report: providing direction about how the existing network can be further optimised.

HB1-320

Provide new infrastructure and services:

Ensure that transport enables and supports growth

- New urban growth areas in the north, north-west and south will need investment in transport infrastructure before significant growth can occur.
- Without investment, a lack of transport infrastructure will constrain development in these areas. Early growth areas in the north-west and south require new internal and external connections within the next decade to enable their development.
- An early investment focus on route protection and land acquisition is required to ensure investment is able to proceed when required and in a cost-effective way. Route protection helps avoid incompatible development and reduces the cost of land purchase for key projects.
- Early investment will also be needed to support Special Housing Areas, address current deficiencies and enable a faster rate of development, particularly in the north-west and parts of the south.

- Transport investment within the existing urban area can also unlock growth by providing improved accessibility and making redevelopment more market attractive. Projects like AMETI, which improves access and connections in east Auckland, are important catalysts for growth, especially in the town centres they serve. Similarly, ensuring that planning documents enable growth in areas with good accessibility and spare capacity is an important way to minimise future investment requirements.
- The extent to which a transport investment enables growth should be an important consideration in its prioritisation for funding.

Further work required for final report: understand which potential investments enable the greatest level of growth, particularly in the next decade.

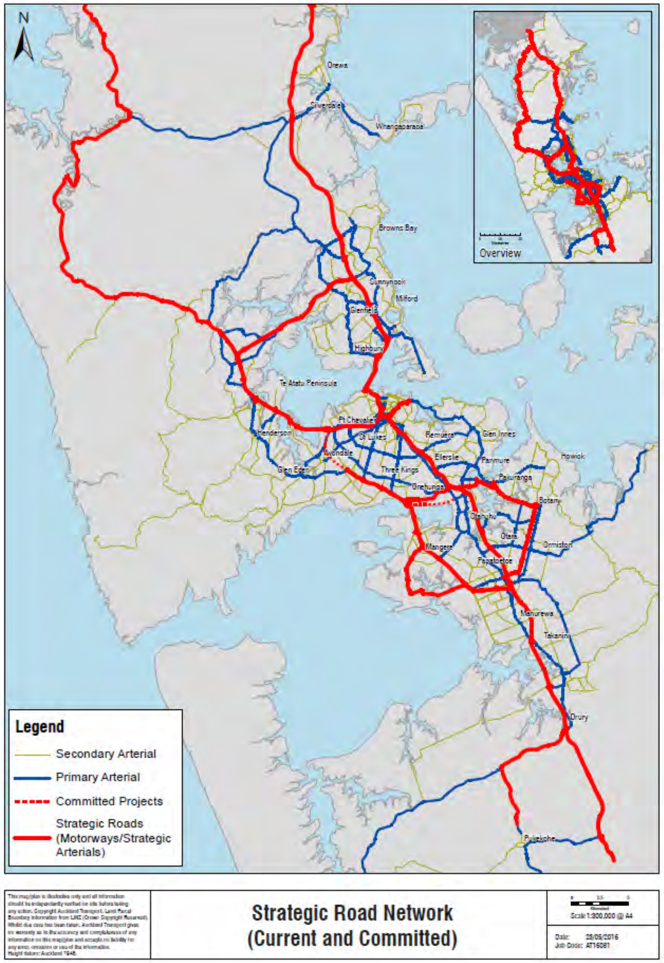
Provide new infrastructure and services:
Targeted investment to strengthen strategic networks

- The strategic road, public transport and rail networks carry a significant proportion of the daily transport task in Auckland.
- They are essential economic arteries, enabling access between different parts of the region, and connections to other parts of the country.
- As Auckland grows, demand pressures on these strategic routes will increase. Maintaining strong and resilient strategic networks that can cope with these increased demands is essential.

- Although there are some opportunities to add new corridors to these networks, this is often expensive and disruptive, especially in existing urban areas.
- This means that a targeted investment approach will be required to deal with the impacts of growth, and to ensure that the core parts of the network have sufficient capacity to operate effectively. The different investment drivers and emphases across each network are described in the following slides.

- A key focus for the next phase of the project is determining the relative priorities for improvements to the strategic networks and the extent to which some of them could be brought forward to deliver benefits at an earlier stage.

Strategic Road Network | Strategic Public Transport Network | Rail Network



Investments to strengthen the strategic road network

Context

- In the existing urban area there are very few opportunities to add new strategic road corridors beyond projects already underway (e.g. Waterview Connection) or committed (e.g. East-West Connections).
- Corridors protected many decades ago have now been largely utilised. Therefore, additional major new roading corridors will either have significant social/environmental/property impacts or will need to be expensively tunnelled, which makes achieving value for money challenging.
- Preliminary analysis suggests major new corridors in existing urban areas (e.g. a new Eastern highway corridor combined with an eastern harbour crossing) would be unlikely to deliver sufficient access improvements or congestion relief to the existing strategic network to offer value for money.

Broad Approach to Strategic Road Network

- Focus on improving existing strategic corridors, widening where needed, with some new connections e.g. East –West Connections, greenfield sites.
- In the long term, there is potential for greater productivity of the strategic network through ITS and vehicle technology improvements which will enable greater throughput.
- Variable network pricing will also enable improved management of the strategic road network to prioritise high value trips.
- In the short to medium term, growth in demand appears likely to drive the need for further improvements to the strategic road network.
- The drivers for these improvements will differ across Auckland, as outlined below:

Central Isthmus	North	West	South
• Inner parts of the motorway network are particularly constrained. In these areas, investment beyond highly targeted choke point treatments appears to deliver limited gains compared to the cost. • Improvements to SH20 (Southwestern Motorway) should focus on optimising available capacity in the Waterview Connection, the Mangere Bridge and the proposed East West Connections. • Ensure port connections are consistent with future port operations.	• Northern Motorway: future enhancements will be strongly tied to timing of Additional Waitemata Harbour Crossing (AWHC) and greenfield growth in the longer term, leading to demand growth north of Albany. • AWHC: protect route for a new crossing, but further analysis of drivers and timing, and better integration with public transport options is needed before investment decisions are made.	• SH16 (Northwestern Motorway): growth in the northwest will place this corridor under increasing strain: improvements should focus on optimising corridor, alongside proposed busway. • SH18 (Upper Harbour Motorway) upgrades are strongly related to enabling projected growth and providing access between the west and the North Shore.	• Southern motorway: once current improvements complete, shift focus to improving airport access from the east and optimising capacity between Manukau and the isthmus. • Upgrades to SH22 (connecting Pukekohe and Drury) and southern part of the southern motorway will be strongly driven by when growth occurs in the southern greenfield area • Investments in AMETI and the Mill Road corridor (the main arterial roading connection for new growth areas in the south) should seek to optimise the southern strategic roading network, improve freight reliability and enhance resilience.

HB1-323

Investments to strengthen the strategic public transport network

Context

- Public transport demand is projected to increase strongly under all future options, partly in response to investments that are already committed (e.g. City Rail Link).
- As Auckland grows, the strategic public transport network (current and future rapid transit and mass transit corridors) will need to carry an increasing proportion of this demand to provide fast, high-capacity attractive services that are reliable and free from road congestion.

Two Key Investment Drivers

- Future investment in public transport is expected to be focussed in two key areas: responding to capacity constraints on the current system; and expanding the strategic network to provide an alternative to car travel, especially in growth areas.

Respond to Capacity Constraints	Expand the strategic public transport network to improve overall network efficiency
• Demand projections for public transport have highlighted an emerging need for a step-change in capacity along some key corridors in the future. The timing and sequencing of this needs to be addressed as a system-wide wide strategic issue. • The future volume of buses needed to meet projected demand will create capacity constraints at key ‘pinch-points’ entering the city centre. Unless addressed, bus speeds and service levels will reduce, and overcrowding will limit the ability for public transport to meet its required share of the transport task in a critical part of the network. • Short term efficiency improvements to existing bus operations will address some of these problems, as will the City Rail Link. At some stage, however, substantial further capacity increases will be required. • The most pressing challenge is to relieve corridors serving the isthmus; followed by those serving the North Shore. • The specific investment response and proposed timing and are the subject to further analysis and will need to be considered alongside other regional priorities. At this stage it appears that an investment that enables many more people to be carried on substantially fewer vehicles will be needed.	• Public transport has an important role to play in enhancing the efficiency of the transport network by enabling greater person-throughput on main corridors. • This role is particularly important in serving new growth areas, which are likely to have longer average trip lengths and place considerable pressure on the transport network. Growth areas to the North and South can be connected to the rapid transit system through extensions to the Northern Busway and rail electrification from Papakura to Pukekohe. • There is no existing rapid transit connection to the new development areas in the North-west, where growth is expected to take place at an early stage. The most cost-effective rapid transit connection is the proposed Northwestern busway. The analysis shows that this would significantly improve accessibility to the West. • A future rapid transit connection would improve accessibility and provide a congestion-free alternative for travel to the Airport, where employment and visitor travel demands are growing rapidly. At this stage, the focus should be on route protection. Heavy rail is not favoured because it is more substantially more expensive and disruptive and would require a significant up-front investment to secure a suitable route within the airport precinct. • Further busway connections between Botany, Flat Bush, Manukau and the Airport should be timed to align with growth and addressing congestion levels along these corridors

Further work required for final report: when should these investments proceed, and how should they be prioritised?

4. Next steps

- 4. Next Steps
  - Steps to the final report
  - How should we prioritise future investments?
  - Feedback sought

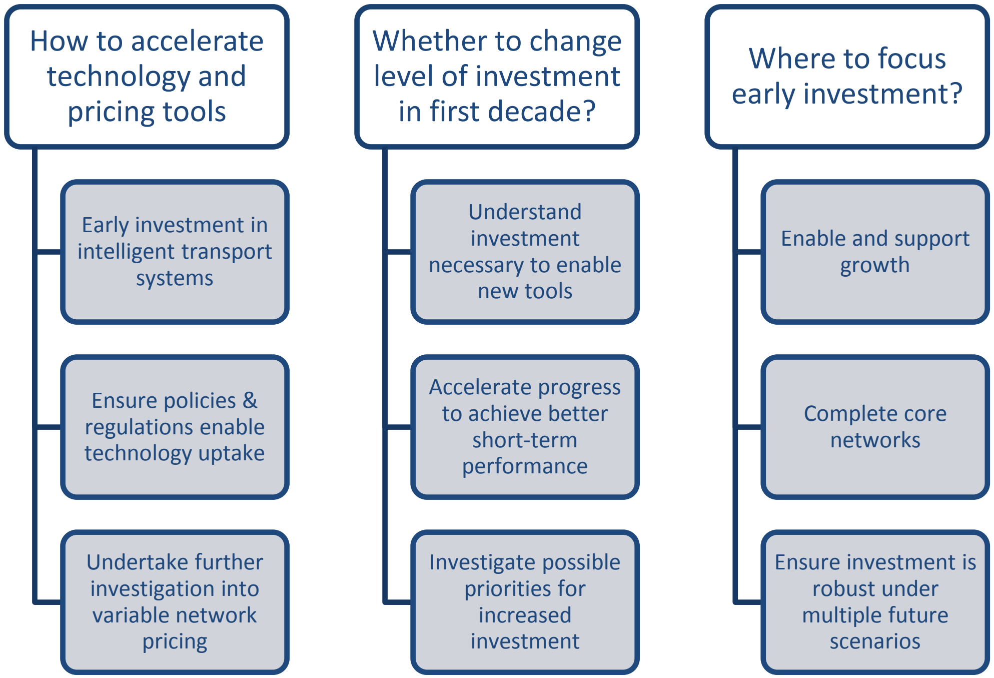
HB1-325

Steps to the final report

Review and feedback on this report from parties (by mid-June) → Third round testing during June-July → Final ATAP report (August)

Current Evidence Gaps	Final ATAP Report
The next stage of the project will include: • Further modelling and evaluation to supplement the work to date, and provide sufficient evidence to support the recommended approach, and demonstrate its costs and benefits • Development and application of a prioritisation framework consistent with the preferred strategic approach **Evidence gaps:** • The extent to which a refined programme could improve outcomes (with no additional funding) • Whether additional or advanced funding is value for money (we have not tested a higher level of investment) • Whether we can ensure net benefits to users from introducing pricing • The combined impact of pricing and technology • Priority/triggers for the big investments • Value for money and contribution to the wider economy • The impact of a faster than projected rate of population growth	The final ATAP report will recommend an aligned strategic approach for the development of Auckland's transport system that delivers the best possible outcomes for Auckland and New Zealand. To meet the ATAP Terms of Reference, this will: • Include an assessment of whether better returns from transport investment can be achieved • Include preferred indicative package(s), for the long-term development of Auckland's land transport system • Indicate the costs, benefits and other implications of implementing the aligned strategic approach and its main alternatives • Include recommendations on how to implement the aligned strategic approach (including consideration of further work and any changes to statutory documents)

Issues to address in developing and implementing the recommended approach



- The final deliverable will identify the steps needed to ensure the next round of statutory documents relating to transport planning and funding in Auckland (including the Government Policy Statement, Regional Land Transport Plan, National Land Transport Programme, and Auckland Plan) are aligned with the strategic approach
- It will highlight the need to invest in improved modelling tools to enable the more detailed investigations needed to give effect to the preferred strategic approach (e.g. models that enable the impacts of pricing and technology to be better understood)
- The final deliverable will also identify where the current planning and funding system may need to change to give effect to the preferred strategic approach. The details of resolving these issues will need to occur beyond ATAP.

HB1-327

Proposed approach to Round 3 testing and what it will tell us

Recommended Approach	Alternative Investment Approaches	Scenario testing
• Show what our recommended approach will achieve & how it meets project objectives • Show the impacts of variable network pricing , timing and phasing implications • Show what investments in the current approach are/are not needed if pricing is introduced • Identify any specific investments needed to enable pricing (especially in first decade)	• Show how far you can get without a stronger focus on managing demand • Show what outcomes can be achieved from additional funding in the first decade • Better understand value for money from different levels of transport investment	• Test a higher rate of population growth to show requirements if recent growth levels continue

How should we prioritise future investments?

As part of the strategic approach there will be a need to prioritise key investments:

- Existing committed expenditure means there is high competition for available funds, particularly in the short-medium term
- Clear prioritisation can enable us to decide which investments should be in each decade.

A prioritisation framework will be developed and refined as part of the next stage of ATAP.

In delivering value for money, recommended prioritisation criteria should include :

- Address most severe deficiencies against ATAP objectives
- Resilience to a range of different futures (pricing and technology)
- Unlock growth required for Auckland

Feedback sought

To enable project timeframes to be met, feedback on this report from the parties is needed by mid-June.

Feedback on the following issues will be particularly useful to the project team:

- Is the emerging strategic approach supported?
- Do the parties support a move to embrace new technologies and demand management (variable pricing) as part of the preferred approach?
- Are there any differences in approach that should be considered?
- Are the recommended prioritisation criteria appropriate?
- Are there any additional issues that need to be addressed or options tested in the next phase of the project?

Auckland Cycling Programme Business Case

September 2017

TABLE OF CONTENTS

SUPPORTING DOCUMENTS

1. Auckland Cycling Programme Business Case – Supplementary Material
2. Auckland Cycling Programme Business Case – Demand and Economic Assessment

EXECUTIVE SUMMARY

The purpose of the Auckland Cycling Programme Business Case is to establish a case for investment in a programme of cycling activities in Auckland over the 2018-2028 period. This summary highlights the strategic case for investment, the recommended programme and assessment of its impacts.

1.1 Strategic context

There is a significant opportunity for cycling to play a more substantial role in contributing to a more effective Auckland transport system. During the programme period, transport demands will continue to grow strongly alongside population and employment across the region, placing increasing pressure on congested networks. Structural transformation in Auckland's economy is likely to be accompanied by increasing concentration of employment in the City Centre and other employment hubs, placing further pressure on access routes to these areas.

Cycling currently plays a minor role in Auckland's transport system, relative to other large New Zealand cities and international comparator cities. The opportunity for increased cycling in Auckland is to:

- Play an increased role for short-medium distance commuting trips, with particular value where it can shift trips off congested road and public transport networks
- Provide connectivity to Auckland's developing Rapid Transit Network, increasing the reach and transport accessibility to jobs and other opportunities provided by public transport
- Improve transport accessibility for groups with lower levels of transport choice, including providing a low-cost, convenient transport option for children and young people and other people with poor access to public transport or private vehicle choices
- Provide a convenient transport choice for everyday household trips, taking pressure off networks serving key Auckland centres.

Increased uptake of cycling can reduce a number of important negative impacts of Auckland's current transport system, including:

- Reducing negative health impacts associated with high dependence on motorised transport and sedentary lifestyles;
- Reducing air, noise and greenhouse gas emissions that impact on local environments and contribute to climate change.

Improving the cycling environment through provision of high quality infrastructure facilities and other policy initiatives can improve the safety of the road transport system. Cycling-related crashes currently account for 7% of total recorded road crashes in Auckland, and 10% of serious injury crashes. This is despite cycling only being used for 0.4% of household transport trips.

1.2 Evidence for problems and opportunities

A series of stakeholder workshops and discussions among the investment partners were held to define a set of clear problems, benefits and investment objectives to guide the investment programme. The three problems that the programme responds to are:

- Problem one: *Cycling is perceived as unsafe and unattractive, resulting in it not effectively contributing to Auckland's transport system* (45%). Although current levels of cycling are low, there is evidence that cycling could play a much greater role in meeting Aucklanders' transport needs. There is considerable latent demand for cycling, which can be realised by overcoming barriers related to lack of high quality cycling infrastructure and concerns about the safety of cycling. Where these issues have been addressed, Aucklanders have responded by cycling more.
- Problem two: *Relatively low levels of cycling and high dependence on private vehicles results in poor environmental, place and health outcomes* (25%). Auckland's transport system currently contributes significantly to local air and noise pollution and to health outcomes related to low levels of physical activity. Population-level data shows that higher rates of cycling area associated with lower health costs from physical activity.
- Problem three: *The current transport system often fails to meet the needs of people using bikes, resulting in them being over-represented in deaths and serious injuries* (30%). People who cycle in Auckland are currently over-represented in road crash statistics. There has been no discernible improvement in cycle safety outcomes during the past five years. International evidence from cities that increased the provision of protected cycle paths have shown substantial increases in cycling activity that have not been accompanied by corresponding increases in cycle crashes. There is an opportunity to increase both the safety and attractiveness of cycling through infrastructure and other improvements.

1.3 Programme investment objectives

A set of five SMART investment objectives were established to guide programme development, options assessment and future monitoring of programme outcomes. They are:

Investment objective 1: *Triple region-wide cycle mode share of total journeys to work/ education from 1% in 2013 to 3% by 2028*

Investment objective 2: *Triple jobs and education opportunities accessible by short cycle trips for people with lower levels of transport choice by 2028.*

Investment objective 3: *Triple cycling journeys to dense activity centres by 2028*

Investment objective 4: *Double the rate of participation in regular cycling activity to 25% of Aucklanders by 2028*

Investment objective 5: *Reduce deaths or serious injuries involving people using bikes by 20% by 2028*

Achieving these investment objectives is expected to address the identified problems and opportunities and contribute to the programmes' desired benefits of increasing the role of cycling in meeting Auckland's transport needs, improving transport accessibility, improving health, environmental and local place outcomes and increasing cycle safety.

1.4 Development of recommended programme

A recommended investment programme for cycling in Auckland during the period 2018-2028 has been developed through an options identification and assessment process. Figure 1illustrates the programme development process, starting with assessment of a broad range of policy tools for achieving the programme investment objectives and refining the programme through development and testing of a longlist and shortlist of cycling network development options.

A number of policy interventions and elements of cycle network development are excluded from the scope of the recommended programme:

- The recommended network development approach is for the existing urbanised area of Auckland. Cycle network development for future urban areas is assumed to be funded and planned through the 'Supporting Growth' planning and business case process.
- The recommended network development approach is for facilities that have potential to serve a significant transport function (eg providing access to jobs or other social or educational opportunities). It excludes recreational cycling facilities such as mountain bike trails and bridalways that serve very limited transport functions.
- The recommended programme includes guidance for NZ Transport Agency Highway and Network Operations investment in stand-alone cycle infrastructure projects within State Highway corridors but excludes recommendations on network development that may accompany major State Highway upgrade projects.
- A number of policy tools that may impact on cycling uptake or cycling safety have been excluded. These include policy tools such as taxes or subsidies that are outside the jurisdiction of the investment partners, tools that are unlikely to have a major impact on achievement of investment objectives or tools that have been recently the subject of decision-making processes (eg Auckland Unitary Plan decisions).

The final recommended programme includes two elements:

A. Recommended approach for development of the Auckland cycling network
B. Recommended package of other initiatives to complement network development.

A. Recommended approach to cycling network development

To achieve the programme's investment objectives, cycle network infrastructure development should be guided by the following principles:

- **Targeting particular customers and trip types**
  The Auckland cycling network needs to provide for a broad range of customers, to maximise potential for increased cycling uptake. This will require high-quality facilities that reduce real and perceived safety risks.

  Investment in new cycling network facilities should also target serving particular trip types that are more amenable to cycling and trip types where mode shift to cycling would benefit the wider transport system. This will mean targeting investment to serve short-medium distance trips, short-trips that connect with rapid transit networks and trips types that have potential to encourage mode shift from private vehicles or public transport on congested corridors.

Some investment in new cycling network development should target serving populations with lower levels of transport choice, as providing a cycling option to these populations is likely to provide additional value to these user groups in increasing their accessibility to jobs and education opportunities.

- **Planning and designing networks and facilities to maximise uptake and safety**
  Network development in Auckland should follow best-practice cycle network planning principles. This means:
  - Selecting routes that provide direct access to key destinations and follow corridors of high (current or latent) demand
  - Selecting routes that link with other parts of the network to form a coherent and legible network
  - Establishing an appropriate network density, with a finer-grained network in areas of higher demand
  - Selecting routes that are attractive for users and that offer a pleasant, interesting, safe and secure environment
  - Selecting routes that minimise major gradient changes.

  Facilities should be designed to be safe and attractive and appropriate to their surrounding context. Auckland Transport's *Evaluating Quality of Service for Auckland Cycling Facilities* provides guidance on facility choice, including types of street environments where separated cycle paths are necessary.

The **recommended level of investment in the overall programme for 2018-2028 is $635 million.** This includes $60 million per annum (or $600 million over the ten-year programme period) for network development funded by Auckland Transport and the NZ Transport Agency. It also includes $3.5 million per annum (or $35 million over ten years) on complementary initiatives. The recommended overall level of investment is similar to that currently being undertaken by the funding partners during the 2016/17 year.

The recommended programme identifies **focus areas for network development** across the Auckland region. Indicative network planning found that $600 million investment can deliver at least 150km of high-quality, safe cycling facilities and associated intersection upgrades. This will add to a network of approximately 380km of facilities assumed under the Do-Minimum scenario to provide a total network of approximately 530km of dedicated cycling facilities by 2028. Conservative cost rates for high-quality facilities have been used, and lower out-turn costs may enable accelerated or extended implementation of network facilities.

Recommended focus areas for 'early start' on construction during the 2018-21 period include network development in the City Centre and Fringe and in selected suburban hubs including Mangere and Henderson. This will improve accessibility to major jobs and education centres, fill network gaps and build off recent investment. Areas for later start include the lower North Shore, New Lynn/ Avondale, the Newmarket – Ellerslie corridor and selected centres in South Auckland.

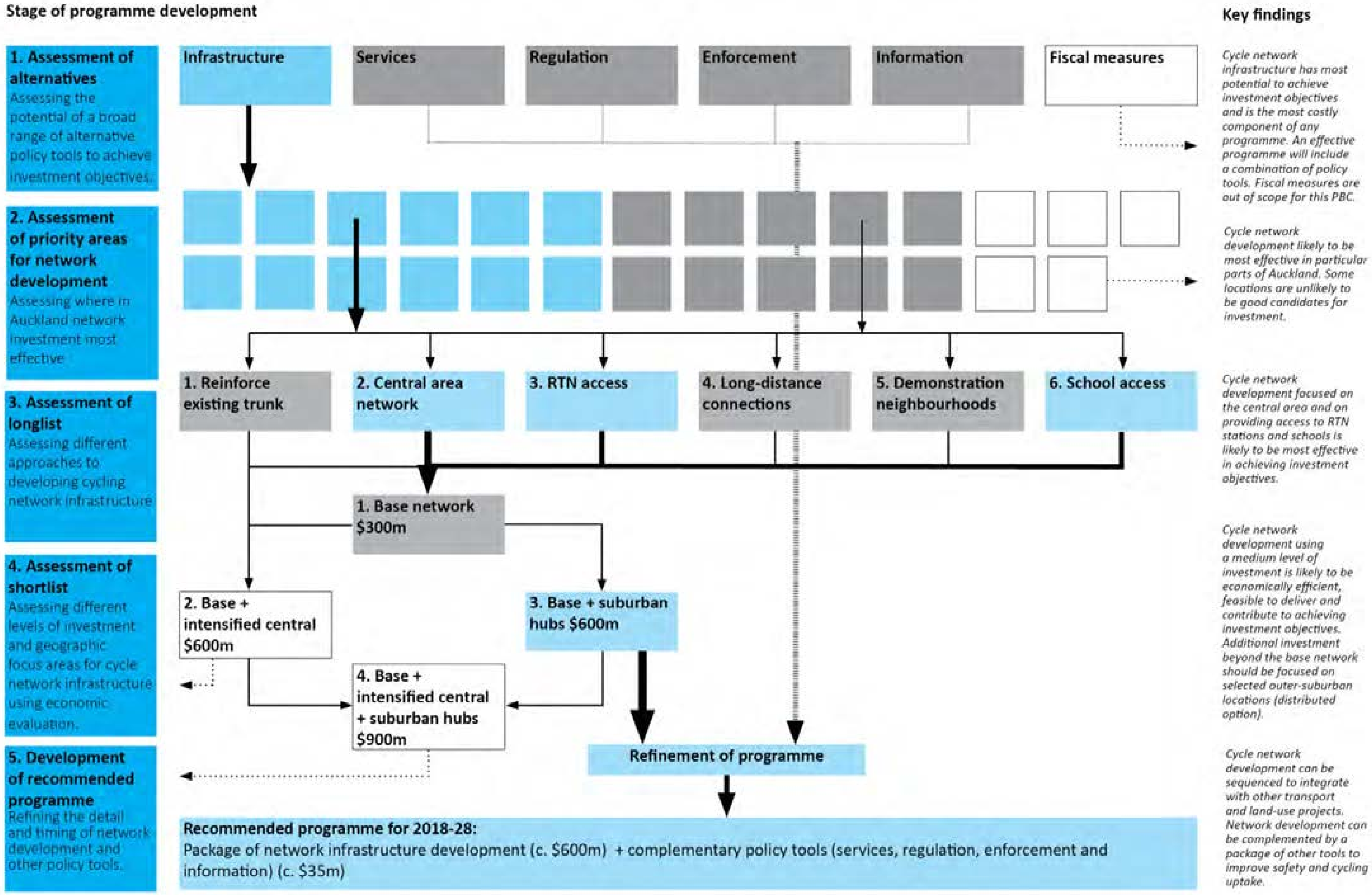
B. Recommended package of other initiatives to complement network development

Alongside implementing the recommended approach to cycle network development, it is also recommended to invest in **a package of infrastructure, service, regulatory, enforcement and information-based initiatives that can complement network development** and contribute to the programme objectives.

Assessment of a range of policy interventions found that while network development will be critical for achieving the programme's objectives, it will also be more effective if complemented by a package of additional interventions

The total indicative cost of the package is approximately $35 million over 10 years with the most substantial costs associated with marketing, promotion and events ($20 million), cycle training programmes ($10 million) and public cycle parking ($5 million). The recommended programme involves modest increases to existing budgets for marketing, promotion and events, cycle training and public bike parking and new expenditure on investigation of bike share. The level of spending on complementary initiatives does not include expenditure for implementing Bike Share. Capital and operating costs for this initiative may be significant (in the order of $40 - $90 million over 10 years) and further investigation is recommended ahead of funding decisions on this initiative.

Figure 1: Overall programme development process



1.5 Impacts of recommended programme

Assessment of the recommended programme has included:

- Evaluation against investment objectives, using qualitative and quantitative assessment and drawing on cycle demand modelling
- Evaluation of risks and implementability
- Economic evaluation of the recommended approach to network development

Achievement of investment objectives

The programme is likely to achieve the full range of investment objectives through provision of an expanded high-quality cycle network for Auckland that makes cycling more attractive, safer cycling facilities that reduce crash risks and a complementary package of promotion, training, enforcement and other initiatives. Table 1 summarises the assessment against the programme's investment objectives.

Table 1: Summary assessment of recommended programme against investment objectives

Investment objective	Assessment
IO1. Triple cycle mode share from 1% to 3% of total journey to work/ education trips by 2028 (30%)	Modelled cycle demand from network development results in 3.2 – 4.1% cycle commute mode share, 50 - 90% above mode share under the Do Minimum and exceeding the target. Initial network expansion focuses on central areas with high congestion levels and populations with shorter trip lengths, more amenable to mode shift. Later network expansion targets selected outer-suburban areas in South and West with relatively high population densities and connections to rapid transit stations, schools and town centres. Complementary promotion, training, public cycle parking and other initiatives will further encourage mode shift.
IO2. Triple jobs and education opportunities accessible by short cycle trips for people with low levels of transport choice by 2028 (20%)	Network expansion targets selected outer-suburban areas in South and West Auckland with high population densities, densities of children and young people and areas with poor access to frequent public transport. Network development will increase overall transport accessibility for residents of these locations. Network development focuses on serving major employment centres (City Centre, Metro centres) and clusters of high-enrolment schools, increasing access to jobs and education opportunities. Modelled cycle demand shows strong increases in demand in South and West Auckland, areas with generally lower levels of transport accessibility. Targeted promotion, training and other initiatives will enhance accessibility benefits provided by network development by increasing customer awareness of new facilities.
IO3. Triple cycle volumes in dense activity centres by 2028 (10%)	Modelled daily cycle demand across CBD cordon of 15,000 trips, 24% higher than Do-Minimum and more than triple 2013 levels. Initial network expansion focused on improving access to City Centre. Later network development targeted at outer-suburban Metro and Town centres.
I04. Increase rate of participation in regular cycling activity from 13% to 25% by 2028 (10%)	Provides network within 400m of 680,000 Aucklanders, 21% more than Do-Minimum. Intensifies network in south and west with low existing cycling participation and where greater participation may have more valuable health outcomes. Modelled cycle demand shows increase in average daily cycle trips from 12,000 in 2013 to 27,400 in 2026 under the Do-Minimum scenario and to between 42,000 and 54,000 under

	the recommended programme. Complementary training and promotion activities will encourage broader participation in cycling.
IO5. Reduce deaths or serious injuries involving people using bikes by 20% by 2028 (30%)	Initial network investment focused on City Centre and central area with highest rate of existing cycle crashes. Outer-suburban investment targeted at locations with relatively high overall road crash rates. Indicative network planning finds that network improvements will provide safer facilities on corridors where over 110 cycle-related and 900 total road crashes have been recorded between 2011 and 2016. Complementary speed management and police enforcement programme will contribute to improved safety outcomes.

Risks and implementability

The recommended programme has been assessed for deliverability and financial feasibility and key risks identified. The financial feasibility of the programme depends on funding decisions from both central government through the Government Policy Statement Process and the NZ Transport Agency's allocation of the National Land Transport Fund to various activities. Proposed levels of investment are similar to that being expended on cycle network development in Auckland by all programme partners during 2016/17.

The programme is likely to be deliverable. Key delivery risks for network development components will include decision-making and stakeholder consultation on road-space allocation on constrained corridors and construction industry capacity. These risks are expected to be manageable.

Economic evaluation

The economic evaluation of shortlist options calculates economic benefits and Benefit Cost Ratios for all four shortlisted options for network development. The recommended programme closely follows the indicative network developed for shortlist option 3. Table 2 summarises the economic evaluation results for the recommended programme under four different scenarios. The resulting four scenarios result in a range of projected benefit levels and accompanying BCRs. This reflects uncertainty in forecasting future transport outcomes.

Table 2: Projected benefits, costs and BCRs for network development component of recommended programme

Benefit stream	Scenario 1: linear demand growth, flat congestion	Scenario 2: linear demand growth, increasing congestion	Scenario 3: expected demand growth, flat congestion	Scenario 4: expected demand growth, increasing congestion
Health and environmental benefits	\$468 m	\$468 m	\$760 m	\$760 m
Safety benefits	\$18 m	\$18 m	\$20 m	\$20 m
Travel time cost savings for cyclists	\$19 m	\$19 m	\$19 m	\$19 m
Decongestion benefits	\$295 m	\$722 m	\$477 m	\$1,168 m
Total benefits (discounted)	**\$800 m**	**\$1,227 m**	**\$1,277 m**	**\$1,968 m**
Total costs (discounted)	**\$431 m**	**\$431 m**	**\$431 m**	**\$431 m**
BCR	**1.9**	**2.8**	**3.0**	**4.6**

The economic evaluation shows that the major economic benefits are from health benefits accompanying increased cycling activity and decongestion benefits from mode shift away from private vehicles. It finds that under all scenarios benefits are likely to exceed costs, with a BCR range of 1.9 to 4.6.

Strategic fit
A programme for improving cycle safety and increasing the role for cycling in an effective Auckland transport network aligns well with organisational objectives for the programme partners.

- It contributes to the draft Government Policy Statement strategic priorities for transport investment to contribute to economic growth and productivity by increasing transport capacity and transport choice on congested corridors serving New Zealand's highest-productivity employment centre.
- It contributes to the NZ Transport Agency's strategic direction for improving road safety, including key recommendations from the Cycle Safety Action Plan 2015.
- It contributes to policies in Auckland Transport's Regional Land Transport Plan for providing an integrated, connected cycle network and 'unlocking suppressed demand for cycling'.
- It supports the Auckland Transport Alignment Project's priorities including making 'making better use of existing networks'. The programme targets strengthening the role of cycling where it is identified as most effective by the Alignment Project; "serving higher intensity areas, short-to-medium trips, and extending the reach of strategic public transport corridors".

PART A – THE STRATEGIC CASE

2 INTRODUCTION

The purpose of the Auckland Cycling Programme Business Case (ACPBC) is to establish a case for investment in a programme of cycling activities in Auckland over the 2018-2028 period. This business case:

- Is focused on a single mode – ie cycling – but acknowledges implications for and dependencies with other transport modes
- Takes a region-wide focus, addressing investments and policies across Auckland as a whole
- Involves Auckland Transport (AT), Auckland Council (AC), and the New Zealand Transport Agency (NZ Transport Agency), and is intended to guide activities of all three investment partners
- Addresses a wide range of interventions within the jurisdiction of the investment partners, including new or improved cycle facilities and complementary initiatives in support of network development to encourage and enable more people to take up cycling. These include speed limit changes, behaviour change programmes such as enforcement, cycling events, training and active transport information, and new services such as bike share and cycle parking.

3 PROGRAMME CONTEXT

This section describes the context for the ACPBC. It addresses four key features of the Auckland context that are relevant to this cycling investment programme:

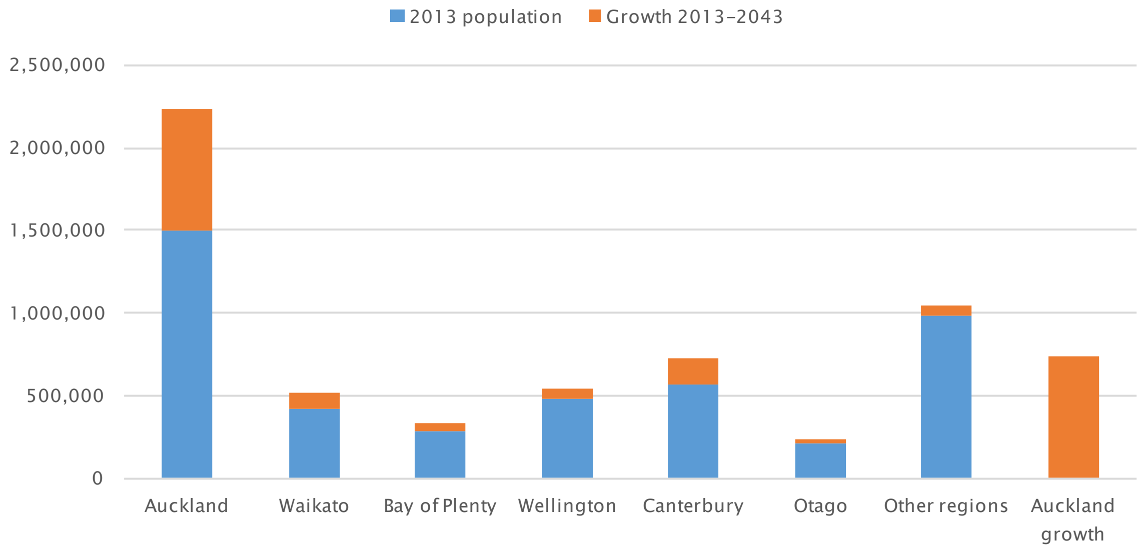
- Auckland's significant population and economic growth, which will result in increasing demands for transport throughout the city, and the changing nature of the city's economy;
- The current and expected future functioning of Auckland's transport system;
- Auckland's patterns of socioeconomic disparities, which are influenced in part by the city's transport system and patterns of accessibility to employment and other opportunities; and
- Auckland's geography and climate, which may influence opportunities for increased uptake of cycling in the city.

3.1 Auckland's population and employment growth

Auckland is expected to continue experiencing significant growth in population, employment, and economic activity in upcoming decades. This will in turn pose new opportunities and challenges for the region's transport system.

Auckland's population is expected to grow 56% over the 2013-2043 period, adding 830,000 new residents to reach a total population of over 2.3 million. This represents a continuation of rapid growth in recent decades. As shown in Figure 2, the region is expected to account for the majority (56%) of New Zealand's overall population growth. This highlights the nationally significant nature of Auckland's growth, as well as the fact that Auckland's economic performance will be increasingly important to the performance of the national economy.

Figure 2: Regional medium population growth projections, 2013-2043 (Statistics NZ, 2016)



Population growth is expected to be accompanied by employment and economic growth. Based on ART model projections, the number of jobs in Auckland is projected to increase from just under 600,000 to more than 850,000 over the next 30 years.

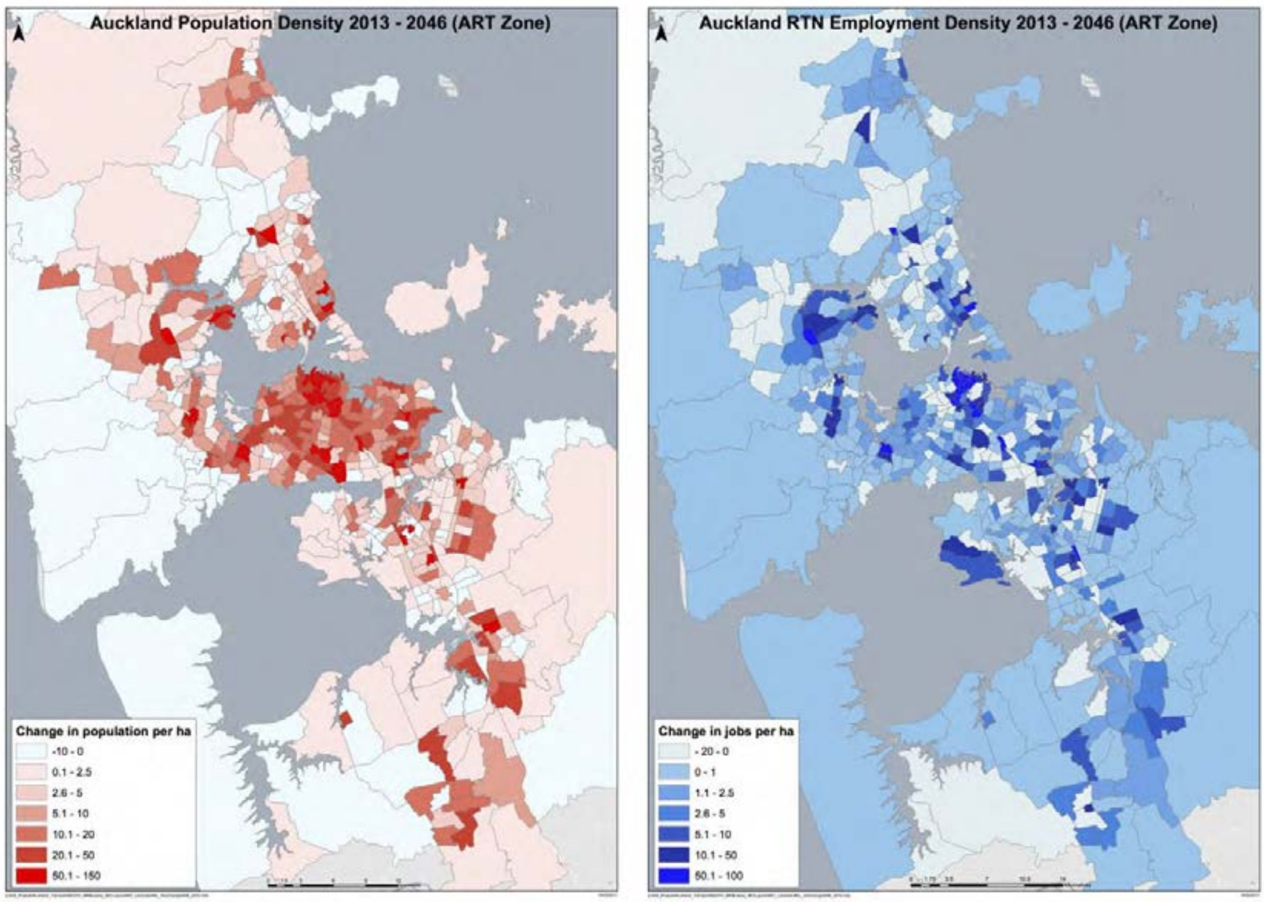
Auckland's future growth is expected to be distributed throughout the city, with growth occurring both 'upwards' and 'outwards'. The following maps show projected changes in population and employment in Auckland over the 2013-2046 period, based on the Auckland Plan Land Use Scenario I9.[1]

These projections indicate that there will be significant increases in residential population densities on the Auckland isthmus, around metropolitan centres, and in greenfield growth areas such as Whenuapai, Silverdale, and Drury. However, most areas of the city are expected to experience some degree of population growth. This will result in growth in transport demands throughout most of the city.

The structure of Auckland's economy is expected to evolve further towards service sectors as Auckland's urban agglomeration economies strengthen (McCann, 2009). As shown in Figure 4, employment in business services, health and educational services, and retail is expected to grow significantly, while employment in industrial sectors like transport and logistics will be relatively flat.

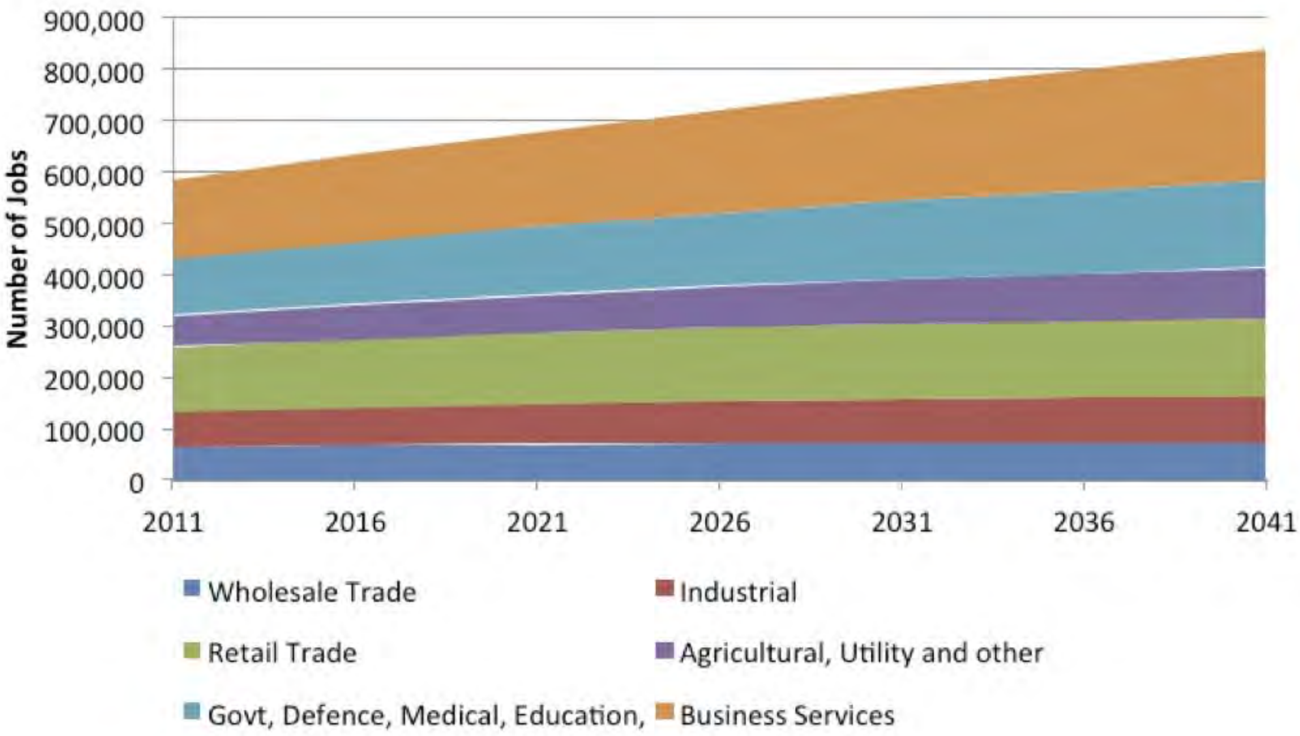
This will in turn influence the spatial distribution of transport requirements. Growth in employment is expected to be concentrated in and around key business areas, such as the city centre and fringe area (which is expected to grow from 21% of citywide employment in 2013 to 26% in 2046), the business park around Auckland Airport, and new and existing Metropolitan Centres such as Takapuna, Westgate, Henderson, Manukau and Albany. Higher employment levels in Auckland's city centre and other major employment centres, will place additional pressure on already congested city centre access routes and access routes to other centres.

Figure 3: Projected change in population and employment in Auckland, 2013-2046 (Scenario I9)



[1] This is the modelling scenario used for ATAP.

Figure 4: The projected future composition of Auckland's economy (AC Business Futures Model, 2012)



The Auckland Unitary Plan (AUP) (operative in part) establishes the regulatory framework for land use and development, including the location and density of future housing and employment growth. It therefore influences the potential for where, when, and how population and employment growth can occur in existing urban areas as well as the location of potential future urban areas.

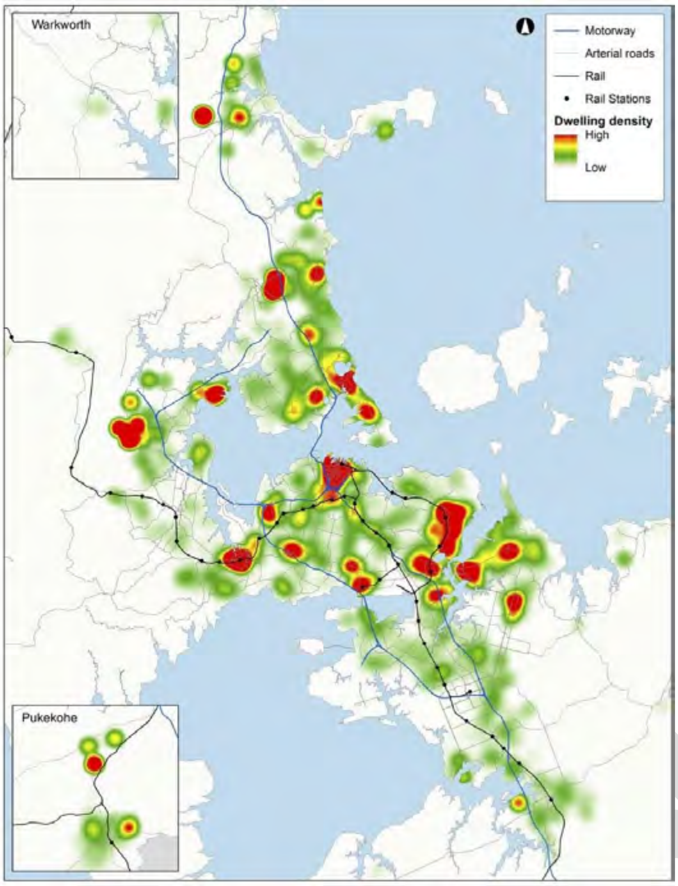
The AUP is expected to enable the land use forecasts incorporated into AT's modelling of future transport demands (land use scenario I9). However, the timing and sequencing of development is potentially more uncertain, as the Unitary Plan opens up more opportunities for development on the whole. Figure 5 summarises the results of development feasibility modelling used for preparation of the AUP, with areas with the greatest commercially feasible development capacity shown in red (excluding FUZ areas). This highlights areas where residential growth is most likely and associated transport demands are likely to increase most rapidly.

Implications for programme development

Forecast population and employment growth has important implications for this cycling investment programme:

- Overall transport demand across the Auckland urban area will grow strongly over the programme period, 2018-28 placing pressure on existing networks and opening up opportunities for cycling to play a more important role in meeting transport demands
- The changing nature of the economy is likely to be accompanied by increasing concentration of job growth in the City Centre and other employment hubs, placing particular pressure on already congested transport networks serving these areas. This presents opportunities for increased uptake of cycling to improve accessibility and transport capacity to jobs centres.

Figure 5: Distribution of commercially feasible development capacity under the Unitary Plan[2]



3.2 Auckland's transport system

Auckland's transport system faces a number of challenges around current and expected future performance. These arise from the city's physical geography and existing transport networks.

Auckland's transport network currently includes the following elements:

- A region-wide network of motorways, arterial roads, and local roads;
- A regionwide public transport network that includes a rapid transit system with several rail lines and the Northern Busway, ferries providing service to destinations in the Waitemata Harbour and Hauraki Gulf, and a bus network that provides service to many destinations throughout the city;[3]
- A partial network of cycle facilities that includes painted cycle lanes on some roads as well as some dedicated off-road cycleways and on-street separated cycleways. As shown in Figure 6, existing and funded cycling facilities are often not connected with each other, resulting in gaps where the quality of cycling experience is low; and
- A network of footpaths along most, but not all, roads.

The city's transport system faces geographic constraints and infrastructure constraints. Auckland's geography also results in a number of 'pinch-points' on strategic transport corridors, such as the Auckland Harbour Bridge linking the North Shore and Auckland isthmus, the Northwestern Motorway

[2] This map is taken from the Independent Hearings Panel's recommendations report. The decisions version ultimately endorsed by AC included some changes to rules that are not likely to affect the feasibility of development in Northwest Auckland.

[3] Rapid transit stations are often, but not always, located at major employment centres such as New Lynn, Albany, and Manukau, as well as suburban and coastal locations.

causeway linking West Auckland to the rest of the city, and the Panmure-Pakuranga Bridge linking East Auckland to the rest of the city. As a consequence, there are relatively few corridors serving journeys between different parts of the Auckland urban area, and it can be difficult to expand transport capacity, and in particular road capacity, at these key points.

Auckland's road network is also relatively sparse for an urban area, and the city has a relatively low density of streets and intersections relative to international cities.4 This inhibits connectivity and accessibility for many walking and cycling journeys. Auckland's relatively limited quantity of streets and intersections also means there are few opportunities to spread transport demands across parallel corridors. This increases competition for limited road space, as multiple modes must share the same corridor. These conflicts are expected to increase as transport demands increase.

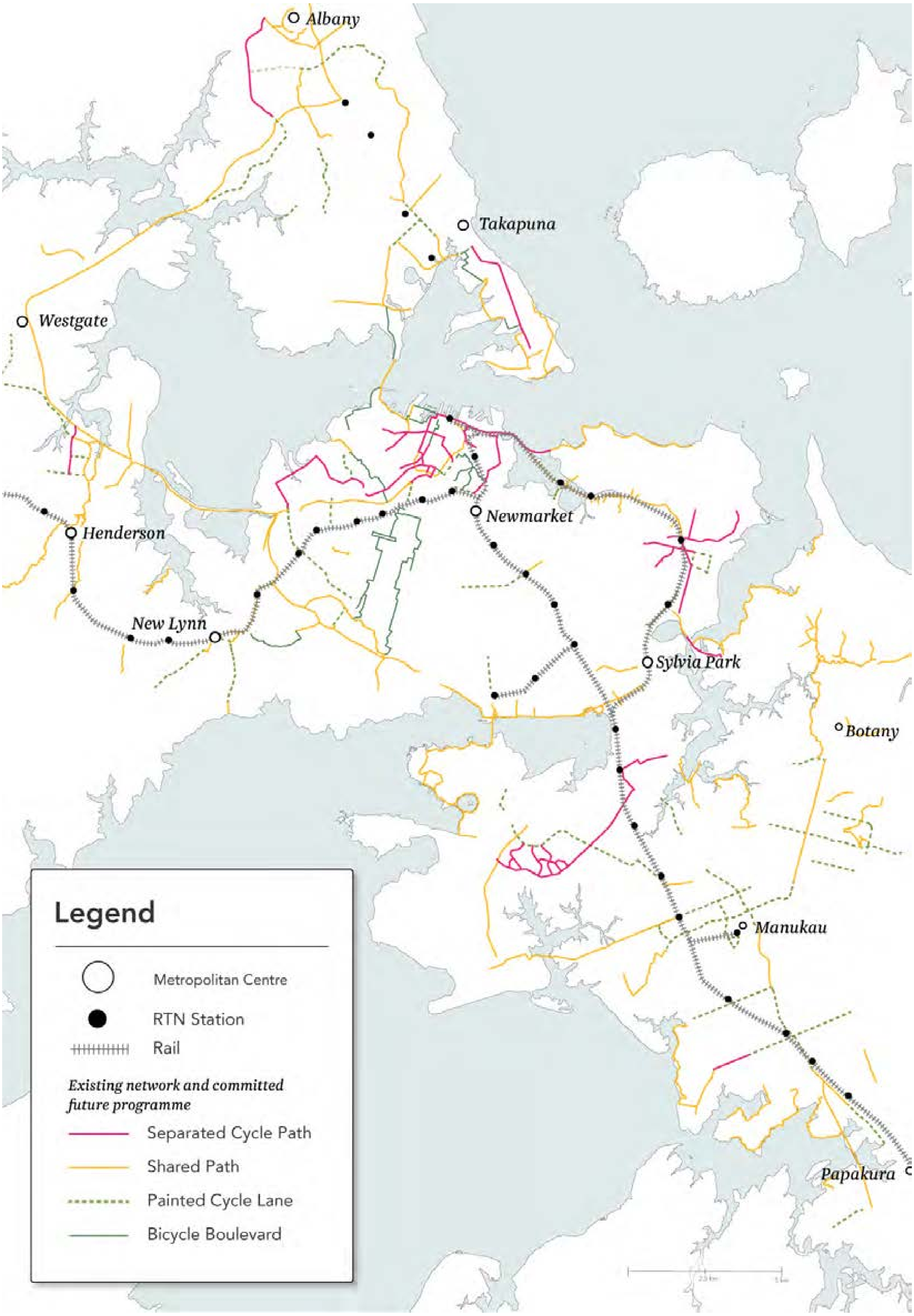
At present, Aucklanders rely mainly upon private vehicles to meet their transport demands. As shown in Table 3, 79% of overall trips and 84% of commute trips are done in a motor vehicle. Cycling accounts for a small share of overall trips – 0.4% of all household trips and 1.2% of commute trips.

Table 3: Current transport mode shares in Auckland (Shaw et al, 2016)

Transport mode	Share of overall household trips (HTS, 2011-2014)	Share of commute journeys (Census 2013)
Motor vehicle (including motorcycles and trips as passenger)	79%	84%
Walking (or jogging)	17%	5%
Bicycle	0.4%	1.2%
Train / bus	4%	8%
Other	1%	2%

[4] On average, Auckland has only 12.7 kilometres of streets and 72.9 intersections per square kilometre, which is half or less the rate as most Australian and European cities.
http://mirror.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3513&AspxAutoDetectCookieSupport=1

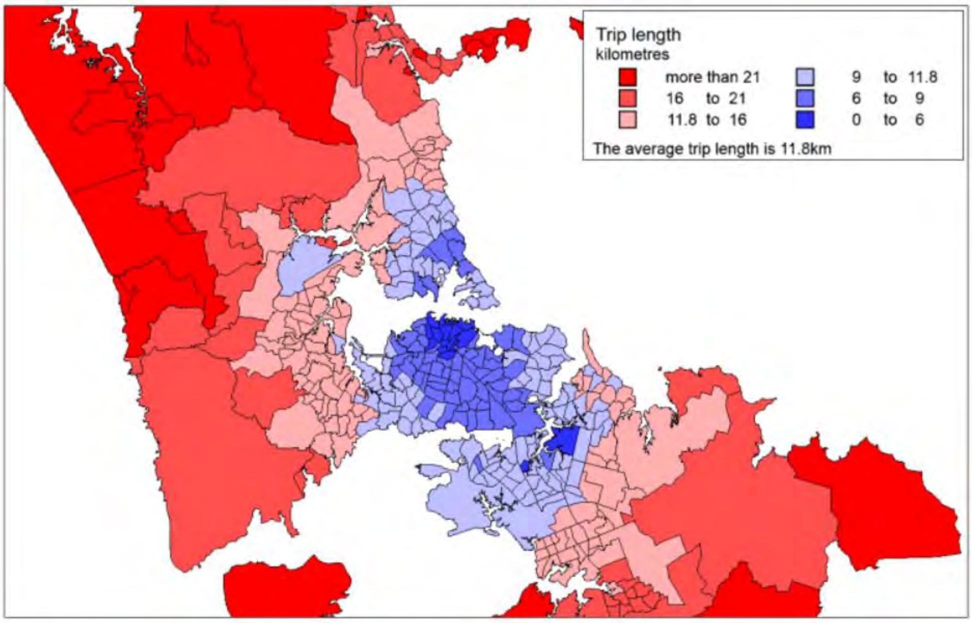
Figure 6: Auckland's cycling network, existing and currently committed future facilities



Data from the 2012-2014 Household Travel Survey shows that the average trip length for all purposes in Auckland was 7.6km. The average cycling trip length (9.8km) was slightly longer than the average length of public transport trips (8.2km) and driving trips (9.1km), although this difference is likely to be within the margin of error for these estimates.

Census commuting data suggests that average trip lengths vary by location. Figure 7 shows average commuting trip length by suburb in 2013. Commute distances tend to be lower towards the city centre and longer towards the fringe, reflecting better access to jobs in more central areas.

Figure 7: Average commuting trip length by residential area (Paling, 2014)



The average commuting trip is longer than the average household trip for all purposes. As shown in Table 4, the average commuting trip was 11.8km, compared with 7.6km for the average household trip. The average trip length by place of work is fairly consistent across Auckland. However, for those living in the CBD and adjacent suburbs, average trip lengths are much shorter at 5.1km and 6.1km respectively. In addition, data on distance travelled to access retail published by Fairgray (2013) suggests that median distance travelled to retail is around 5km.

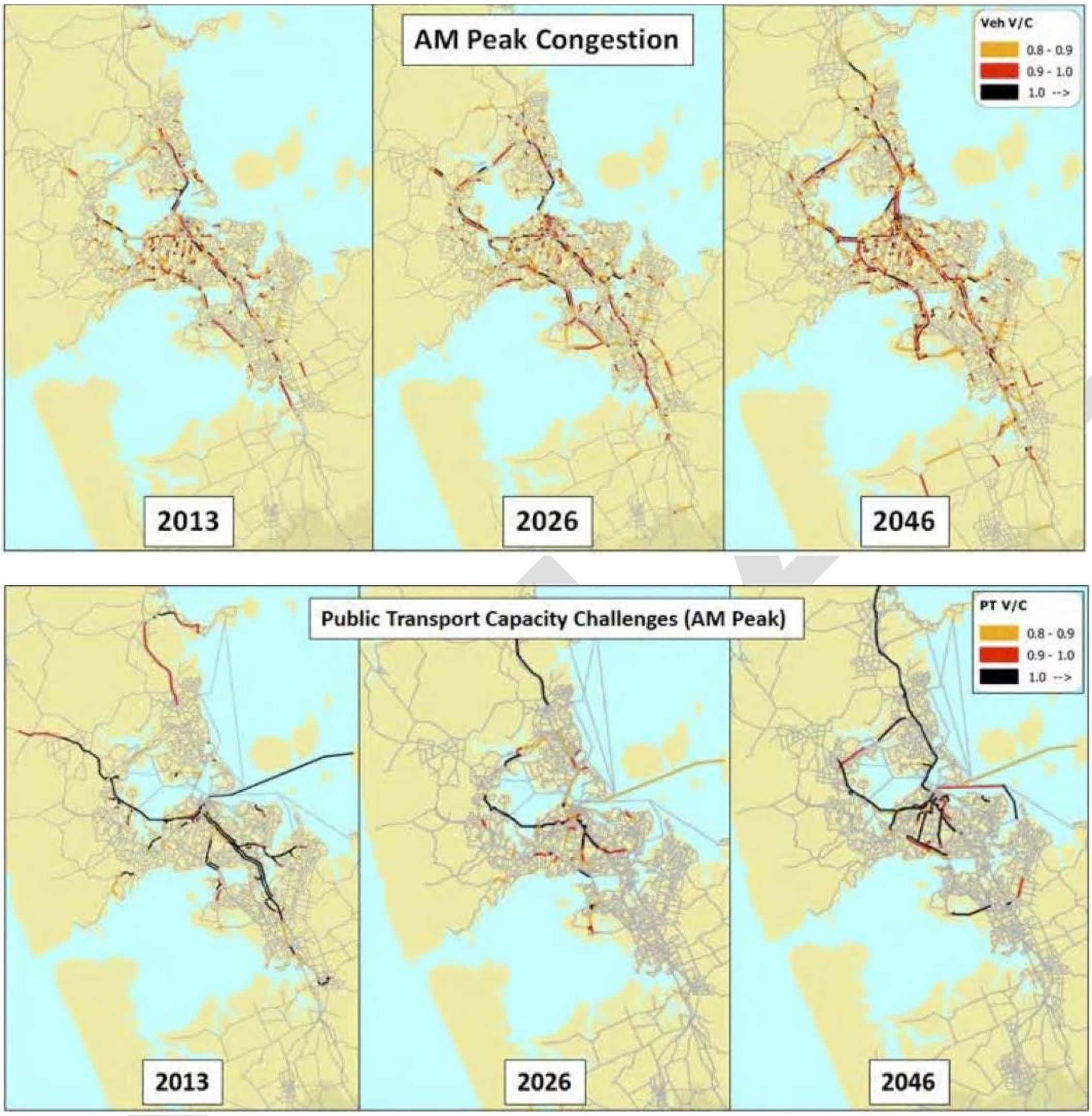
Table 4: Average travel distance for commute trips in Auckland, Paling (2014) derived from 2013 Census Data

	Average Distance by Place of Work (km)	Average Distance by Residence (km)
CBD	12.1	5.1
Other Central	11.2	6.1
Inner Urban	10.8	9.2
Outer Urban	12.3	13.1
Rural	13.4	18.9
Total	11.8	11.8

According to the ATAP *Foundation Report*, strategic modelling of vehicular travel modes projects that public transport mode share will increase over time, with the PT share of vehicular trips during the AM peak increasing from 7% in 2013 to 15% in 2046. This modelling does not forecast growth in cycling trips in the absence of further intervention as cycling is not incorporated within the model.

While noting that congestion is a by-product of a successful city, ATAP observes that peak-time and interpeak congestion is forecast to increase over the next two decades. Maps showing the location of projected congestion and PT capacity constraints are reproduced in Figure 8.

Figure 8: Projected future AM peak congestion and PT capacity challenges (ATAP Foundation Report)



Implications for programme development

Auckland's transport infrastructure network and forecast growth in transport activity have important implications for this cycling investment programme:

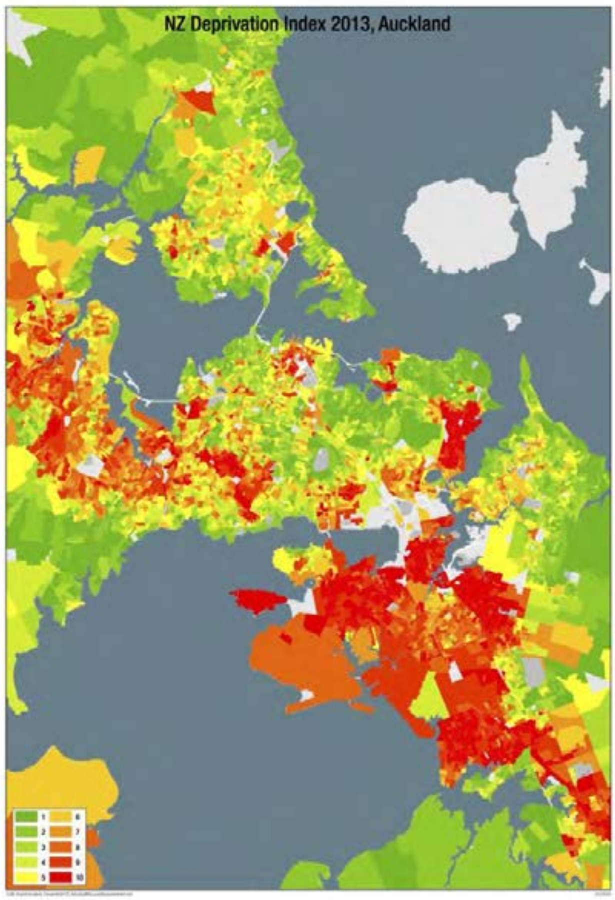
- **Cycling currently plays a limited role in Auckland's transport system. However, many household transport trips are short-medium distance trips, that may be viably undertaken by cycling. This is an opportunity for increased cycling uptake.**

- **Auckland's road network faces geographic and infrastructure constraints. This contributes to congestion on key corridors. Cycling may have a high value to overall transport system performance where it can provide additional capacity on congested corridors that are costly to significantly expand for other modes.**

3.3 Socioeconomic disparities in Auckland

Auckland is also characterised by socioeconomic disparities (or inequality) between residents and communities. Figure 9 shows NZ Deprivation Index scores in Auckland, which rank communities on a scale of 1 to 10, where 1 is the least socioeconomically deprived, based on a range of indicators, and 10 is the most socioeconomically deprived. This shows that communities in South Auckland, West Auckland, and the outlying parts of the Auckland isthmus are among the most socioeconomically deprived, nationwide. Conversely, communities in the inner Auckland isthmus, North Shore, and Howick are among the least socioeconomically deprived.

Figure 9: NZ Deprivation Index in Auckland (University of Otago)

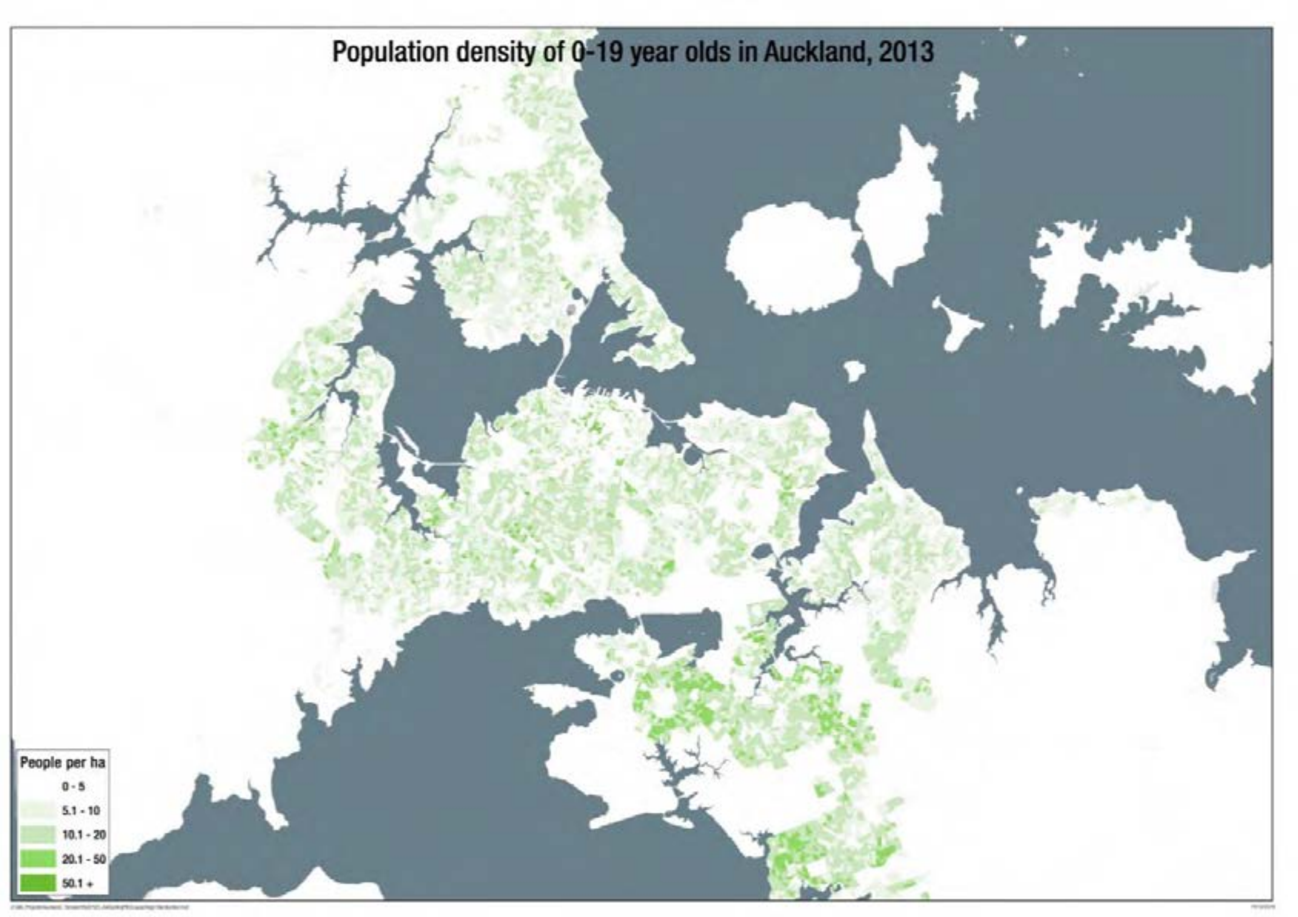


Patterns of socioeconomic deprivation relate to transport outcomes, including accessibility to jobs. ATAP analysis showed that relatively deprived areas in West Auckland and South Auckland are expected to see a reduction in accessibility to jobs via car over the next decade, albeit with some improvement in accessibility via public transport.

Many young Aucklanders live in areas with high socioeconomic deprivation. Figure 10 shows the density of young people (aged 19 and under) throughout Auckland. While young people are distributed throughout Auckland, South Auckland has the greatest concentration of young people.

A high concentration of young people means that benefits from improving access to educational facilities via low-cost transport modes are potentially relatively high, provided that these modes are safe. Many education trips are short so are suitable for shifting to walking and cycling. Historically a much higher proportion of these trips occurred via active modes. Enabling increased use of walking and cycling for education trips can reduce chauffeuring burdens and free up caregivers from making vehicle trips to transport children and young people around the city.

Figure 10: Density of young people in Auckland (2013 Census)



Implications for programme development

Auckland's spatial distribution of socio-economic deprivation and of populations of children and young people has implications for cycling investment:

- **The spatial distribution of socio-economic deprivation is reflected in spatial patterns of transport disadvantage. Cycling may play a role in increasing transport accessibility for deprived communities by providing a relatively low-cost transport option.**

- **Cycling may play a particularly important transport accessibility role for children and young people who have less access to transport choice. Some areas with concentrations of children and young people also coincide with areas of high socio-economic deprivation.**

3.4 Auckland's geography and climate

Finally, Auckland's geography and climate are relevant for this cycling investment programme.

Auckland's geography, particularly the location of its harbours, has constrained the city's growth in many directions and stretched the main urban area to nearly 50 kilometres north-south and over 30 kilometres east-west. According to NZIER (2014), only 32% of the area within 30 kilometres of the city centre is made up of developable land, compared with 48% of the area around the six major Australian cities. This has contributed to Auckland being a relatively dense city, as well as a physically extensive one (Nunns, 2014).

Parts of Auckland also have hilly topography as a result of the city's volcanic heritage. Figure 11 illustrates the city's topography, with 20-metre contour lines. This shows that:

- The built-up areas of South Auckland are flat, as are parts of West Auckland along the Waitemata Harbour;
- There are steep gradients in the Waitakere area and parts of the North Shore;
- The Auckland isthmus has a mix of gradients, with steeper gradients near the harbour edge, including around the city centre, and a relatively flat plateau area in the middle of the isthmus.

Figure 11: Auckland's topography (Land Information New Zealand)

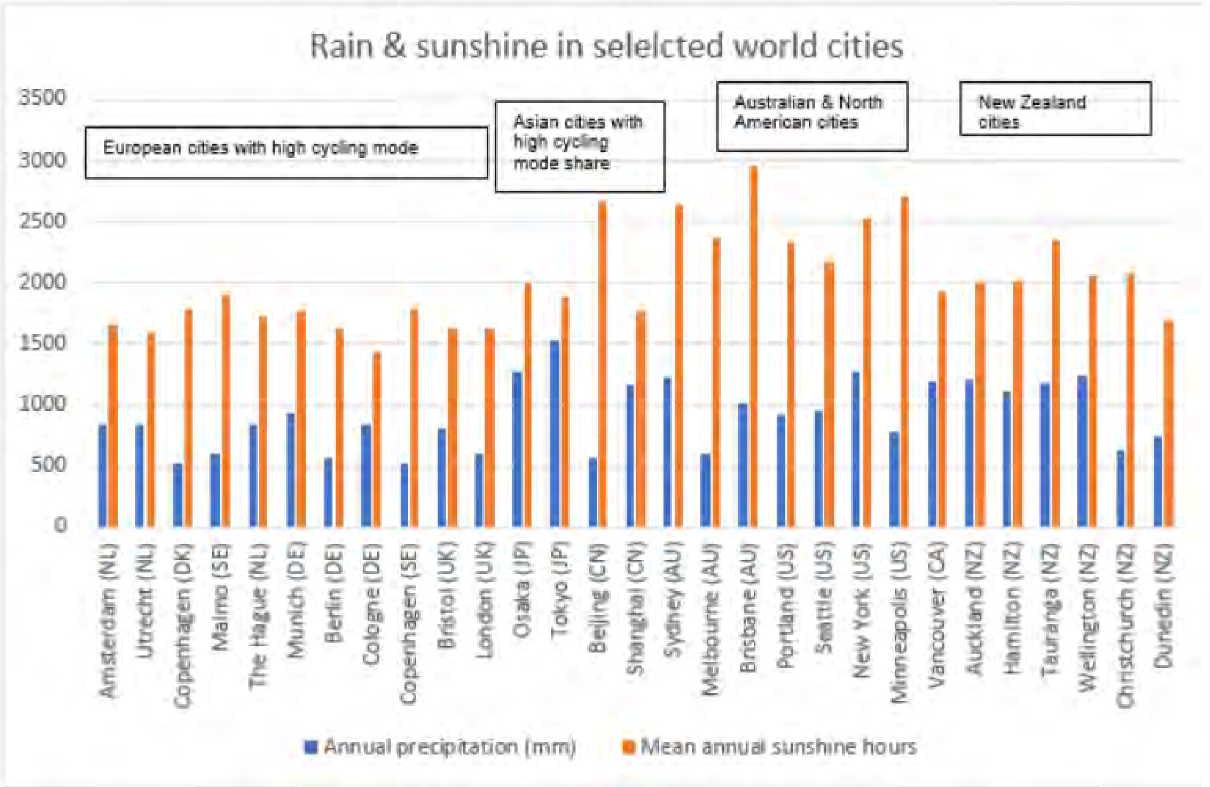
Auckland climate is subtropical, with warm, humid summers and mild but wet winters.[5] As shown in Figure 12, Auckland's climate is comparable to other North Island cities, but wetter than South Island cities. It is both sunnier and wetter than northern European cities with high cycling mode share, wetter than many Australian cities, and drier and sunnier than Tokyo and other Asian cities. In short,

[5] https://www.niwa.co.nz/education-and-training/schools/resources/climate/overview/map_north

Auckland's climate offers some advantages and some disadvantages for cycling. On the one hand, it has a relatively mild and sunny climate, but on the other hand, it tends to be humid and wet.

While wet weather may be a barrier to increased cycling uptake for some users, substantially higher cycling mode share is observed in a number of cities with similar levels of precipitation (eg Osaka, Tokyo, Shanghai and Vancouver). Terrain and climate appear to interact with multiple other factors such as cycling infrastructure quality and road safety conditions to determine levels of cycling uptake.

Figure 12: Rain & sunshine in selected New Zealand and world cities



Implications for programme development

Auckland's geography, terrain and climate have implications for cycling investment:

- Urban density means that multiple potential travel destinations are reasonably close together and hence could be realistically served by cycling. While much of Auckland's urbanised area is likely to have sufficient density and a mix of employment and residential uses to support cycling, facilities in more sparsely populated parts of the city may struggle to attract strong demand.
- Hilly terrain is likely to be a barrier to increased cycling uptake in some parts of the city such as the Western North Shore, Waitakere foothills and some parts of the Isthmus. This may limit the potential for effective network investment in these areas. Terrain-related barriers may be reduced in future years with wider adoption of electric bicycles.
- Auckland's relatively high level of precipitation may be a climatic barrier to increased cycling uptake. However, features of Auckland climate are also supportive of cycling and international comparison shows significantly higher levels of cycling uptake in cities with similar levels of precipitation.

4 PARTNERS AND KEY STAKEHOLDERS

This section outlines the key investment partners to the business case who will have a responsibility for delivering on the investment, as well as other partners and stakeholders have an interest in the expected outcomes.

4.1 Investment partners

Auckland Transport, Auckland Council and the New Zealand Transport Agency are joint investment and delivery partners for the Auckland Cycle Programme. The ACPBC is intended to guide all stand-alone cycling network and complementary investment delivered by the partners including:

- AT-led cycling network investment on local road corridors
- NZ Transport Agency-led cycling network investment within State Highway corridors
- AC-led stand-alone cycling network investment within AC-managed parks and reserves
- Complementary investment in activities such as promotion, events and road safety campaigns.

Excluded from the scope of the ACPBC are:

- NZ Transport Agency-led cycling network investment that accompanies major state highway projects
- AT or NZ Transport Agency-led cycling network investment delivered as part of the 'Supporting Growth – Delivering transport networks' package of infrastructure development
- AC (Local Board) - led Greenway projects or shared path projects.

All three investment partners have participated in the development of the ACPBC, under the leadership of AT. The ACPBC has been governed by a Project Control Group involving representatives from each of the three organisations.

4.1.1 Auckland Transport

AT is the road controlling authority responsible for the majority of roads in Auckland, and has responsibility for the planning, maintenance and operations for these roads. AT will lead planning and delivery of cycle network development within local road corridors. To support network development, AT also leads a comprehensive user behaviour change programme including events, training, campaigns and activations targeting specific groups with the highest propensity to cycle.

4.1.2 New Zealand Transport Agency

The NZ Transport Agency is the crown entity responsible for planning and investing in land transport networks, managing the state highway network and providing access to, and use of, the land transport system. The NZ Transport Agency has multiple roles relevant to the ACPBC. It:

- Allocates funding under the National Land Transport Programme (NLTP) that determines funding availability for the Auckland programme
- Co-funds AT-led cycle network development projects through the NLTP
- Administrates recent additional Government investment in cycling via the Urban Cycleways Programme
- Leads planning and delivery of cycle network components within state highway corridors, through its Highways Networks and Operations division
- Sets road user rules and road design standards and guidelines.

4.1.3 Auckland Council

AC is responsible for land use planning and setting long term policy in Auckland. In addition, AC develops cycle facilities within parks and delivers streetscape improvements in town centres. Through the Auckland Unitary Plan, AC sets planning regulations on provision of cycling end of trip facilities within new buildings. AT is a joint partner with AC on the delivery of the Greenways programme which is being developed with Local Boards across Auckland. AC's 21 Local Boards are elected to represent the views of local communities in AC group decision making processes.

Panuku Development Auckland is an Auckland Council agency that leads urban revitalisation projects throughout the region. Panuku redevelopment programmes offer opportunities for integration with cycle network development.

4.2 Other partners and stakeholders

There are a number of other partners and stakeholders that are relevant to this project. These include advocacy groups and other potential delivery partners, as mentioned below. Throughout the ACPBC development, the following groups have been involved (further details on consultation process are included in following section):

4.2.1 Bike Auckland

Bike Auckland is a not-for-profit member driven organisation that represents people on bikes in Auckland. Its membership is "made up of professionals and amateurs, hipsters and commuters, triathletes, sprinters, roadies, BMX riders, mountain bikers, parents, kids, friends, families – and combinations of all of those".[6] Bike Auckland's aim is to make Auckland a world-class city for – and through – people on bikes. It consults and advocates with AC, AT, the NZ Transport Agency and others public and private organisations for an improved cycling environment in Auckland. Bike Auckland is affiliated to the Cycle Advocates Network, New Zealand's national network of bike advocates.[7]

4.2.2 Automobile Association

The Automobile Association is an incorporated society that represents nearly one million members across New Zealand.[8] As well as offering various services to these members such as insurance and roadside rescue, they have a strong role in advocacy. This covers all aspects of roading including calling for improved road safety and better infrastructure.

4.2.3 Generation Zero

Generation Zero is a nationwide youth led organisation founded with the central purpose of providing solutions for New Zealand to cut carbon pollution through smarter transport, liveable cities and independence from fossil fuels[9]. In Auckland they have run several high profile campaigns calling for improved cycling funding and infrastructure.

[6] https://www.bikeauckland.org.nz/about/what-we-do/
[7] https://can.org.nz/about-can
[8] http://www.aa.co.nz/assets/about/newsroom/publications/Association-Profile-2015-lr.pdf
[9] http://www.generationzero.org/about

4.2.4 Greater Auckland

Greater Auckland is a non-profit information and advocacy group incorporated in 2015, who advocate for better urbanism, housing choice and transport options[10]. They host a blog and advocacy forum that discusses urban and transport issues, with a focus on Auckland.

4.2.5 University of Auckland – School of Population Health

The School of Population Health is part of the Auckland University Faculty of Health Sciences. Their goal is to "provide the knowledge and skills to improve the health of all New Zealanders, by focusing on factors that affect the wellbeing of entire populations". The school's expertise covers all aspects of primary care, health services, and public health. They produce research on a wide range of public health topics[11]. This includes the link between transport and health, and especially the link between health and active transport.

4.2.6 Auckland Regional Public Health Service

The Auckland Regional Public Health Service is funded by the Ministry of Health to be Auckland's regulatory public health agency[12]. They work to "improve public health well-being, promote positive public health, prevent illness in populations". Their action plan recognises that transport has an impact on public health, and they support encouragement of healthy transport options such as walking and cycling.

4.3 Consultation with funding partners and stakeholders

Consultation on the development of the PBC with internal and external stakeholders included:

- In Dec. 2016, drop-in poster sessions to share information and receive feedback on the long-list options. Representatives from AT, AC, the NZ Transport Agency, Bike Auckland, Generation Zero, Auckland Regional Public Health Service and the University of Auckland attended.
- In Feb. 2017, a session with Bike Auckland representatives to present an update on the PBC and share information as well as receive feedback on initial indicative networks under consideration for the recommended programme. This session helped guide the development of the short list options.
- In April and May 2017, engagement sessions with the funding partner agencies to share information and receive feedback on the short-list assessment and recommended programme were conducted.
- In April and May 2017 stakeholder meetings to share the recommended programme and gather information on potential challenges and opportunities for coordinated work with key delivery partners including AT Metro, Safety, Strategy, Parking, and Road Corridor Delivery, AC Parks, the NZ Transport Agency and Panuku Development Auckland.
- In May 2017, meetings with key external stakeholders including Bike Auckland, Generation Zero, Greater Auckland and AC local boards affected by the recommended programme: Albert-Eden, Devonport-Takapuna, Waitemata, and Orakei.

[10] http://www.greaterauckland.org.nz/about

[11] https://www.fmhs.auckland.ac.nz/en/soph/about/our-school.html

[12] http://www.arphs.govt.nz/about

5 STRATEGIC ASSESSMENT – OUTLINING THE NEED FOR INVESTMENT

This chapter outlines the rationale for investing in cycling in Auckland, drawing upon the Strategic Case prepared in March 2016. The ACPBC refines the problems and benefits previously established for the Strategic Case prepared in 2016 for the 2015-2018 programme. It identifies problems with the existing situation and the benefits of overcoming these problems, outlines the alignment to investment partners' strategies and goals, and identifies other issues and constraints that may affect the programme. In addition, it draws together existing and new evidence to identify the magnitude and consequences of the problems.

5.1 Defining the problem

A series of stakeholder workshops and discussions among the investment partners were held to define the problem. This included a facilitated investment logic map (ILM) workshop on 28 October 2016 and confirmation of the ILM by the Project Control Group at a meeting on 29 November 2016. The ILM is presented as Figure 13 on the following page.

Investment partners agreed the following key problems:

- Problem one: Cycling is perceived as unsafe and unattractive, resulting in it not effectively contributing to Auckland's transport system (45%)
- Problem two: Relatively low levels of cycling and high dependence on private vehicles results in poor environmental, place and health outcomes (25%)
- Problem three: The current transport system often fails to meet the needs of people using bikes, resulting in them being over-represented in deaths and serious injuries (30%).

Auckland-specific evidence for these problems, and evidence to support the investment objectives, is presented in sections 4.5-4.7 below.

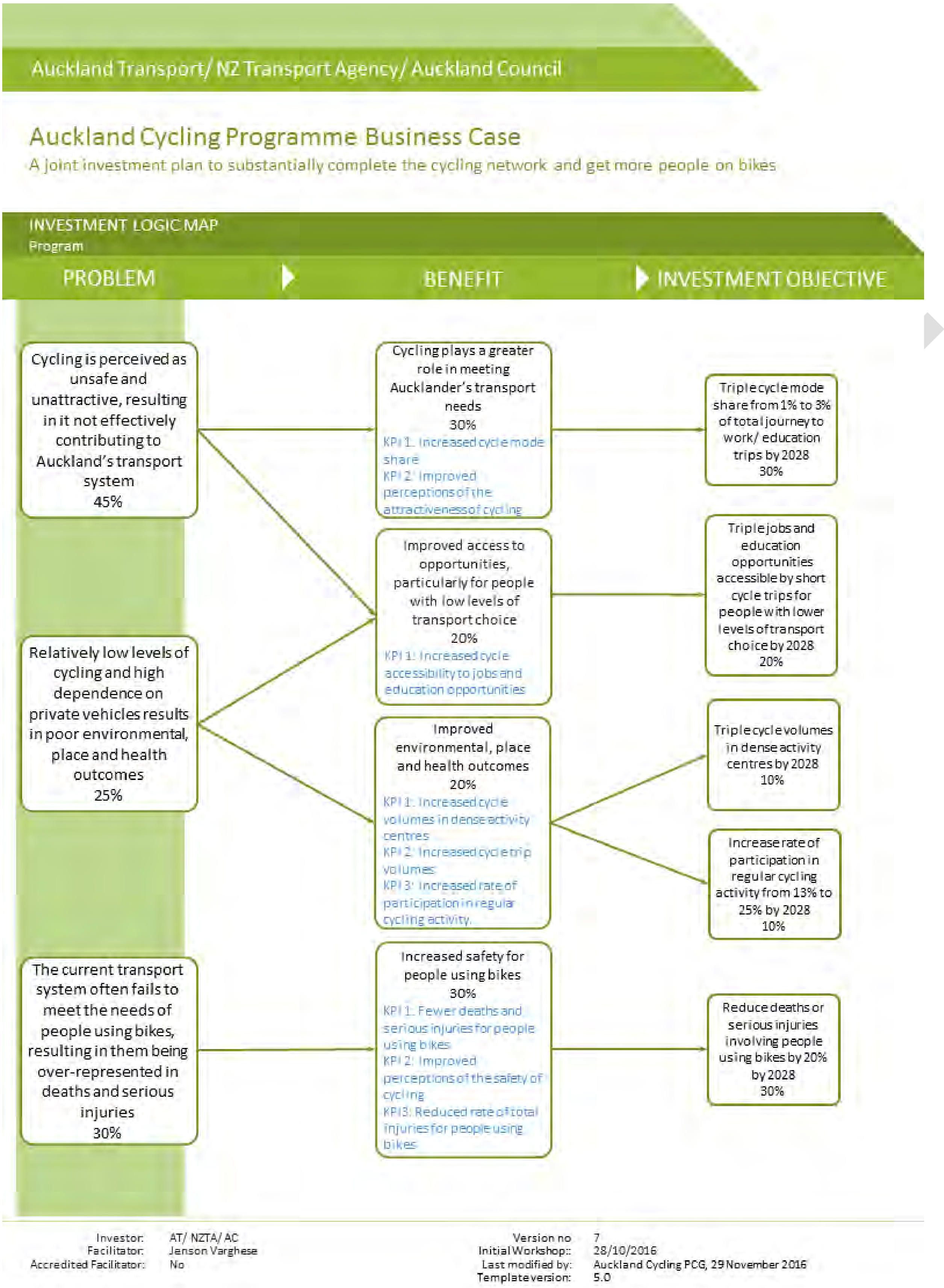
5.2 The benefits of addressing the problem

The ILM identified four potential benefits of addressing these problems:

- Benefit one: Cycling plays a greater role in meeting Aucklander's transport needs (30%)
- Benefit 2: Improved access to opportunities, particularly for people with low levels of transport choice (20%)
- Benefit 3: Improved environmental, place and health outcomes (20%)
- Benefit 4: Increased safety for people using bikes (30%)

These reflect the expected outcomes from addressing the problems. The benefits are linked to five investment objectives which are discussed in more detail in Sections 4.5 to 4.7.

Figure 13: Investment logic map for cycling in Auckland



5.3 Alignment to existing strategies/organisational goals

This section describes how the identified problems and investment objectives align with national, regional, and organisational strategies. It draws upon publicly-available strategies, including draft strategies that are currently in consultation but expected to be concluded by the time the ACPBC is completed.

5.3.1 Ministry of Transport

Draft Government Policy Statement on Land Transport Funding 2018-2028

The GPS is relevant to the ACPBC in determining the level of government funding available for cycling activities and setting strategic objectives to which the programme needs to be aligned. The draft GPS was released in February 2017. This document sets out the government's priorities for expenditure from the National Land Transport Fund over the next 10 years and defines how funding is allocated between different 'activity classes', which cover different areas of transport expenditure.

The GPS establishes the government strategic priorities for the transport system. Each strategic priority has associated objectives, with both long and short-term results. The three strategic priorities are:

- Economic growth and productivity;
- Value for money; and
- Road safety.

There are six objectives, including the following objective which relates to cycling: "A land transport system that provides appropriate choices". The expected result from this is "Increased safe cycling through improvement of cycle networks". An increase in cycling is seen to have a number of benefits including improved health outcomes, cost savings for users and providing transport choice. The draft GPS identifies the perception of cycling as risky as a key barrier to achieving these benefits and identifies "good quality, fit for purpose cycling facilities" as a means of overcoming this perception.

5.3.2 NZ Transport Agency

Four NZ Transport Agency strategic documents are particularly relevant for guiding the ACPBC:

- The NZ Transport Agency Statement of Intent 2015-2019
- The NZ Transport Agency Draft National Cycle Programme 2017
- Safer Journeys – New Zealand Road Safety Strategy 2010-2020
- Cycling Safety Action Plan 2015

NZ Transport Agency Statement of Intent 2015-2019

The NZ Transport Agency produces a Statement of Intent (SoI) every three years that sets out its strategic direction to implement the GPS on Land Transport Funding. It includes goals, objectives and priorities for short term focus. One of the six priorities identified in the most recent (2015) SoI is to "make urban cycling a safer and more attractive transport choice".

The NZ Transport Agency's SoI especially focuses on urban cycling in Auckland, Wellington and Christchurch where the aim is to "significantly increase mode share … and bring forward both cycling safety and transport choice benefits". The expected result is that cycling trips in the three main cities will increase by 10 million over the current baseline of 32 million by 2019.

Safer Journeys – New Zealand Road Safety Strategy 2010-2020

The *Safer Journeys – New Zealand Road Safety Strategy 2010-2020* developed by the National Road Safety Committee sets out a national strategy for improving road safety, including for cyclists. This strategy introduced the 'Safe System' approach to New Zealand, which aims to address every aspect of the road system to improve safety. The four areas identified are safe roads, safe speeds, safe vehicles and safe road use. One of the areas under safe road use is 'safe walking and cycling'. The Strategy aims to achieve these through several methods:

- Reduced urban speeds, especially around schools;
- Increase cycle skills training;
- Encouraging people to share the road; and
- Provision of safe and convenient routes for walking and cycling, especially to and from school.

The Road Safety Strategy provides guidance on safety-related interventions for the ACPBC.

Cycling Safety Action Plan 2015

In 2015 the NZ Transport Agency published a Cycling Safety Action Plan entitled *Making Cycling Safer and More Attractive*. This was produced to aid implementation of the 35 recommendations that the Cycling Safety Panel made in its 2014 report. The key areas of focus for improvements identified in this Action Plan are:

- Improving quality and quantity of cycle infrastructure;
- Improved design guidance to ensure facilities match world best practice, with a special focus on intersections;
- Reviewing road rules; and
- Reducing speeds in urban areas.

The Road Safety Strategy provides guidance on safety-related interventions for the ACPBC.

5.3.3 Auckland Transport

In addition to supporting national-level policy, the ACPBC has been developed to align with established AC and AT policy. Relevant AT strategic documents are:

- Regional Land Transport Plan 2015-2025
- SoI 2016-2019.
- Roads and Streets Framework

Regional Land Transport Plan 2015-2025

The Regional Land Transport Plan (RLTP) sets out the transport strategy for Auckland, as well as the 10 year programme of activities that can be delivered within current available funding. The Investment Logic Mapping process undertaken for the RLTP in 2015 identified four key problems that transport policy and investment for the region needs to address:

1. Limited quality transport options and network inefficiencies undermine resilience, liveability and economic prosperity
2. The existing transport network won't adequately support growth in a way that achieves a quality compact city
3. The transport system creates adverse health, safety, cultural and environmental effects
4. Meeting all transport expectations is increasingly unaffordable and will deliver poor value for money

In response to these problems, the RLTP sets out the objectives and policies for key strategic areas. The relevant policies for cycling include:

- Increasing the proportion of trips made by walking, especially in the city centre, metropolitan centres and town centres and for short local trips especially trips to school;
- Providing an integrated, connected cycle network linking key population centres, education centres and transportation facilities; and
- Unlocking the suppressed demand for cycling.

AT Statement of Intent 2016-2019

AT's SoI sets out the strategic direction for AT and the three year programme to achieve the stated goals. It also includes key performance indicators to ensure progress can be measured regularly of the life of the SOI.

One of the key strategies identified is the "development of safe cycleways and walkways". The key performance indicators identified alongside this strategy are:

- Doubling cycle trips across Auckland from 2014/15 to 2018/19
- Achieving an 18% increase in cycle movements in the city centre between 2016/17 and 2018/19.

The Roads and Streets Framework

Auckland Transport is currently developing the Roads & Streets Framework to provide for clearer guidance on road and street design. Core priorities are:

- To deliver better, active and inclusive places and new destinations
- To transform conditions for walking, cycling and public transport
- To maintain an efficient road and street network for movement and access.

Roads and streets have to fulfil a complex variety of functions to meet people's needs as places in which to live, work, play, study and invest. The Framework describes, balances and integrates the intended strategic and local place and movement functions of roads and streets, as well as the levels of service for all transport modes. It provides future modal priorities and service priorities, as well as a toolbox of local and strategic measures to help resolve conflicts between the different functions. Future plans, projects and schemes should reflect the Roads & Streets Framework, especially in new growth areas.

The Framework includes a family of street types and identifies six functions to describe the broad spectrum of roles that Auckland's road and streets need to perform over 24 hours. These are living, unlocking, moving, functioning, protecting and sustaining functions across Auckland's roads and streets. As the region continues to grow, it is vital that its roads and streets are fit for purpose and perform better across these critical functions.

Improved cycling facilities are emphasised in the desired outcomes across most of the Framework street functions:

- The *living* function specifies a desired outcome for streets that are welcoming and accessible for everyone.
- The *movement* function sets intentions for significantly improved environment for walking and cycling, higher cycling and walking activity and priority for reliable public transport services as well as diverse transport choices for all income groups and transport disadvantaged people.
- The *protection* function focuses on continued reduction in casualties and improved safety for vulnerable users.

- The *sustainable* function outcomes include imbedding sustainable travel options such as cycling, a reduction in per km/person emissions, improved design and layout of roads to minimise exposure to air pollution, a substantial increase in the volumes of active travel.

The Framework recommends prioritising cycling and pedestrians where living and other functions such as protecting are important. It also endorses priority for cycling facilities on mixed use arterials, preferably protected from adjacent vehicular traffic and on collector streets.

5.3.4 Auckland Council

Auckland Council documents with particular relevance to Auckland's transport system and cycling include:

- The Auckland Plan
- The City Centre Master Plan.

The Auckland Plan

The Auckland Plan provides a 30-year strategic vision for Auckland and is the primary strategic document published by AC to guide its own activities and the activities of council-controlled organisations like AT. It establishes a long-term spatial plan for the city, including informing land use and transport planning.

Cycling is seen to contribute to the goals of Auckland Plan in a number of ways including health benefits, reducing pollution and providing alternatives to traffic congestion. To achieve this the plan calls for improving the "safety, personal security and attractiveness of walking and cycling alternatives" and "investing in, and integrating public transport and walking and cycling networks to provide convenient and efficient alternatives." The Auckland Plan is currently being refreshed, providing the opportunity for cycling to be further embedded in the City's vision.

In addition, AC publishes a Letter of Expectation for AT to inform the development of its Statement of Intent. The most recent (2017) Letter of Expectation supports:

> *"maintaining momentum on delivering the cycling programme, incorporating priority for cycling and walking into projects, and building the case for a continuation of central government's Urban Cycleways Fund beyond 2018."*

The Auckland City Centre Master Plan

The Auckland City Centre Masterplan is a 20-year vision that sets the direction for the future of the city centre as the cultural, civic, retail and economic heart of the city. Underpinning the plan is a focus on a range of projects that will make the city centre more family-friendly, pedestrian-friendly and environmentally-friendly.

The Plan recognizes the challenges facing a growing Auckland and identifies that over the coming 20 years, nearly all of the growth in trips to and within the city centre during the peak periods will need to be accommodated by public transport, walking and cycling. The plan expects five times as many cycling trips are needed to meet increasing travel demand during this time period and supports the current and future partnership between AT and the NZ Transport Agency on a one network approach to provide a balance between movement and plan which involves providing for travel growth through cycling as well as public transport and walking.

Specific to a cycle network, the Plan identifies the need for a high-quality and connected cycle network:

Development of a high-quality and connected cycle network will unlock the potential for cycling to provide a significant proportion of short trips to and around the city centre. The NZ Transport Agency and Auckland Transport are developing a central motorway junction cycleway to provide a new dedicated pedestrian/cycleway into the city centre. Lower vehicle speed limits and high-quality off-road paths will be components of the package that will make cycling on city streets safer and more attractive. The increase in cycling will be supported by Unitary Plan requirements for more end-of-trip facilities such as cycle parking, showers and lockers.

5.3.5 Auckland Transport Alignment Project

In response to the transport challenges arising from urban growth, the Auckland Transport Alignment Project (ATAP) was established in partnership between AC and central government. ATAP provides important strategic policy context for the ACPBC.

ATAP established common central and local government objectives for Auckland's future transport network and identified a recommended approach for investing in and managing the network. ATAP's *Recommended Strategic Approach*, published in September 2016, provides clarity about future transport network management and investment in Auckland, including the timing and need for key transport infrastructure projects.

ATAP did not address urban cycling in detail. However, it did note that safety and active modes (walking and cycling) were areas where "the views of central and local government are already well aligned on the priorities and likely level of future funding." It therefore takes implementation of the *Safer Journeys Action Plan*, the *Auckland Road Safety Plan*, and the *Urban Cycleways Programme* as given, noting that "there is a need to continue to make improvements to road safety and active modes (walking and cycling)."

ATAP highlighted that walking and cycling had potential to make positive contributions to the transport network. In particular, it identified these modes as being well suited to "serving higher intensity areas, short-to-medium length trips, and extending the reach of strategic public transport corridors." This links strongly to one of ATAP's four key objectives which is to improve public transport's mode share where it will address congestion.

It suggested furthermore that walking and cycling had the potential to increase transport system capacity in the central area, where transport corridors are physically constrained and where higher person throughput is a high priority. This can contribute to one of the recommendations which is to "make better use of existing networks".

5.4 Issues and constraints

This section identifies key issues and constraints that could materially affect the programme. To that end, it notes key constraints that have been identified in consultation with investment partners, and discusses implications for programme development. It also notes key uncertainties, particularly around the delivery of cycle facilities as part of other projects, and describes how they have been addressed.

5.4.1 Constraints on programme development

There are two main types of constraints on programme development: Constraints related to investment partners' statutory powers and constraints arising from existing decisions in other policy areas. These constraints are considered when assessing the long-list of policy options to deliver on investment objectives, and when developing a short-list of options for programme development.

Constraints related to statutory powers

The investment partners have relatively broad statutory powers, including funding and delivering transport investment, promoting legislative changes (in the case of the NZ Transport Agency), and regulating land use and development (in the case of AC). While the NZ Transport Agency has a national mandate, AT and AC are regional entities and hence cannot shape policy at a national level.

There are two important constraints arising from the investment partners' statutory powers:

- First, the investment partners do not have the ability to set national tax policy. This limits their ability to pursue some policies that are used to promote cycling in some other jurisdictions, such as fringe benefit tax exemptions for expenditures on cycle commuting. Policy options related to tax subsidies for cycling or implementation of congestion pricing therefore cannot be implemented without support from other agencies.
- Second, the regional focus of AT and AC means that they cannot directly influence national-level legislation and regulation, such as the Road Code. The NZ Transport agency *does* have this ability, but it is constrained by its need to set policy to address national problems, rather than problems that arise mainly in the Auckland context.

Constraints related to existing decisions

There are several areas where existing decisions are unlikely to be substantially revisited, at least not within the 2018-2028 period. These include policies related to land use planning, public transport network planning, and parking policy, all of which may affect programme development.

First, as noted above, the recently-completed Auckland Unitary Plan (operative in part) sets out policies, objectives and land use planning rules for Auckland. In addition to regulating the location and intensity of future residential and business growth, it has introduced new requirements to provide cycle parking and end of trip facilities with new developments. Given the cost and time required to progress major plan changes, the Auckland Unitary Plan is unlikely to be substantially revised during the 2018-2028 period. As a result, land use planning policies, including requirements for cycle parking and end of trip facilities, are unlikely to change over this period. These new requirements also offer an opportunity to increase the role future development will contribute to accommodating the needs of people undertaking trips by bike.

Second, AT has recently undertaken several major public transport network planning and development exercises. This includes the rollout of the New Network, which provides more frequent, connected services throughout the city, the development of the City Rail Link to unlock capacity in Auckland's rail network, and the delivery of supporting infrastructure such as public transport interchanges at Otahuhu and Panmure. The NZ Transport Agency is also delivering the extension of the Northern Busway to Albany. The broad structure of Auckland's public transport network is unlikely to be substantially revised during the 2018-2028 period, which provides certainty about where there may be opportunities to integrate cycling and public transport.

Third, AT's (2015) Parking Strategy establishes principles for management of on-street parking, including availability and price of parking. While higher parking prices can encourage people to shift from driving to other transport modes, AT's parking strategy focuses on the role of pricing and other parking management techniques such as time limits in optimising parking occupancy, rather than achieving other goals such as mode shift. This policy is not expected to be substantially revised during the 2018-2028 period.

5.4.2 Areas of uncertainty

There are a number of areas of uncertainty that must be considered in programme development. Table 5 summarises the main areas of uncertainty. Further elaboration of uncertainty and risks is included in the recommended programme assessment.

Table 5: Uncertainty log for ACPBC

Factor	Time	Uncertainty[13]	Impact on programme	Comments
Factors affecting demand				
Progress towards ATAP Recommended Strategic Approach, including road pricing	2018-2028 period	Reasonably foreseeable	Road pricing is likely to increase demands for alternatives to driving, including cycling	Demand forecasts for cycling have been made without including the effect of road pricing
Location of future residential and employment growth	Ongoing	Reasonably foreseeable/ Hypothetical	The location of growth may affect demand for cycling in different locations	Demand forecasts have been made using the base (I9) land use forecast used in ATAP. However, the precise location of future growth is uncertain and reliant on behaviour of a number of private and public sector development actors.
Changes to bicycle technology that may increase the attractiveness of cycling, eg reductions in prices for batteries and e-bikes	Ongoing	Reasonably foreseeable	Cheaper batteries and e-bikes may increase the attractiveness of cycling for more people	Demand forecasts have been made without assuming higher e-bike uptake
Changes to road safety technologies that may increase road and cycling safety – eg vehicle, traffic signal, information systems technologies	Ongoing	'Hypothetical' to 'Reasonably foreseeable'	Earlier availability of new road safety technologies may improve road safety in general and increase cycling demand.	Demand forecasts have been made under base assumptions that do not expect these changes in the 2018-2028 period
Changes to the passenger mobility system eg 'mobility as a service' – that may impact on the relative attractiveness of transport modes	Ongoing	'Hypothetical' to 'Reasonably foreseeable'	Earlier availability of connected / autonomous vehicles may reduce demand for cycling; conversely, more integrated multi-modal 'mobility as a service' changes may increase attractiveness of cycling for some trips.	Demand forecasts have been made under base assumptions that do not expect these changes in the 2018-2028 period

[13] 'Near certain' refers to cases that have policy or funding approval, tenders let, or which are under construction. 'More than likely' refers to factors where planning consent application is imminent or where there are adopted plans. 'Reasonably foreseeable' refers to cases where there are adopted/draft plans or development conditional upon other interventions. 'Hypothetical' refers to policy aspirations that are still labouring under considerable uncertainty.

Factor	Time	Uncertainty[13]	Impact on programme	Comments
Factors affecting supply				
Availability of funding relative to other transport priorities	2018-2028	'Reasonably foreseeable' to 'More than likely'	Shifts in priorities for funding across transport modes will impact on the supply of new infrastructure and speed of implementation.	Funding levels for cycling through the GPS or AC LTP have not yet been determined.
Timing of major transport corridor upgrades for other modes	2018-2028	'Reasonably foreseeable' to 'More than likely'	Major corridor upgrades may provide opportunities to develop new cycling facilities in some cases In other cases, they may disrupt or constrain cycling provision	Key examples: Isthmus Mass Transit; Lincoln Rd corridor upgrade; Northwest Busway; ATAP recommendation to raise arterial corridor throughput. Opportunity for cycling projects to lead corridor improvements rather than being 'reactive' to other modal priorities.
Trade-offs with other modes using transport corridors	2018-2028	More than likely	Implementation of cycling facilities on constrained road corridors likely to be impacted by decisions on road space allocation with other modes (eg parking, bus lanes, general traffic lanes).	AT's Roads and Streets Framework provides guidance on making trade-offs between modes. The feasibility of developing new facilities will depend on consultation and decision-making processes at a project level.
Timing of road renewals / resurfacing	2018-2028	More than likely	Road renewals may provide opportunities to develop new cycle facilities at a lower cost; however, renewals are difficult to forecast far in advance	Policy guidance / strategy is needed in order to identify where and how to take advantage of renewals
Development of Supporting Growth networks greenfield areas	2018-ongoing	More than likely	Cycling facilities are expected to be provided as part of Supporting Growth package; however, the design and integration of these facilities may be uncertain	Policy guidance is needed in order to align Supporting Growth network development with broader cycling programme
Cycle facility investments made by local boards and AC parks team (greenways / local paths)	Ongoing	Reasonably foreseeable	These investments have the potential to make minor contributions to investment objectives	Policy guidance may be needed in order to align investments or ensure consistency in delivery
Factors affecting cost				

Factor	Time	Uncertainty[13]	Impact on programme	Comments
General cost inflation for civil construction	Ongoing	Reasonably foreseeable	Cost inflation will drive up the cost of delivering cycle facilities, thus limiting the amount of network that can be delivered for a fixed budget	This has been addressed by using high cost rates drawn from recent facility delivery in Auckland
Capacity constraints in the industry leading to timeframe / cost risk, eg availability of consultants and contractors to design and build facilities	Ongoing	Reasonably foreseeable	Capacity constraints may limit the quantity of cycle facilities that can be delivered within the timeframe; they can be overcome in the medium term by recruiting and training	This has been addressed by testing investment levels that have been demonstrated to be feasible to deliver in the 2015-2018 period
Consultation and engagement processes and impact on cost and rate of delivery	Ongoing	Reasonably foreseeable	Delivery of individual cycling projects requires substantial consultation resources. Relatively small cycle projects require same level of consultation as large projects.	May be opportunities to streamline consultation and engagement processes through consultation on packages of network improvements.

5.5 Problem 1 - evidence

Problem 1 is:

> *Cycling is perceived as unsafe and unattractive, resulting in it not effectively contributing to Auckland's transport system.*

The core problem identified is the ineffective contribution that cycling is making to Auckland's transport system and the primary reason for this is public perceptions that cycling is unsafe and unattractive. The following sections summarise evidence for these problems and implications for programme development. They address:

- The current role of cycling in meeting Aucklanders' transport needs;
- Barriers to cycling uptake in Auckland; and
- Potential for increased cycling to contribute to a more efficient Auckland transport system.

5.5.1 Cycling's current limited role in Auckland's transport system

Cycling currently plays a minor role in meeting Aucklanders' transport needs. Data available shows that:

- Cycling accounted for 0.4% of Aucklanders' overall household travel in 2010-2013 (based on the Household Travel Survey). The average Auckland resident makes 22 cycle trips per year, compared with approximately 4,000 motor vehicle trips, 850 walking trips, and 182 bus and train trips.
- 1.2% of Auckland commuters used a bicycle as their main means of transport to work on the day of the 2013 Census.
- 13% of Aucklanders cycle once or more a week (AT/ TRA Active Mode Survey 2016).

Survey and census data also shows that cycling is currently a niche activity, with young to middle-age males significantly more likely to cycle than other population groups. Cycling is predominantly undertaken for recreational rather than utility purposes. More detailed information on current cycling activity in Auckland and characteristics of cycle users is provided in Supplementary Material, Section 1.1.

A comparison with cycling activity in other cities in New Zealand and internationally suggests that there is potential for cycling to play a more significant role. Table 6 compares cycle mode share in Auckland and five other New Zealand cities. Cycling is used for a much lower proportion of total household trips in Auckland than in all other main centres. Christchurch has the highest cycle mode share, with cycling accounting for 3.6% of overall household trips and 7.0% of commuter trips, followed by Wellington (1.5% and 4.3%). This suggests that there are opportunities to increase cycling participation in Auckland, as these cities are culturally similar, with broadly comparable oceanic climates and (with the exception of Hamilton and Christchurch) similar topography.

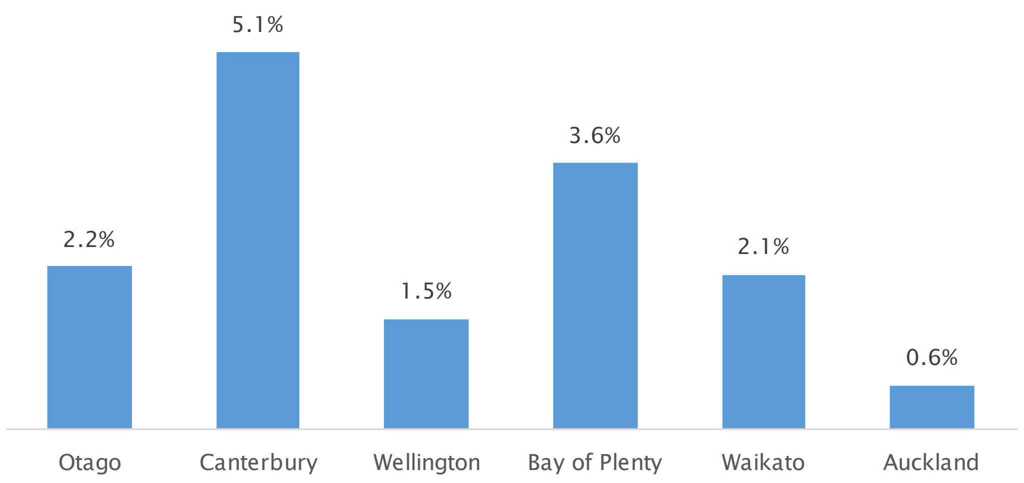
Table 6: Comparison of cycle mode share in New Zealand cities (Shaw et al, 2016)[14]

City	Cycle mode share of all household trips (HTS 2011-14)	Cycle mode share of commuting trips (Census 2013)
Auckland	0.4%	1.2%
Tauranga	1.9%	3.2%
Hamilton	1.1%	3.8%
Wellington	1.5%	4.3%
Christchurch	3.6%	7.0%
Dunedin	1.3%	2.8%

A detailed analysis of cycle mode share for short (less than 5km) household trip chains suggests that Auckland's geographic scale (which results in longer average trip distances) is not the key barrier to cycling participation. As Figure 14 shows, cycling accounts for only a small share of short trips taken by Aucklanders compared to other main urban centres. While cycling accounts for approximately 5% of short household trips in Christchurch, it only accounts for 0.6% of short trips in Auckland. This indicates that other barriers discourage Aucklanders from cycling even for short trips.

[14] Shaw, Caroline, Marie Russell, Kim van Sparrentak, Annabel Merrett and Harry Clegg (2016) Benchmarking cycling and walking in six New Zealand cities Pilot study 2015, New Zealand Centre for Sustainable Cities University of Otago, Wellington.

Figure 14: Cycle mode share for trip chains of less than 5 kilometres (Household Travel Survey, 2010-14)



5.5.2 Perceived and actual barriers to cycling uptake in Auckland

The primary cause of low levels of cycling in Auckland is the widespread perception that cycling is unsafe and unattractive. This in turn reflects the reality of cycle facility provision, road user behaviour, and the relative attractiveness of other transport modes.

Survey evidence suggests that there are a large number of people who would consider cycling but who are dissuaded by current cycling conditions. TRA (2016) estimate that up to half of Aucklanders would consider cycling if the conditions were right. They classify users into five categories based on their current behaviours and stated preferences, as summarised in Table 7. 22% of the population willing to consider cycling, despite being not currently active cyclists, and an additional 25% of the population may be prompted to increase from being occasional to regular users. These people constitute a significant 'Interested but concerned' group. TRA's findings are consistent with other survey research, for instance, a 2005 survey reported by Kingham et al (2011) that found that 27% of non-cyclists in Christchurch were keen to cycle given the right conditions.

Table 7: Aucklanders' willingness to adopt cycling (TRA, 2016)

Category	Definition	Share of Aucklanders
Rejectors	Would not cycle regardless of conditions	46%
Considerers	Not currently active, but would consider cycling	22%
Occasional	Cycle less than once a week	12%
Medium	Cycle once a week	13%
Frequent	Cycle two or more times a week	6%

People who do not currently cycle cite perceived lack of safety as the primary barrier to cycling more. TRA (2015) investigated barriers to cycling uptake among Aucklanders that could cycle for everyday journeys but who do not currently cycle (ie 'Interested but concerned' users) and identify the factors that would enable greater rates of cycling uptake. Their key findings are as follows:

- People who currently cycle are more likely to report that "there are lots of cycleways available" and that they "have friends who cycle". This points to the role of cycle facilities in encouraging use, as well as the fact that social networks can normalise cycling.
- People who do not cycle report concerns with safety as a primary barrier. 50% state that they don't feel safe cycling because of how people drive, 43% state that there are not enough cycle

lanes separating bikes from traffic, and 38% report that they don't feel safe cycling after dark. Only a minority of potential cyclists agree that Auckland has a well-connected cycle network that sufficiently separates cyclists from traffic.

- Potential cyclists report that "more cycleways" is the primary factor that would encourage them to cycle more. 64% of potential cyclists reported that this would encourage them to cycle more, compared with 39% who stated that "parking hassles" would be a motivator, and 24% that stated that better cycle parking or improved shower/storage facilities would be a motivator.

Subsequent research by TRA (2016) found that only a minority of respondents agreed that "cyclists are sufficiently separated from traffic" (19% agreed), "there are enough cycle lanes and cycle paths" (23%), or "Auckland has a well-connected cycle network" (31%).

International research shows that cycle facilities that physically separate cycle users from traffic can help overcome perceptions of poor safety (see Supplementary Material, Section 1.1). Analysis of demand uplift accompanying recent cycling network investment in Auckland confirms that provision of separated cycle facilities has resulted in increased cycling activity (see Supplementary Material, Section 1.2).

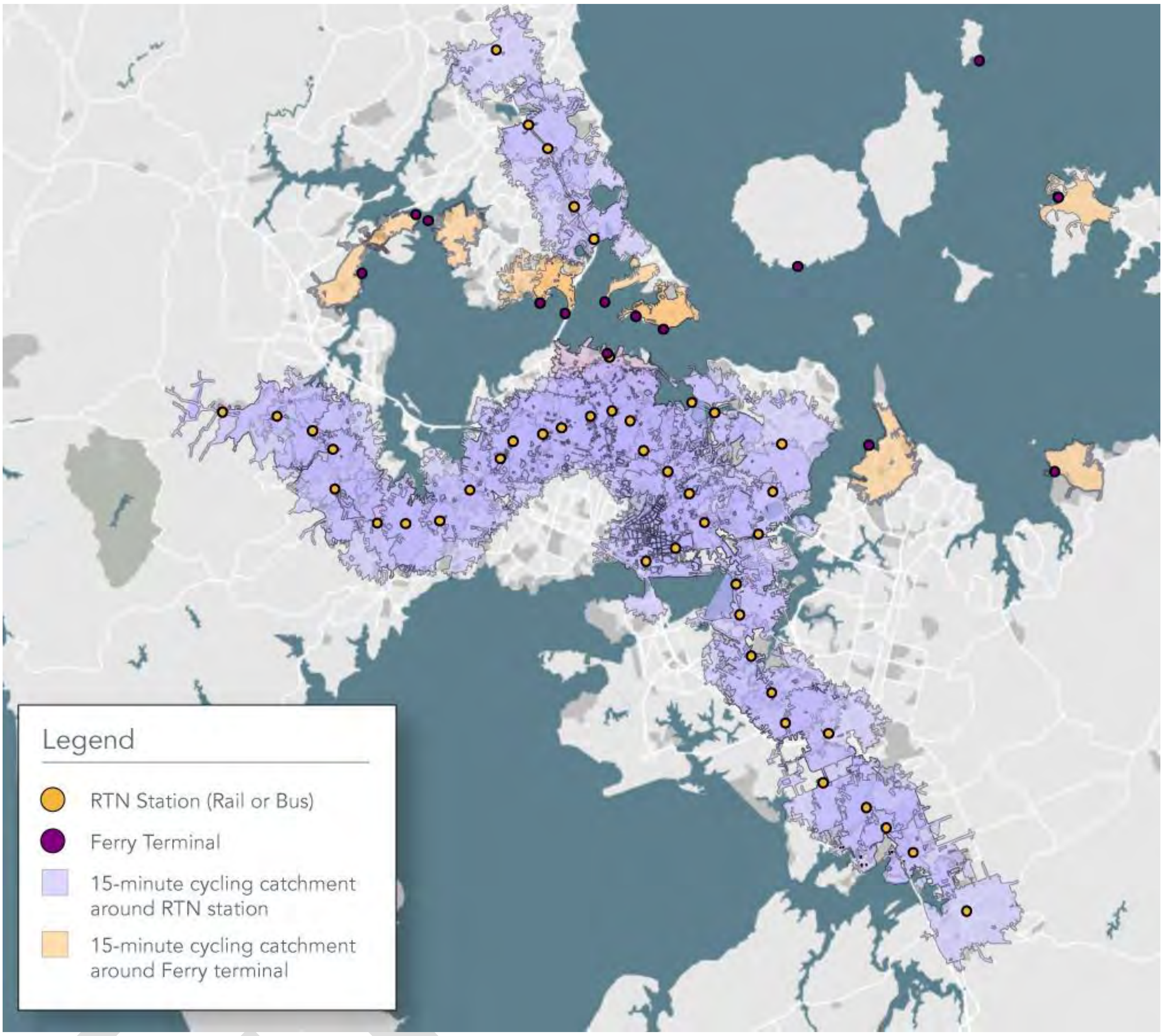
5.5.3 How cycling can contribute to a more efficient and effective transport system

Increased cycling activity in Auckland has potential to contribute to a more effective and efficient regional transport system in several ways.

Cycling has particular potential to serve short-medium distance passenger transport trips (1km-7km), with very short trips more likely to be undertaken by walking, and longer-trips likely to be more suitable served by public transport or cars for most users. A 7km trip is approximately 30 minutes cycling time. Household travel survey data shows that the average household trip length is 7.6km, suggesting a substantial potential market for trips of less than 7km, or within easy cycling distance. Currently, cycling is only used for 0.6% of household trips of less than 5km, suggesting a large potential for increased use of cycling for short-medium trips.

In addition to serving short-medium distance trips, cycling also has potential for serving first-leg, last leg trips within longer distance regional-scale trips when combined with public transport. There is substantial potential for cycling to play a role in supporting Auckland's Rapid Transit Network (RTN) by serving a larger catchment than the immediately walkable catchment around stations. Figure 15 maps the 15-minute cycling catchment around all Auckland rail and busway stations, showing that much of the urbanised area is within cycling distance of rapid transit. Over 730,000 people currently live in these catchment areas (52% of the region's total population in 2013). Using cycling to support RTN access can contribute to wider benefits associated with mode shift to public transport for regional-scale trips including congestion, accessibility and environmental benefits.

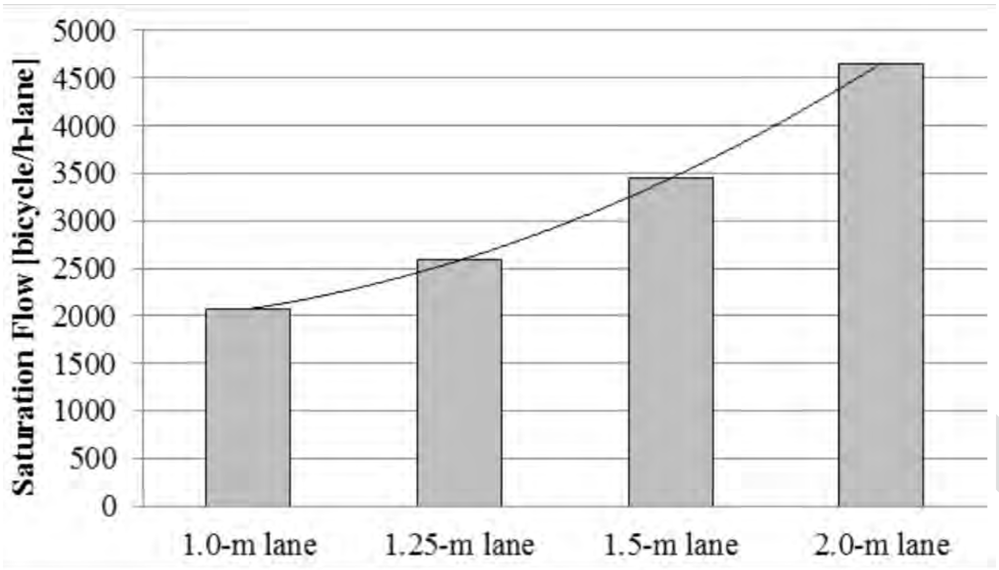
Figure 15: 15 Minute cycling catchment around Auckland RTN stations (Source: MRCagney analysis)



Cycling can also play a role in contributing to a more effective regional transport system by increasing total transport capacity on congested corridors and relieving pressure on congested parts of the road and public transport network. Bus capacity constraints currently exist on a number of central routes (eg Mt Eden Road buses) and shifts to cycling on these routes can reduce capital and operational expenditures associated with providing additional buses and attempting to cater to peak demand periods.

When cycle facilities are well utilised, they can enable more people to access key destinations without requiring more space for travel or parking. This reflects the fact that cycle lanes of a given width can accommodate more people moving than a general traffic lane, as well as the fact that cycle parking takes up less space than car parking. Figure 16 shows that cycle lanes of between 1.0 and 2.0 metres wide can move between 2,000-4,700 people per hour, even taking intersections into account. By comparison, general traffic lanes can move around 1,800 vehicles per hour and are typically 3.0 to 3.5 metres wide. However, in order for cycle facilities to be successful in increasing total mobility within constrained corridors, they must be relatively well utilised. This reinforces the importance of ensuring that cycle facilities reach key destinations.

Figure 16: Maximum ('saturation') flow on cycle lanes (Serani et al, 2015)



5.5.4 Implications of the evidence

Although current levels of cycling are low, this evidence shows that cycling could play a much greater role in meeting Aucklanders' transport needs. There is considerable latent demand for cycling, which can be realised by overcoming barriers related to lack of high quality cycling infrastructure and concerns about the safety of cycling. Where these issues have been addressed, Aucklanders have responded by cycling more.

Cycle facilities that physically separate people on bikes from traffic on busy streets are most likely to succeed in increasing the attractiveness of cycling for a wider range of users. Coupled with cycle share and well located cycle parking complementary facilities will further support uptake in cycling in the city centre. This is reflected both in survey data and analysis of actual outcomes following cycle facility implementation in Auckland and other cities.

5.5.5 SMART investment objectives

Addressing this problem can contribute towards two benefits, as shown in the ILM in Figure 13:

Benefit 1: Cycling plays a greater role in meeting Aucklanders' transport needs

Benefit 2: Improved access to opportunities, particularly for people with low levels of transport choice

These benefits in turn relate to two SMART (Specific, Measurable, Achievable, Realistic, Time-bound) investment objectives:

Investment objective 1: Triple region-wide cycle mode share of total journeys to work / education from 1% in 2013 to 3% by 2028

Investment objective 2: Triple jobs and education opportunities accessible by short cycle trips for people with lower levels of transport choice by 2028.

These investment objectives aim to establish realistic targets for guiding the programme and measuring success. They have been determined with reference to local and international comparisons and current baseline conditions.

For investment objective 1, current cycling commute mode share is around 1% (2013 census) for the region as a whole, and 1.3% for the Auckland urbanised area. Mode share varies across the urban area with the highest mode share in Devonport-Belmont (3.6%) and Inner West (Ponsonby, Grey Lynn, Point Chevalier, 3.4%). Mode share is 0.5% or below in some outer-suburban areas such as Botany, Manurewa and Gulf Harbour.

Determining a realistic target for increased cycling mode share at the regional-scale has drawn on evidence about levels of increased cycling uptake in international cities that have invested heavily in cycling, and evidence on cycling mode share levels in other New Zealand Cities. Current cycling commute mode share levels in other major New Zealand cities ranges between 3% and 7% (see Table 6).

The target for tripling mode share is considered to be an ambitious, but realistic target for 2028. While Auckland is moving from a relatively low base level of cycling, tripling cycling activity over 10 years involves a substantial shift in travel behavior across the region. Such substantial shifts in travel behavior toward cycling have been observed in comparator cities over a ten-year time frame. It is likely that cycling mode share will continue to vary considerably across the region, with much higher mode share in parts of Inner Auckland. Achieving the mode shift target of 3% will mean cycling mode share in Auckland in 2028 will be roughly equivalent to current mode share in Tauranga or Dunedin, but less than half the level currently observed in Christchurch.

For investment objective 2, there is currently no established data on job accessibility by cycling. An experimental cycling accessibility indicator has been developed by MRCagney. It estimates that the average Auckland resident has access to around 5,000 jobs within 30 minutes 'low-stress' cycle time. Analysis of cycle access to major tertiary campuses suggests that around 85,000 Aucklanders can access one of Auckland's top five tertiary education campuses within 30 minutes cycling.

Investment objective 2 focuses on improving accessibility for people with low levels of transport choice (rather than for the average Auckland resident). People with low levels of transport choice who can benefit from improved cycle accessibility include:

- Children and young people – who are unable to drive or are less likely to have the financial resources available to own a car (eg people aged 10-19 years, see Figure 10).
- People living in locations distant from frequent public transport (people resident in locations more than 800m distant from a frequent bus service or RTN station, see Supplementary Material, Section 2.6).
- People living in household with no or lower levels of access to a private car.

Elderly people also have reduced travel choice, but cycling does not usually provide a viable alternative for improving accessibility due to less able bodies for this population. Improving the accessibility of jobs and education opportunities by short cycling trips for these populations will require improved facilities that reduce the perceived 'cost' of cycling. Achieving this investment objective may involve targeting some investment in areas with concentrations of these population groups.

5.6 Problem 2 - evidence

Problem 2 is:

> *Relatively low levels of cycling and high dependence on private vehicles results in poor environmental, place and health outcomes.*

The core problem identified is the poor environmental, place and health outcomes that accompany Auckland's current transport system. An important cause of this problem is the current transport system's dependence on private vehicles. Increasing uptake of cycling presents an opportunity to reduce the negative impacts of Auckland's transport system on these outcomes. The following sections summarise evidence for these problems and implications for programme development. They address:

- Environmental outcomes from Auckland's transport system;
- Place outcomes arising from the current situation;
- Health outcomes arising from the current system; and
- The potential effect of cycling on these outcomes.

To conclude, implications for the investment programme are identified.

5.6.1 Environmental outcomes from Auckland's transport system

Road transport can have significant impacts on environmental quality, including:

- Greenhouse gas emissions, which affect global environmental outcomes by contributing to climate change;
- Emissions of fine particulates and other pollutants that have a detrimental effect on human health; and
- Runoff from road surfaces, which may increase contaminants such as heavy metals in water bodies.

At present, Auckland's transport system has a significant environmental impact at a global and local level. Transport is Auckland's single largest source of greenhouse gas emissions, accounting for 38% of overall emissions.[15] Although fuel economy has increased in recent years, growth in demand for motorised travel has resulted in a significant increase in transport emissions since 1990.[16]

Transport emissions also have a significant effect on human health in Auckland. Pollutants emitted by motor vehicles, in particular fine particulates, have a detrimental effect on human health from either short-term or long-term exposure. Short-term and long-term exposure to fine particulates in Auckland currently meet World Health Organisation guidelines, which define unacceptable levels of exposure (Parliamentary Commissioner for the Environment, 2015).[17] However, the costs of poor air quality are still large in aggregate, as there is no thoroughly safe level of exposure to particulates. According to the 2012 *Health and Air Pollution in New Zealand* study (Kuschel et al, 2012), emissions from transport account for the largest source of anthropogenic particulate emissions in Auckland. This study estimated that in 2006 transport emissions led to:

- 126 premature deaths among adults and 0.6 deaths among infants;
- 28 cardiac hospital admissions and 57 respiratory hospital admissions; and
- Total social costs of $466 million from mortality and morbidity.

5.6.2 Place outcomes arising from the current situation

The transport system can have significant positive and negative effects on surrounding land uses. On the one hand, transport facilities can contribute to the vitality of urban places by improving

[15] http://www.aucklandcouncil.govt.nz/SiteCollectionDocuments/aboutcouncil/planspoliciespublications/technicalpublications/tr2016044aucklandsgreenhousegasinventoryto2014.pdf

[16] However, transport emissions appear to have flat-lined over the 2009-2014 period.

[17] http://www.pce.parliament.nz/media/1256/the-state-of-air-quality-in-new-zealand-web5.pdf

accessibility and enabling workers and customers to travel to them. On the other hand, transport network operations can have localised negative effects related to:

- Emissions and air quality impacts, which are addressed above and which may also discourage people from spending time in affected areas;
- Vehicle noise, which can make in unattractive to spend time near transport corridors, operate a business in these areas, or live in them; and
- Competition for scarce urban space, in which transport facilities may 'crowd out' other public or private uses.

Auckland's high reliance on cars for passenger transport results in detrimental impacts on local place values relative to a transport system more reliant on public transport and active modes.

5.6.3 Health outcomes arising from the current situation

The transport system can contribute positively or negatively to health outcomes, as it influences the amount of physical activity people undertake on a regular basis. Active transport modes - walking and cycling - require more physical activity than motorised transport. Levels of physical activity in turn influence the prevalence of a number of chronic diseases, such as diabetes, cardiovascular diseases, and obesity.

Auckland currently experiences a range of poor health outcomes as a result of diseases of inactivity. Market Economics (2013) estimated that physical inactivity caused the premature death of 246 New Zealanders in 2009, including 73 premature deaths in Auckland.[18] They estimate that this resulted in social costs of $402 million in Auckland.

Health outcomes associated with physical inactivity differ between different parts of Auckland, reflecting a range of socioeconomic factors as well as the availability of active transport opportunities. While obesity rates are an imperfect proxy for physical inactivity, they provide a rough indication of variations between areas. Table 8 summarises estimated obesity rates for the three Auckland DHBs and compares them to national averages using data from the 2011-2014 New Zealand Health Survey.19 This shows that although obesity rates are lower than the national average for both children and adults in the Waitemata and Auckland DHB areas (covering the North Shore, West Auckland, and the Auckland Isthmus), they are substantially higher than the national average in the Counties Manukau DHB area.

Table 8: Obesity rates in Auckland (New Zealand Health Survey, 2011-2014)

DHB	Obesity rate for adults	Obesity rate for children
Waitemata	24%	7%
Auckland	22%	9%
Counties Manukau	37%	18%
New Zealand total	30%	10%

5.6.4 The potential impact of cycling on these outcomes

There are several ways in which increased uptake of cycling can contribute to better environmental, place, and health outcomes.

[18] https://www.waikatoregion.govt.nz/services/regional-services/regional-growth-and-development/reporting-and-information/the-costs-of-physical-inactivity

[19] http://www.health.govt.nz/publication/regional-results-2011-2014-new-zealand-health-survey

First, in contrast to motor vehicle use, cycling results in no direct emissions impacts and few other negative environmental impacts. Consequently, shifting some journeys from motor vehicles to bicycles has the potential to improve these environmental outcomes.

Second, increased cycling can improve place outcomes in dense activity centres by allowing more people to access those areas without increasing the localised dis-amenities associated with vehicle operations, such as higher noise levels. Because bicycles occupy relatively little space, they can also allow more people to access these centres without imposing large space requirements for parking.[20]

Third, increased cycling uptake can improve health outcomes by resulting in higher overall rates of physical activity. A number of studies have found that use of active modes can lead to health benefits, including reductions in mortality and morbidity from diseases of inactivity (Genter et al, 2008).[21]

5.6.5 Implications of the evidence

Increased cycling could play a role in improving environmental, place, and health outcomes from Auckland's transport system. In particular, population-level data shows that higher rates of cycling are associated with lower health costs from physical inactivity, which are likely to be highest in South Auckland and potentially other low socioeconomic status areas. Cycling also has the potential to improve environmental outcomes, by reducing vehicle emissions (or at any rate not increasing them) and by enabling more people to access dense activity centres where space to add additional road space and parking is limited.

5.6.6 SMART investment objectives

Addressing this problem can contribute towards two benefits, as shown in the ILM in Figure 13:

> *Benefit 2: Improved access to opportunities, particularly for people with low levels of transport choice*
>
> *Benefit 3: Improved environmental, place, and health outcomes*

These benefits in turn relate to three investment objectives:

> *Investment objective 2: Triple jobs and education opportunities accessible by short cycle trips for people with low levels of transport choice by 2028.*
>
> *Investment objective 3: Triple cycling journeys to dense activity centres by 2028*
>
> *Investment objective 4: Double the rate of participation in regular cycling activity to 25% of Aucklanders by 2028*

These investment objectives aim to establish realistic targets for guiding the programme and measuring success. They have been determined with reference to local and international comparisons and current baseline conditions.

Investment objective 2 is discussed above, under Problem 1. Investment objective 3 aims to specify a measurable and realistic target that reflects achieving the benefits of improved environmental and place outcomes associated with increased cycling. Increasing cycling activity in dense activity centres

[20] The average car park occupies 25-30m^2, including maneuvering space, while cycle parks occupy 1-2m^2 of space. Research shows that people who access retail destinations in New Zealand spend a comparable amount to people who arrive by car (Fleming et al, 2013).

[21] http://www.NZ Transport Agency.govt.nz/assets/resources/research/reports/359/docs/359.pdf

has been selected as an appropriate target as the environmental and place benefits accompanying increased cycling and mode shift away from motor vehicles is greatest in these locations.

Investment objective 3 can be measured by monitoring cycling counters or cycling parking located in dense activity centres or Census data on journey to work mode share by workplace address. These measures can allow monitoring of changes in cycling activity in a dense centre such as the Auckland City Centre or Takapuna Centre. It is suggested that the specific centres where this measure will be monitored will be determined as part of the recommended programme and reflect the areas prioritised for investment.

Comprehensive baseline measures for investment objective 3 are not available. However, AT's cycling counter network data provides some benchmarks for establishing a realistic target. Table 9 presents data from eight established cycle counters where information on medium-term growth trends is available. The NW cycleway at Kingsland (serving the City Centre) showed the highest growth rate in cyclist numbers between 2011 and 2016 at 114% (a rough doubling in numbers over five years).

Table 9: Growth in cycle counts at eight long-established counters

Cycle counter	Cyclists counted in 2011	Cyclists counted in 2016	Percent change
Great South Road	31,807	31,469	-1%
Highbrook	14,277	13,026	-9%
Lake Road	95,883	101,326	6%
NW Cycleway (Kingsland)	112,358	240,463	114%
NW Cycleway (Te Atatu)	130,634	183,239	40%
Orewa	60,319	116,439	93%
Twin Streams	31,450	41,664	32%
Upper Harbour	41,513	56,090	35%

The target to triple cycling journeys in dense activity centres over the ten years to 2028 is likely to be an ambitious but realistic target. This target may be more easily achievable than the regional mode share target (also a target to triple cycling mode share) given that cycling activity is likely to be more concentrated in dense activity centres where investment has been focused. Achieving this target will require continuing the rates of growth observed over the past five years at the NW cycleway for the next ten years across all the selected activity centres.

Investment objective 4 is a target to increase participation in regular cycling which has been selected as a measure of health benefits associated with cycling. Participation in regular cycling (once or more a week) by a high proportion of the population is considered to make a good contribution to health benefits associated with increased levels of physical activity.

Baseline measures show that 13% of Aucklanders currently cycle once a week or more (TRA 2016). The survey data finds that participation has risen sharply over the 2014-2016 period, from 6% to 13%. The survey also reports that 54% of the population would be willing to cycle if conditions were improved.

A target of 25% of the population regularly cycling by 2028 is considered a realistic target. While recent rapid growth in cycling participation has been observed, such rapid growth rates are unlikely to continue as cycling is taken up by those more amenable to cycle and attracting additional users becomes more difficult.

5.7 Problem 3 - evidence

Problem 3 is:

> *The current transport system often fails to meet the needs of people using bikes, resulting in them being over-represented in deaths and serious injuries.*

The core problem identified is the relatively high level of road crash deaths and serious injuries for people using bikes. The primary cause of this problem is poor system-wide performance in meeting the needs of people using bikes. This includes poor infrastructure provision, and road user behaviour. The following sections summarise evidence for these problems and implications for programme development. They address:

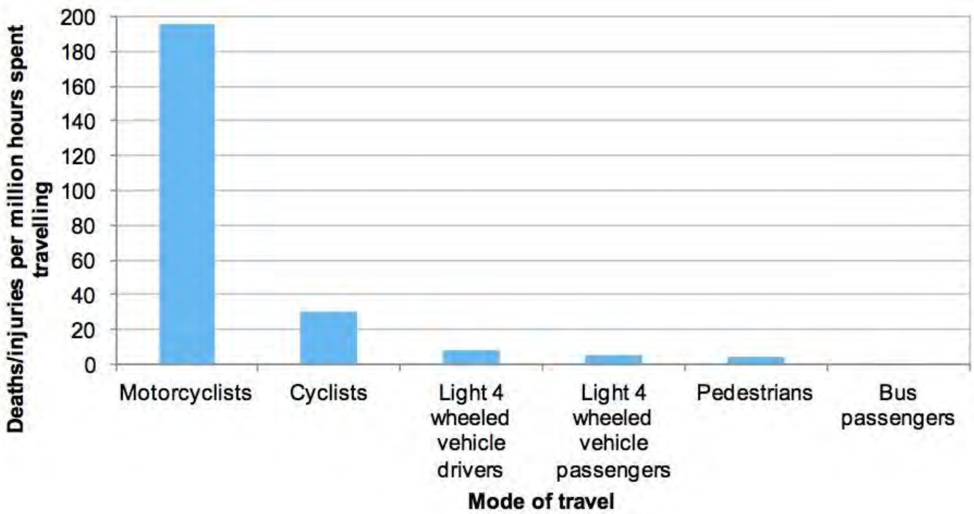
- Existing road safety outcomes for people on bikes;
- International comparisons for cycle safety;
- The location and cause of cycle-related crashes;
- The impact of traffic speed on cycle-related crashes; and
- The potential effect of policy changes on these outcomes.

To conclude, implications for the investment programme are identified.

5.7.1 Existing road safety outcomes for people on bikes

People who cycle in New Zealand in general, and Auckland in particular, are overrepresented in road crash statistics. This indicates poor safety outcomes for people on bikes. Figure 17 summarises data on rates of deaths and injuries for six transport modes for New Zealand as a whole. According to the Ministry of Transport (2016), cyclists in New Zealand experience around 30 deaths or injuries per million hours spent travelling.[22] Over the 2009-2013 period, there were a total of 43 deaths and 4069 injuries among people cycling on the road. By comparison, death / injury crash rates are considerably lower for light vehicle drivers and passengers, pedestrians, and public transport users, but considerably higher for motorcycles.

Figure 17: Deaths and injuries in motor vehicle crashes per million hours spent travelling, 2009-2013 (Ministry of Transport, 2016)



[22] http://www.transport.govt.nz/assets/Uploads/Research/Documents/Cycling-2016.pdf

People on bikes are also overrepresented in crashes in Auckland. Table 10 presents data on cycle-related road crashes in Auckland over the 2011-2015 period.[23] Over this period, there were over 200 cycle-related crashes per annum, with slightly less than one fatal crash per annum, around 40 serious crashes (resulting in a serious injury) and around 170 minor crashes per annum. This is likely to understate the true number of minor and serious crashes, as some crashes go unreported (NZ Transport Agency, 2016).

There are no discernible recent trends in the number of crashes, with total numbers reasonably stable over the period. The most recent year for which full data is available, 2015, saw the highest annual number of fatal and serious injuries involving cyclists during the 5-year period.

Cycle-related crashes account for around 7% of total recorded crashes in Auckland, excluding crashes on motorways, and 10% of serious injury crashes. This is in spite of the fact that cycle trips only make up 0.4% of total transport trips. This suggests that crash risk for cyclists is relatively high, compared with other transport modes.

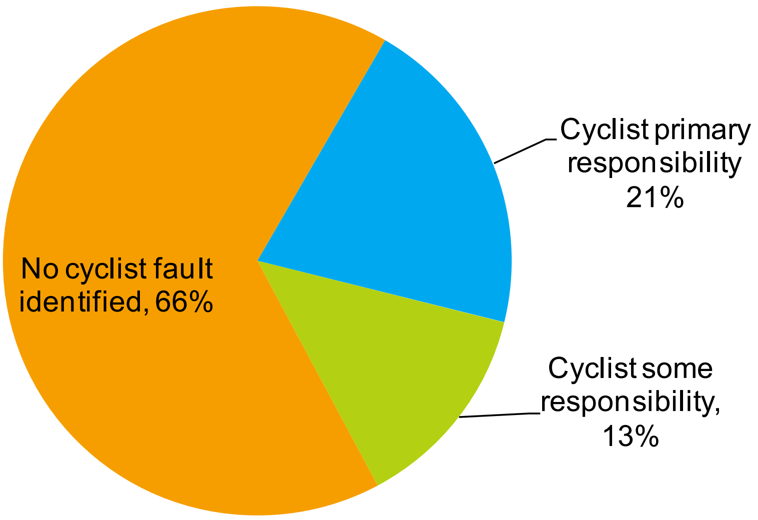
Table 10: Road crashes involving vehicles and cyclists or cyclists only, Auckland, 2011-2015 (NZ Transport Agency Crash Analysis System)

Year	2011	2012	2013	2014	2015	Total 2011-2015
Fatal crashes	0	1	1	0	1	3
Serious injury crashes	49	16	38	38	54	195
Minor crashes	177	189	168	163	155	852
Total	226	206	207	201	210	1050
Share of fatal crashes (ex motorway crashes)	0.0%	3.3%	2.5%	0.0%	2.5%	1.7%
Share of serious crashes (ex motorway crashes)	14.3%	4.9%	9.8%	10.2%	10.9%	10.0%
Share of total crashes (ex motorway crashes)	7.3%	6.9%	7.1%	7.5%	6.8%	7.1%

People on bikes were not at fault in the majority of cycle-vehicle crashes. As shown in Figure 18, no cyclist fault was identified in 66% of crashes, while cyclists had the primary responsibility for 21% of crashes that resulted in a death or injury. This suggests that the design of transport facilities, road rules and enforcement, rather than cyclist negligence, is a primary driver of high crash rates for people on bikes.

[23] A small number of crashes between cyclists and pedestrians have been excluded from this data. There were no fatal crashes in this category.

Figure 18: Percentage of cycle-vehicle collisions by fault, 2011-2015 (Ministry of Transport, 2016)



5.7.2 Cycle safety outcomes in cities that have significantly increased cycling activity

Evidence from three cities that have significantly increased provision of protected cycle paths and have seen increased cycling participation over the last decade suggests that increasing urban cycling can be achieved without significantly increasing cyclist deaths and serious injuries. The common feature across these three cities is extensive provision of protected cycle paths.

Detailed analysis is provided in Supplementary Material, Section 1.4. In summary:

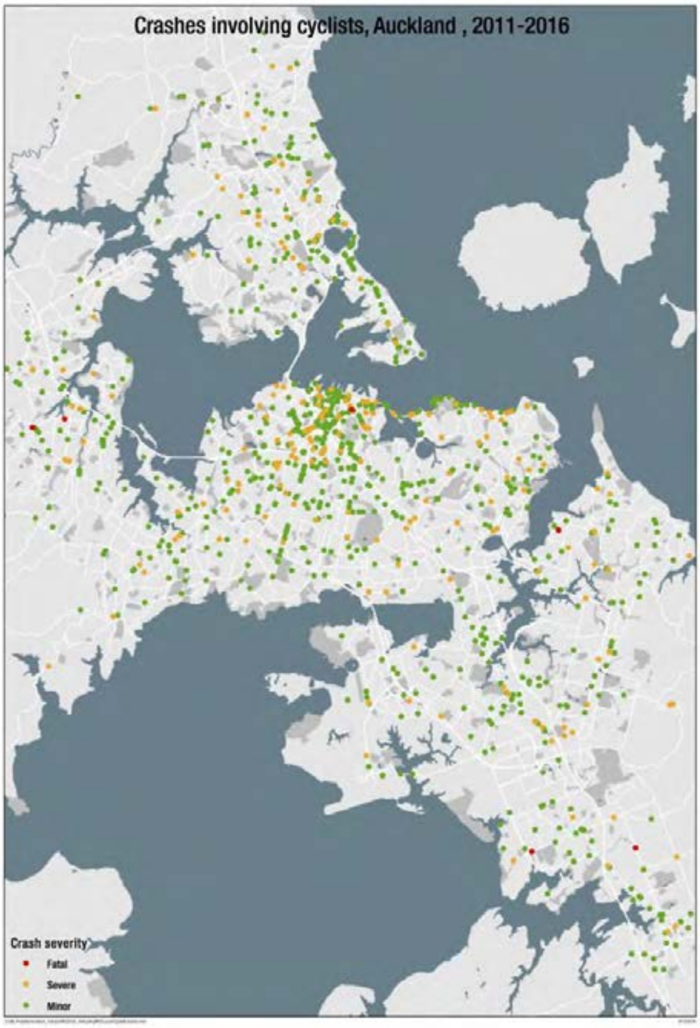
- Between 2000 and 2015, cycle commuting mode share in Portland, Oregon rose from 1.8% to 7.0%, or a fourfold increase. However, the five-year rolling average of cycle crash deaths fell from 1.8 to 1.4 per annum. This difference is unlikely to be statistically significant given the large variation in year-to-year crash outcomes.
- Between 2005 and 2015, the number of cycle commuters in New York City rose from 16,500 to 45,000, a nearly threefold increase. The true increase in cycle volumes is likely to be even greater given significant uptake in bike share. Over the same time period, the five-year rolling average of cycle crash deaths fell from 18.0 to 16.4 per annum. Once again, this difference is unlikely to be statistically significant given the large variation in year-to-year crash outcomes.
- Between 2006 and 2012, the number of weekday cycle movements in Seville, Spain rose from 13,100 to 72,600, more than a fivefold increase. Over the same time period, the five-year rolling average of cycle crash deaths and serious injuries rose from 5.0 to 5.6. This difference is unlikely to be statistically significant given the large variation in year-to-year crash outcomes.

5.7.3 The location and cause of cycle-related crashes

Data on the location and cause of cycle-related crashes can help to illuminate which aspects of the transport system contribute to poor safety outcomes for people on bikes.

Figure 19 illustrates the spatial distribution of reported cycle-related crashes in Auckland, colour-coded by severity, during the 2011-2015 period. Crashes are heavily concentrated in the city centre and city fringe area, where cycle volumes are highest. Clusters of crashes are also apparent on key arterial roads, particularly in Auckland isthmus, eg Tamaki Drive, Dominion Road, and Lake Road in Devonport/Belmont. There are also concentrations of crashes around several Metropolitan Centres, in particular Henderson, Takapuna and Manukau, where cycle volumes are likely to be relatively high.

Figure 19: Location of cycle-related crashes, Auckland urban area, 2011-2016



New Zealand-wide data shows that most cycle-related crashes in urban areas occur at intersections. The Cycling Safety Panel (2014) found that 60% of urban cycle crashes were at intersections and an additional 14% at driveways. By comparison, 70% of cycle crashes in rural areas occurred on roads or road shoulders.

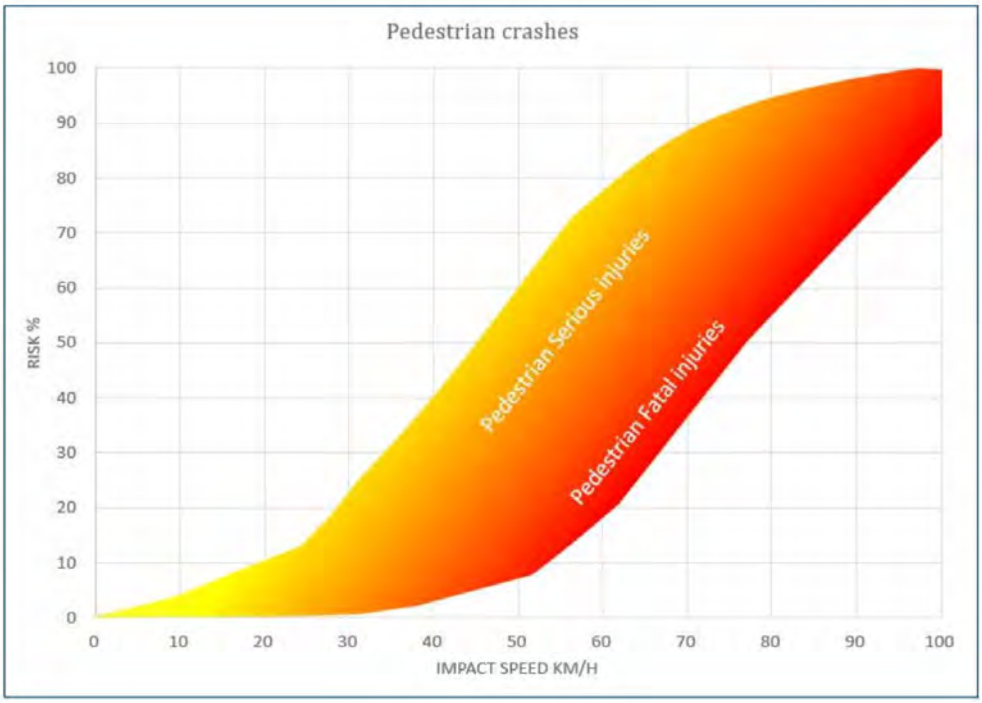
This data suggests that cycle-related crashes are prevalent throughout the city, and that they tend to be concentrated in places where there are a number of both cyclists and cars, including major arterial roads and around dense activity centres that attract significant transport demands. Crashes at intersections and driveways account for a majority of overall cycle-related crashes.

5.7.4 The impact of traffic speeds on cycle-related crashes

Higher vehicle speeds exacerbate the effect of crashes between vehicles and people on bikes, as they increase the likelihood of death or serious injury. Consequently, traffic speeds on streets shared by cars and cyclists may contribute to poor safety outcomes.

Figure 20 shows the how the risk of death or serious injury for pedestrians struck by cars varies depending upon the speed of travel. Risk profiles for people on bikes are similar. The risk of death or serious injury rises fourfold as car speeds rise from 30km/hr to 50km/hr.[24]

Figure 20: Probability of death or serious injury as a function of impact speeds (Cycling Safety Panel, 2014)



At present, average unimpeded vehicle speeds on Auckland urban roads are above the standard speed limit of 50km/hr and during the past ten years have been consistently higher than in other main urban centres in New Zealand (Shaw et al 2015). High vehicle speeds on Auckland urban roads are likely to contribute to poor safety outcomes for people on bikes. In turn, this dissuades potential cyclists, as they perceive cycling on high-traffic roads without dedicated cycle facilities as risky and to be avoided.

5.7.5 Implications of the evidence

There is strong evidence for this problem statement and the significance of addressing the problem. The evidence compiled in this section shows that people on bikes currently experience higher rates of death and injury than other road users in Auckland. A range of interventions are needed in order to address safety outcomes for people on bikes. Following the Cycle Safety Panel (2014) report, this could include interventions to promote:

- Safe road user behaviour;
- Safe road infrastructure for cyclists;
- Safe road speeds; and
- Safe vehicles.

The Panel summarised their recommendations as follows:

> *The number one priority that will do the most towards achieving the ultimate vision, and in the shorter term reduce the incidence of cycling crashes, is providing improved cycling*

[24] http://www.saferjourneys.govt.nz/assets/Safer-journeys-files/Cycling-safety-panel-final-report.pdf

infrastructure, particularly in urban areas where the great majority of crashes occur. The Panel feels strongly that increasing the provision of fit-for-purpose, connected and completed urban cycle networks will make the biggest impact on improving cycling safety.

Our second priority is speed; it contributes to the outcome in every crash and excessive speed increases the likelihood of a crash happening. Over 2,000 people died or were seriously injured in on-road crashes in 2013 (NZ Transport Agency 2014b). The speed at the time of crash contributed to the severity of injury in every case.

The Panel's third priority is therefore to initiate a major culture shift among all road users so that sharing the road safely, whether you are a cyclist, car or truck driver, is more important than getting from A to B as quickly as possible. This will require a mix of regulatory, advertising and training interventions. However, infrastructure, speed management and increased participation in cycling will also help drive this culture shift.

This analysis shows that this diagnosis is applicable to Auckland, as well as New Zealand as a whole.

5.7.6 SMART investment objectives

Addressing this problem can contribute towards one benefit, as shown in the ILM in Figure 13:

Benefit 4: Increased safety for people using bikes

This benefit in turn relates to one investment objective:

Investment objective 5: Reduce deaths or serious injuries involving people using bikes by 20% by 2028

This investment objective aims to establish a realistic target for guiding the programme and measuring success. It has been determined with reference to local and international comparisons and current baseline conditions.

Baseline measures for crashes and serious injuries are provided in Table 10 and show that during the past five years there has been an average of approximately 1 death and 40 serious injury crashes involving cyclists per year in Auckland. Comparison of crash rates at the national-level shows that cycle crash rates in New Zealand are relatively high.

Establishing a target for numbers of deaths and serious injuries requires consideration of both the anticipated increase in the total level of cycling and targeted improvement in the crash rate. While a target for a reduced crash *rate* rather than reduced *number* of deaths and serious injuries was considered, this was rejected on the basis that calculating rates (eg per cycle trip or cycle distance travelled) is complex due to shortcomings in data on cycling activity and because establishing a 'hard target' focuses attention on achieving improved safety outcomes and is consistent with policy directions for a safer system established by AT and the NZ Transport Agency.

In the context of a targeted tripling of cycling activity (investment objectives 1 and 3), achieving a reduction in cyclist deaths and serious injuries is challenging and would require significant policy action in a number of areas. However, evidence from several cities shows that it is possible to maintain or even slightly reduce the number of fatal crashes even in the context of a significant uplift in cycling activity. Achieving the 20% reduction would correspond with 80 less serious injuries and around 2 less cycle-related deaths over the 10-year period 2018-2028.

PART B – DEVELOPING THE PROGRAMME

Part B of the ACPBC maps the path from identifying a broad range of alternatives and options for achieving increased cycling and improved cycle safety in Auckland through to refining a recommended programme of interventions that achieve the programme's investment objectives. Part B includes the following:

- **Section 5** summarises how a range of alternative approaches and options for achieving the investment objectives were identified and assessed. The longlist assessment focuses on optimising the approach to cycle network infrastructure development.
- **Section 6** summarises how a shortlist of cycle network development options was developed and assessed. The shortlist builds on the findings of the longlist assessment to refine a preferred approach to cycle network expansion for Auckland. It includes reporting on economic evaluation of shortlisted options against a 'Do-Minimum' investment scenario.
- **Section 7** summarises the recommended programme, based on the findings from the shortlist assessment.
- **Section 8** provides a summary assessment of the recommended programme.
- **Section 9** provides an initial financial case for the recommended programme.

These sections are supported by more detailed technical appendices.

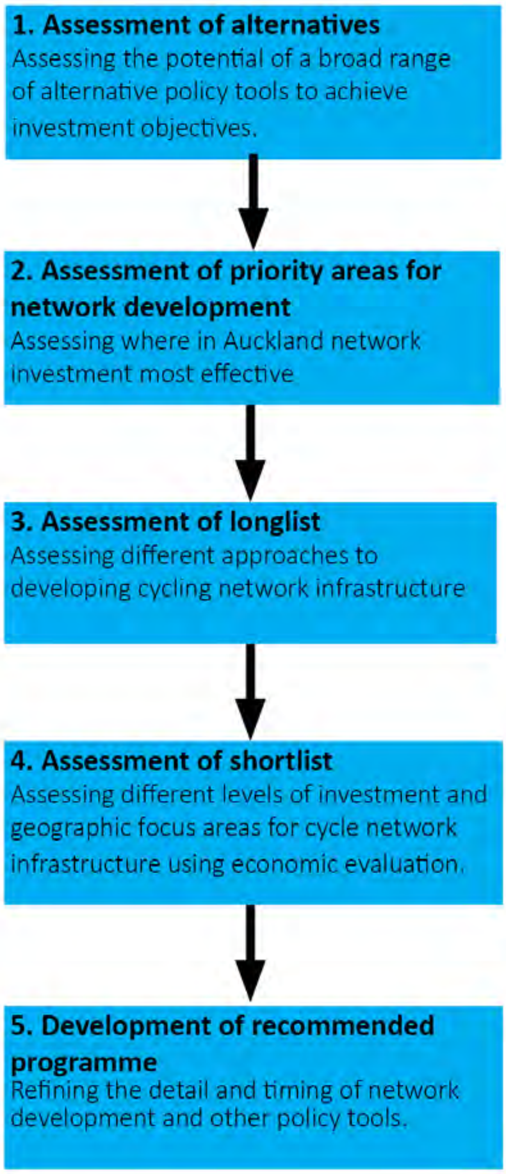
6 ALTERNATIVES AND OPTIONS

This section provides the following:

- A summary of how a broad range of alternative approaches to policy and investment interventions were considered as potential methods for achieving the investment objectives and responding to the problems identified in Part A.
- A summary of how a longlist of cycle network infrastructure development options were generated and assessed.

The outcomes from the assessment of alternatives and a longlist of network development options informs the later development of a recommended investment programme.
Figure 21 illustrates the overall process for programme development.

Figure 21: Approach to programme development



6.1 Assessing alternative policy tools

A stakeholder workshop on 28th October 2016 identified a range of policy tools that may contribute to addressing the problems and achieving the investment objectives identified by the Strategic Case. Over 25 distinct policy interventions were identified and grouped into six categories:

- Infrastructure provision (eg cycle network development)
- Services (eg bike share)
- Regulation (eg road traffic speed limit reductions)
- Enforcement (eg traffic speed policing)
- Information (eg cycle education programmes)
- Fiscal measures (eg financial incentives for cycling).

Supplementary Material, Section 2.1 outlines the individual interventions in more detail and specifies the 'Do-Minimum' level of activity across each intervention and a 'Do-Maximum' that describes the potential scope of additional activities within the 2018-2028 timeframe of the programme.

6.1.1 Filtering policy tools for relevance

An initial qualitative assessment of the potential policy tools was undertaken to exclude interventions that would not be relevant for further stages of programme development. Three criteria were used to filter out potential policy tools: (1) interventions are likely to have minimal impact on achieving investment objectives; (2) there is limited scope for further policy intervention due to the fact that there is already a clear policy direction; and (3) investment partners have limited control over policy tools. The following interventions were excluded from further stages of programme development:

- Regulation
    - Land-use planning changes (eg requirements for end-of-trip facilities in new office buildings)
    - Changes to street and cycle facility design standards
    - Changes to vehicle regulations impacting on cycle safety (eg heavy commercial vehicle features)
- Fiscal measures
    - Parking management changes
    - Changes to road and parking pricing
    - Changes to vehicle and fuel taxes
    - Financial incentives for cycling (eg tax incentives for bike purchase).

As noted in Section 5.4, there are limits to the use of some of these policy tools due to the statutory powers of the investment partners or recent policy development resulting in limited scope to make further changes.

6.1.2 Initial assessment of remaining relevant policy tools

The remaining policy tools were assessed further to improve understanding about how they could contribute to a potential programme. This assessment relied on qualitative assessment and a review of empirical evidence about their potential to contribute to the five investment objectives. Local and international evidence was gathered on the impact of various interventions on:

- Increasing cycle mode share (relevant to achieving investment objective 1)
- Increasing cycle accessibility (ie the destinations easily accessible by cycling and influenced both by route directness and route quality) (investment objective 2)
- Increasing cycle volumes in dense activity centres (investment objective 3 and 4)

- Reducing crash rates for people using bikes (investment objective 5).

There is relatively little published evidence on the effect of some types of interventions. Qualitative assessment and contextual evidence (eg on the share of overall transport budgets spent on information and promotion), has been used to understand the potential effects where quantitative estimates are not available.

Table 11 summarises the results of the initial assessment. Each intervention has been assessed in isolation to identify its individual contribution to investment objectives. Further commentary on this assessment is included in Supplementary Material, Section 2.1.

Table 11: Summary of initial assessment – potential of individual policy tools relevant to the ACPBC to contribute positively to investment objectives

Intervention	IO 1: 1. Triple cycle mode share from 1% to 3% of total journey to work/ education trips by 2028 (30%)	IO 2: Triple jobs and education opportunities accessible by short cycle trips for people with low levels of transport choice (20%)	IO 3. Triple cycle volumes in dense activity centres by 2028 (10%)	IO 4. Increase rate of participation in regular cycling activity from 13% to 25% by 2028 (10%)	10 5. Reduce deaths or serious injuries involving people using bikes by 20% by 2028 (30%)
Infrastructure					
Cycle network development					
Traffic calming/ street design					
Public cycle parking					
Services					
Bike Share					
Bikes on buses					
Regulation					
Speed limit reductions					
Road rule changes					
Enforcement					
Road speed limit enforcement					
Driver-cyclist policing					
Cycle lane enforcement					
Information					
Marketing and promotion					
Travel behaviour change					
Training					
Wayfinding and signage					

Key

High potential to support investment objective	Some potential to support investment objective	Minor potential to support investment objective	Unlikely to have substantial impact on achieving investment objective

The key findings from this assessment are as follows:

- Infrastructure interventions – in particular cycle network development and traffic calming / street design – were seen as the most likely to make a significant contribution to all five investment objectives. Speed limit reduction (a regulatory change) is also likely to contribute to all objectives.
- Other interventions are likely to address some investment objectives, but not all. These interventions can play a valuable complementary role to network development, but are unlikely to be effective if developed in isolation. For example, cycle parking, accompanying

promotion and training are all likely to be vital elements in maximising use of new network infrastructure. Likewise, bike share programmes are likely to be more effective if paired with cycle network development or traffic calming / street design measures.

Implications for further stages of programme development

The initial assessment of alternative policy tools concluded that:

- An effective programme for increasing cycling uptake and improving cycle safety is likely to include an integrated package of activities, including network infrastructure development and a range of other activities including promotion, education, non-network infrastructure including cycle parking, speed and road-rule enforcement, and potentially new services such as bike share.
- Cycle network development is likely to be a particularly important component of any programme for achieving investment objectives and will require the most substantial financial investment. Cycling network infrastructure includes separated cycle paths, on-street cycle lanes, intersection treatments and traffic calming infrastructure. The costs of constructing and maintaining these facilities is likely to be higher than other programme elements such as promotion or enforcement.
- Given the financial cost of network development and its potential to address all investment objectives, further option development and assessment should focus on optimising infrastructure development.
- Other interventions will also play an important role in the programme. Promotion, behaviour change and training need to be closely integrated with network development to ensure new facilities are well-used. These programme elements have lesser ranges of potential cost and scope (eg there are limits to the feasible extent of additional investment on promotional interventions). They are also predicted to have lesser potential impact on investment objectives. For these reasons, other programme elements will be packaged into a ‘best feasible package’ at the stage of developing the recommended programme. Further assessment of options will focus on comparing approaches to network development.

6.2 Assessing priority areas for network development

The previous assessment of alternative tools found that an effective programme will involve a package of integrated policy tools. Network development, however, was highlighted as the most costly component of any cycling programme and the intervention likely to have the most substantial impacts on achieving investment objectives. The following sub-sections of Chapter 6 focus on refining an optimal approach to Auckland cycling network development. This involves:

1. Assessing priority areas for network development, by considering the potential for network investment across all areas of urbanised Auckland to contribute to investment objectives (this section)
2. Generating a longlist of network development approaches following the findings of (1) and (2) (Section 6.3)
3. Testing the performance of these longlist options through analysis of indicative network development plans (6.4).

6.2.1 Approach to assessing priority areas for network development across Auckland

All urbanised areas of the Auckland region were scored for the potential of cycle network development in these locations to contribute to achievement of the programme benefits and investment objectives. Rural areas were excluded from this analysis as low population and job density in these areas means that network development is likely to be less effective in contributing to the programme objectives.

An index of 'cycling network investment potential' was developed by aggregating a range of quantitative indicators using spatial data. The indicators used data sets including Census, the NZ Transport Agency road crash, Ministry of Education school enrolment and University of Otago Socio-economic deprivation data. These spatial data allowed for comparison of current transport behaviour, road safety outcomes and characteristics of land-use across different parts of the Auckland urbanised area.

Indicators were selected as proxies for assessing the potential of cycle network investment to contribute to the programme benefits and investment objectives. For example, locations with higher levels of recent cycle-related road crashes were assessed as having higher potential for cycle network development and facility upgrades to contribute positively to improved safety outcomes. Table 12 describes the full range of indicators used in developing the index, the data sources used for the indicators, the relationship of indicators to programme benefits and investment objectives.

A set of 38 geographic areas covering the Auckland urban area was established and index scores calculated for each area. Scores were weighted by the spatial area to standardise for the different sizes of the geographic areas. The geographic areas were defined by dividing up all urbanised areas of the Auckland region into areas of a scale where cycle network development would serve useful trip purposes (eg areas of at least 2km across), and that resulted in a manageable number of areas for comparative analysis. The defined geographic areas involved aggregating Census Area Units to allow for data analysis.

Table 12: Indicators and data sources used for Cycling Network Investment Potential Index

Benefit	Investment objective (weighting)	Indicators contributing to index (source) [weighting in index]	Rationale for use of indicator and relationship to investment objective
1. Cycling plays a greater role in meeting Aucklanders' transport needs	Triple cycle mode share from 1% to 3% of total journey to work/ education trips by 2028 (30%)	1.1. Cycling commute mode share: % of total commuters (workers only) cycling in the selected area (Census 2013) [15%]	Areas with high existing cycling mode share are likely to have relatively good existing cycling conditions and supportive demographic factors. Network improvements in these areas may mean higher potential for mode shift to cycling.
		1.2. Length of commute trip: commute distance (home to work, km) for all commuters, all modes in the selected area (Census 2013) [5%]	Areas with lower average commute trip lengths (e.g. less than 7km, or approx. 30 minutes cycle time) are likely to have higher potential for mode shift to cycling for commute purposes.
		1.3. Total school enrolment: number of students enrolled at all schools located in the selected area (Ministry of Education) [5%]	Network improvements in areas with high school enrolments mean higher potential for mode shift to cycling for journey to school trips.
		1.4. Job density: density of jobs located in selected area (Statistics NZ, Business Demography Data) [5%]	Network improvements in areas with high job densities mean higher potential to support mode shift for cycling to work trips.
2. Improved access to opportunities, particularly for people with low	Triple jobs and education opportunities accessible by short cycle trips for	2.1. Average socio-economic deprivation index score for the population in the selected area (University of Otago) [7%]	Network improvements in areas of high deprivation may have higher value in providing a cycling choice for people more likely to have low transport choice (those with less access to private cars and children).

Benefit	Investment objective (weighting)	Indicators contributing to index (source) [weighting in index]	Rationale for use of indicator and relationship to investment objective
levels of transport choice	people with low levels of transport choice by 2028 (20%)	2.2. Density of people age 0-19 years in the selected area (Census 2013) [7%]	Network improvements in areas with high densities of children and young people may provide more value in improving transport choice for those without ready access to private vehicles.
		2.3. Density of residents with poor access to AT's Rapid Transit Network (RTN) or Frequent Bus Network: people living beyond 800m distance from either RTN station or Frequent Bus Network route (MRCagney analysis using AT and Census data) [7%]	Network improvements in areas with high numbers of people that are poorly served by rapid transit or frequent bus routes may provide additional value by increasing transport choice for those with lower levels of PT availability.
3. Improved environmental, place and health outcomes	Triple cycle volumes in dense activity by 2028 (10%)	3.1 Job density: density of jobs located in selected area (Statistics NZ, Business Demography Data) [10%]	Job density is a proxy for the presence of activity centres, as activity centres are generally associated with clusters of employment. Network improvements that provide access to dense activity centres may provide more value by encouraging mode shift to cycling and reduced vehicle traffic in locations with high place values and high densities of pedestrian activity.
	Increase rate of participation in regular cycling activity from 13% to 25% by 2028 (10%)	3.2. Population density: density of resident population within selected area (Census 2013) [10%]	Network improvements in areas with higher population density are likely to have more ability to attract more users, and produce greater population health benefits.
4. Increased safety for people using bikes	Reduce deaths or serious injuries involving people using bikes by 20% by 2028 (30%)	4.1. Existing road crash density for areas treated by new network (15%) (the NZ Transport Agency Crash Analysis System) [10%]	Network improvements in areas with poor existing overall road safety outcomes may have more potential for improving cycle safety.
		4.2. Existing cycle-related crash density for areas treated by new network (15%) (the NZ Transport Agency Crash Analysis System) [20%]	Network improvements in areas with poor existing road safety outcomes for existing cyclists may have more potential for improving cycle safety.

6.2.2 Results of assessment

The results are mapped in Figure 22. Detailed results for each geographic area are provided in Supplementary Material, Section 2.2. The assessment highlights locations within Auckland where network investment is most likely to best contribute to investment objectives, including cycle mode share, cycle accessibility, health, environmental and safety objectives. Key areas where investment is likely to be most effective include:

- The City Centre and Fringe
- Other central areas including the Central Isthmus, Devonport/ Belmont, Inner West and Mount Albert.
- Selected areas of South Auckland, particularly Papatoetoe/Otara, Manurewa and Mangere.
- Selected areas of West Auckland including New-Lynn/ Avondale and Te Atatu Peninsula
- North Shore areas that are more central including Devonport/ Belmont and Takapuna.

The index also highlights areas that are less likely to be good candidates for network investment. Low-scoring areas generally have low levels of existing cycling activity, low road crash rates and low density of school enrolments, children and young people, total population and jobs. These include:

- The Southern part of the Isthmus
- Howick, Pakuranga, East Tamaki and Botany in the East
- Manukau, Takanini and Papakura in the South
- The Airport and Wiri areas
- Westgate, Henderson and Titirangi/ Glen Eden in the West
- North Shore areas outside of the central, lower North Shore areas of Devonport/ Belmont and Takapuna.

Figure 22: Index of cycling network investment potential, total scores, Auckland urbanised areas

6.2.3 Identifying areas for further analysis and inclusion in longlist options

The index of cycling network investment potential provides an initial assessment of all Auckland areas for their potential as locations for further development of the cycling network. The index, however, does not include all factors relevant to decision-making on locations for network development. In particular, it is based on data that describe current land-use and does not consider future growth potential. It also excludes consideration of the current cycling network and opportunities for investment to link with this network.

A further round of filtering was undertaken to identify areas that would proceed for further analysis and areas that would be discounted from further stages of programme development. Table 13 summarises areas included and excluded:

- All areas with relatively high scores (40+, shaded blue) were taken forward for further stages of programme development
- Areas with lower scores (less than 40) were excluded unless any of the following factors were present, suggesting some potential for effective network investment:
    - Presence of a Metro centre, suggesting a major destination and opportunities for cycling to serve transport demands
    - Presence of substantial recent or planned cycling investment, offering opportunities to reinforce the value of this investment through further network development
    - Presence of substantial existing low-stress street network (easy terrain, low-traffic streets), suggesting potential for increased cycling uptake (see Supplementary Material, Section 2.6)
    - Major future growth area, suggesting substantial changes to land-use and population characteristics and potential for cycling to provide for increased transport demands in area.

Table 13: Auckland areas included/ excluded from longlist development

High Investment Potential Index score, included in further stages of programme development	Low Investment Potential Index score, but included in further programme development due to other factors.	Low Investment Potential Index score, excluded from further programme development.

Area	Index Score	Comment
City Centre and Fringe	100	Included for further programme development.
Central - Isthmus	60	
Devonport-Belmont	58	
Inner West	56	
Mount Albert	55	
Papatoetoe - Otara	48	
Manurewa	46	
Mangere	46	
New Lynn - Avondale	45	
Te Atatu Peninsula	44	
Eastern Bays	44	
Takapuna	44	
Remuera - Ellerslie	42	
Glen Innes - Panmure	41	
Otahuhu	40	
Henderson	40	

Area	Index Score	Comment
Pakuranga	38	Metro centre, major future growth area, opportunities to link with AMETI cycling investment
Onehunga - Mt Wellington	38	Metro centre (Sylvia Park), potential to link with East-West link investment
Northcote - Glenfield	37	Opportunities to link with Skypath investment
Howick	36	Existing extensive low-stress cycling network
Blockhouse Bay - Hillsborough	36	Excluded.
Manukau	34	Metro Centre, major future growth area.
Northern Corridor	33	Opportunities to link with Skypath investment
Papakura	31	Metro Centre.
Birkenhead	30	Excluded.
Titirangi - Glen Eden	26	
East Tamaki	26	
Takanini	25	
Westgate	25	Major growth area, Metro Centre
East Coast Bays	25	Excluded.
Orewa	22	Existing extensive low-stress cycling network
Botany	22	Excluded.
Greenhithe - Schnapper Rock	20	
Albany	19	Major growth area, Metro Centre
Airport	18	Major employment growth area
Warkworth	17	Excluded.
Pukekohe	16	Existing extensive low-stress cycling network
Gulf Harbour	16	Excluded.
Wiri	13	

6.3 Generating a longlist of network development options

The assessment of priority areas for network development identified broad areas of urban Auckland where network investment is likely to be most effective for achieving the programmes objectives. It also identified areas that are likely to be low-priority and are excluded from further stages of programme development.

At the longlist stage, a series of more detailed network development options were generated to further test how different approaches to network development may be more or less effective in contributing to programme outcomes. Indicative networks were mapped and tested using multi-criteria analysis.

6.3.1 Common elements across longlist options

Before identifying the set of longlist options, a set of common elements were established underpinning all options:

- Cycle network components excluded from scope

- Target customer groups and implications for facility and network design
- Investment levels

Cycle network components excluded from scope

The longlist options focused on network improvements that would achieve the programme objectives; increasing increased cycling uptake and safety in a way that would address wider Auckland transport challenges. Therefore, network components primarily focused on providing for recreational cycling trips, and serving only minor transport functions, were excluded from consideration in development of longlist networks.

Longlist network development also focused on providing improved cycle facilities in existing urban areas, rather than new urban areas. Transport infrastructure funding mechanisms and planning processes for future urban growth areas in Auckland are being undertaken through the Supporting Growth investment package. Network development for the longlist excluded consideration of constructing cycle facilities in these future growth areas.

Target customers and trip types and implications for facility and network design

Indicative network planning for the longlist options aimed to provide networks that would cater to a broad range of customers and to serve particular trips types where cycling could play a viable transport role and be most effective in contributing to investment objectives.

Identifying the target customers was based on a review of current cycle use in Auckland and opportunities and barriers to further uptake (see Supplementary Material, Section 1.1). This suggested that:

- Providing network facilities that cater to a broad range of users is most likely to achieve investment objectives. A substantial proportion of the population fall into the 'Interested but concerned' category of users[25] but are dissuaded from cycling by poor perceptions of safety, and lack of high quality cycle facilities.
- Conversely targeting investment only at existing users (many of which fall into the 'strong and fearless' category) would involve catering to a very small niche population in Auckland and would be unlikely to achieve the investment objectives of substantial increase in cycling uptake. Existing regular cyclists (at least weekly) are approximately 13% of the population (TRA 2016), while commute mode share is only 1% (Census 2013).

New networks for longlist options would therefore need to be based on safe, high-quality cycle facilities that cater to 'all ages, all abilities', rather than providing facilities that may be acceptable to existing users.

Identifying target trips types was informed by evidence discussed above in Section 5.5.3 that suggested that the efficiency of network investment may be strengthened by targeting investment to serve:

- Short-medium distance trips (1-7km, or less than 30 minutes easy cycling time) to major destinations (eg City Centre).
- Short-distance trip-legs (1-3km) that serve first and last leg connections with longer-distance journeys using RTN modes.

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[25] Geller, R. (2009). *Four types of cyclists*. PortlandOnline.

- Trip types that have potential to encourage mode shift from private vehicles or public transport on congested corridors (eg peak period commute trips).

The longlist network planes therefore focused on shorter-distance networks around outer-suburban RTN stations and longer distance networks (up to 7km) from major destinations such as the City Centre.

Investment levels for network development

Determining the appropriate level of investment for cycle network development is an important objective for the ACPBC. The level of investment will have ramifications for the amount and quality of network development that can be delivered during the 2018-2028 period.

For the purposes of assessing different approaches to network development at the longlist stage, some initial assumptions about the level of investment available and feasible to deliver were made. This allows for development of conceptual networks within an indicative budget and for testing of outcomes resulting from this level of investment.

Three indicative levels of investment for the network development components of the 2018-2028 programme period were considered based on recent historic levels of investment in Auckland cycling facilities by the programme investment partners:

- *Low investment ($300m)* roughly reflecting the average level of walking and cycling expenditure by both AT and the NZ Transport Agency over the last five years. This would represent a continuation of historical levels of funding, but a drop from levels of funding in the second half of the 2015-2018 UCF investment period. It is considered feasible to deliver given funding constraints identified above.
- *Medium investment ($600m)* reflecting a similar level of investment by AT and the NZ Transport Agency to average annual expenditure levels by the funding partners during the 2015-2018 programme period. This level of expenditure is considered feasible to deliver.
- *High investment ($900m)* reflecting a level of investment which is similar to that programmed in the last year of current UCF period. This level of funding would represent a higher level of commitment from funding partners, and may be challenging to deliver with current industry capacity and internal planning and project management capacity within AT.

For development of the longlist options, the medium investment level was selected as a common budget across the options. This allows for comparison of how effective different approaches to using this budget may be in achieving the investment objectives. The shortlist assessment stage will further test the differences in outcomes from spending higher or lower levels.

6.3.2 Identifying longlist options

A detailed account of the process used to identify longlist options is provided in Supplementary Material, Section 2.2. This section provides a summary.

Six longlist options were defined that reflected common themes for approaches to developing the network raised by investment partners and stakeholders:

- Option 1: Enhance connections to existing trunk routes and extend trunk network
- Option 2: City Centre and central area network
- Option 3: Rapid Transit Station access
- Option 4: Develop new long-distance corridors
- Option 5: Demonstration neighbourhoods
- Option 6: Enhance connections to schools.

Table 15 summarises the longlist options, the locations of major network investment within each option (using the geographic areas defined in Section 6.2), and reference to predominant facility type and types of journeys and users served by each option.

The focus areas for investment for each option were selected using various methods depending on the longlist option. Detailed discussion of longlist generation methods are included in Supplementary Material, Section 2.3. Table 14 summarises how areas for network development were selected for each option.

An indicative map of network expansion was developed for each longlist concept. All options involved expansion from a 'baseline' (2018) network over the ten-year period 2018-2028. The indicative location of a network of new and upgraded facilities including separated cycle paths, on-street cycle lanes, on-street local paths (ie traffic calming) and off-street greenways was specified. Indicative networks were developed assuming a total budget of approximately $600 million for the ten-year period 2018-2028, and standard cost rates for each cycle facility type.

For each option, network development was focused in areas where a coherent network could be feasibly delivered over the 2018-2028 period. The general principle was to develop a 'best indicative version' for each option that was most likely to achieve the programme's investment objectives within selected focus areas. Best practice cycle network planning principles were used to guide detailed network development (see Supplementary Material, section 2.2.2). Across all options, the following principles were used, based on a review of local and international network planning guidance:

- Select routes that provide direct access to key destinations and follow corridors of high (current or latent) demand
- Select routes that link with other parts of the network to form a coherent and legible network
- Establish an appropriate network density, with a finer-grained network in areas of higher demand
- Select routes that are attractive for users and that offer a pleasant, interesting, safe and secure environment
- Select routes that minimise major gradient changes.

Facility categories were selected for each segment based on using an appropriate facility-type for the street context.[26] For example, on-street separated paths were used on high-traffic or multi-lane roads while mixed traffic facilities were used on low-traffic residential streets. This follows guidance in AT's *Evaluating Quality of Service for Cycle Facilities: Practitioner's Guide* (2016) which suggest separated paths are required in high-volume, higher-speed traffic environments while painted cycle lanes and mixed traffic facilities are only appropriate on streets with low traffic volume and speed.

Figure 23 illustrates the indicative network developed for Option 3: Rapid Transit Station access as an example of how network concepts were developed for each option. It shows how a connected network has been developed to link key destinations, and how network segments have been categorised by facility type.

[26] The facility types used in analysis were: on-street separated cycle paths; off-street dedicated or shared cycle paths; on-street painted cycle lanes; and mixed traffic cycle facilities (eg traffic calming or 'local path' treatments).

Table 14: Summary of approach to determining focus areas for investment for longlist options

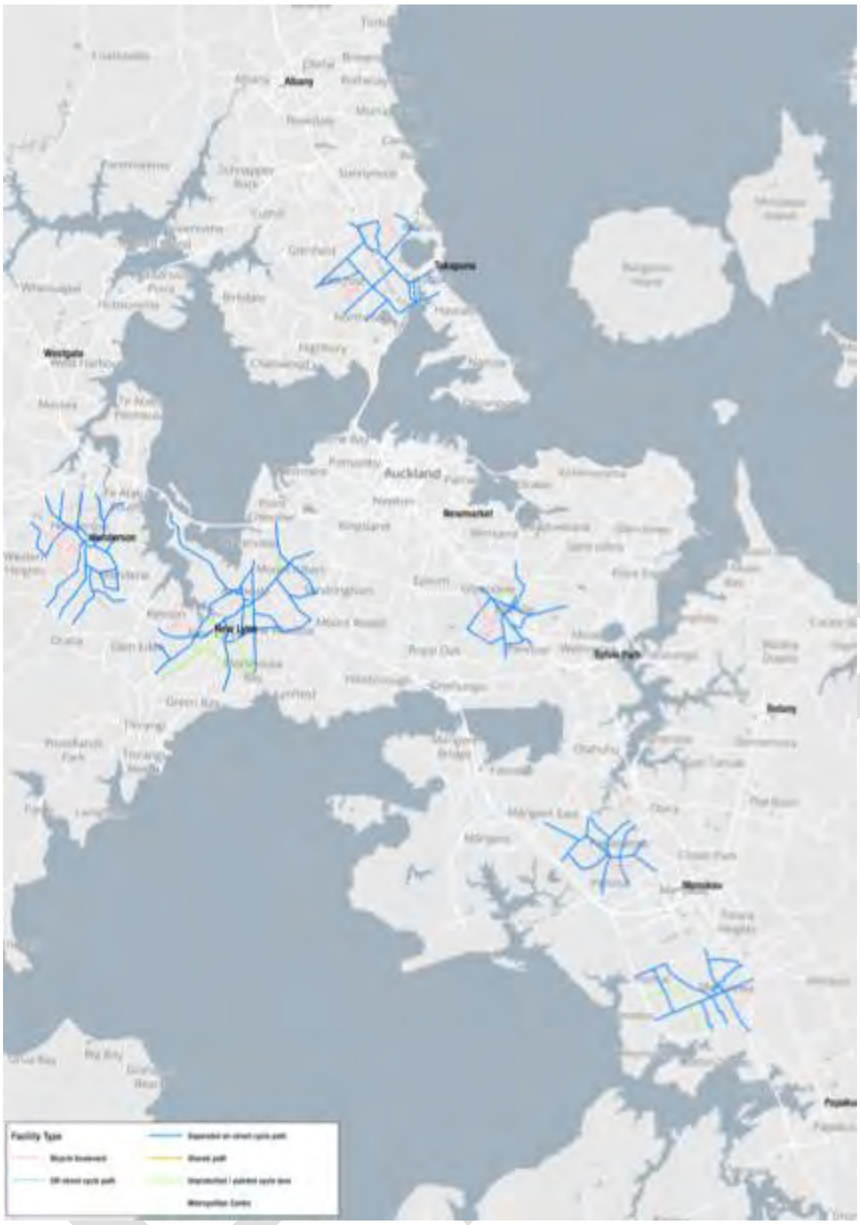
Longlist option	Approach used to determine focus areas for investment and development of indicative network plans
Option 1: Enhance connections to existing trunk routes and extend trunk network	The existing trunk network was identified and mapped. Potential new feeder routes to the existing trunk network were identified. Feeder routes were selected that were likely to follow corridors of relatively high transport demand and connect with major destinations. New indicative feeder routes were identified within a maximum distance of 3km from trunk routes. Potential extensions to trunk routes or new trunk routes were identified. New trunk routes were selected based on first priority trunk routes identified by NZTA and Bike Auckland in their 2016 Bike Blueprint, routes identified in Auckland Transport's Auckland Cycling Network (ACN) and other obvious extensions to existing trunk routes.
Option 2: City Centre and central area network	The area within 30 minutes cycling of the Auckland City Centre was identified using GIS cycle accessibility tools. Integration of cycling trips with ferry journeys was also considered as part of the 30-minute city centre cycling 'catchment'. Potential corridors for new cycling facilities were identified by referring to AT's ACN. City Centre routes were selected based on AT's 2023 City Centre Strategic Cycle Network. Other corridors were identified by isolating corridors of potential high demand, based on visual reference to maps of existing cycling demand and distribution of activity density. Corridors where infrastructure upgrades may contribute to safety benefits were identified by visual reference to maps of the location of cycle crashes during the 2011-2016 period. A loose grid of new cycling facilities was established with approximately 1km distance between routes.
Option 3: Rapid Transit Station access	Eight RTN stations were selected as the focus for network development. Stations were selected by first filtering out stations that were not adjacent to town centres and filtering out stations that within 5km of the city centre. The remaining stations were scored for their potential for cycle network development to be effective using a range of indicators (eg station boardings, resident population within the 15-minute cycling catchment, extent of existing low-stress cycling network). For the eight selected stations, radial networks serving the station and town centre area were developed to a distance of up to 3km from the station.
Option 4: Develop new long-distance corridors	Metropolitan Centres were mapped, based on the Auckland Unitary Plan. Other major suburban employment hubs including Penrose/ Onehunga and East Tamaki were also identified. Potential corridors for dedicated cycle facilities that connect Metropolitan Centres were identified, with reference to AT's ACN and Bike Auckland's Bike BluePrint. Opportunities for dedicated off-street and high quality trunk routes were prioritised to form the indicative network– eg alongside motorways and railway lines.
Option 5: Demonstration neighbourhoods	Ten suburb-scale neighbourhoods were selected for treatment. The neighbourhoods were selected with consideration of the following criteria: Potential for increased cycling uptake, based on the extent of the existing low-stress street network for cycling. Neighbourhoods with an extensive network of low-stress cycling streets (low-traffic volumes, flat gradient) were selected. Current cycling activity, based on Census commute mode share. Neighbourhoods with higher existing cycling mode share were selected.

Longlist option	Approach used to determine focus areas for investment and development of indicative network plans
	Geographic diversity. A selection of neighbourhoods in different parts of the Auckland region were selected. Indicative cycle networks were established for the selected neighbourhoods, within an area of approximately 2km by 2km around suburban centres. Routes were selected using best practice cycle network planning principles. Networks were designed to provide a dense grid of high-quality safe-routes throughout the neighbourhood with particular consideration for connecting major trip generators including schools, town centres and social and community facilities.
Option 6: Enhance connections to schools	Eight clusters of schools were selected as representing areas where cycle network development may be most effective: The location and number of students for all primary, intermediate and secondary schools across the Auckland region was mapped. The total school enrolment density for all Census Area Units in the Auckland region was mapped to further identify locations where high numbers of students attended school. Eight school clusters were selected by visual inspection, selecting clusters of multiple closely-located high-enrolment schools, within areas of high school-student density. For the selected school clusters, a high-quality network of radial routes was developed to serve the schools.

Table 15: Summary of longlist options

	1. Enhance and extend existing trunk routes	2. City centre and central area network	3. RTN station access	4. New long-distance corridors	5. Demonstration neighbourhoods	6. School access
Summary of option	*Enhance connections to existing high-quality trunk routes (eg NW cycle path, Eastern cycle path, Waterview-New Lynn cycle path, SH20 cycle path). Extend trunk network.*	*Establish a grid of new and upgraded high-quality trunk routes on key demand corridors within 7km of City Centre.*	*Establish a connected cycle network serving 'first mile, last mile' cycle connections to the rapid transit network (2-3 km catchment from key RTN stations).*	*Establish high-quality cycle connections on key regional transport corridors, particularly between Metropolitan employment and activity centres.*	*Establish area-wide attractive cycling conditions for selected neighbourhoods with either existing low-stress networks or high potential for benefits from increased cycling.*	*Establish high-quality connections to clusters of high-roll schools.*
Locations for major network investment	Northern Corridor Takapuna Mount Albert New Lynn/ Avondale Henderson Te Atatu Peninsula Eastern Bays Remuera/ Ellerslie Pakuranga	City Centre and Fringe Devonport/ Belmont Takapuna Inner West Mount Albert Central Isthmus Remuera/ Ellerslie Eastern Bays	Takapuna/ Northcote (Smales Farm/ Akoranga stations) Henderson New Lynn/ Avondale Mount Albert Ellerslie Papatoetoe Manurewa	Northern Corridor Westgate Henderson New Lynn Remuera/ Ellerslie Airport Manukau	Orewa Devonport/ Belmont Te Atatu Peninsula Inner West Mount Albert Howick Mangere Papatoetoe/ Otara Manurewa Pukekohe	Takapuna Henderson Mount Albert Central Isthmus Howick Mangere Papatoetoe/ Otara Manurewa
Mix of facility types	Mix of facility types appropriate to street context. On-street separated paths on high-traffic streets, cycle lanes or traffic calming on low-traffic streets, shared paths in off-street locations, intersection upgrades.	Mix of facility types appropriate to street context. On-street separated paths, local paths (where traffic volumes are low), low-speed downtown streets. Intersection upgrades.	Mix of facility types appropriate to street context. On-street separated paths, local paths, neighbourhood wide low-speed treatments. Intersection upgrades.	Longer-distance trunk routes - predominantly on-street protected cycle paths or off-street paths.	Predominantly local paths and area-wide traffic calming and low speed treatments. On-street separated paths to connect low-stress networks.	Mix of facility types appropriate to street context. Neighbourhood wide low-speed treatments. Intersection upgrades.
Customer focus	City Centre commuters, residents living near existing trunk routes, all ages/ abilities.	City Centre Commuters, Central area residents, all ages/ abilities.	RTN users within selected station catchments, all ages/ abilities.	Suburban residents working/ visiting Metro centres, all ages/ abilities.	Residents of selected neighbourhoods, all ages/ abilities.	School-age children, 8-18 at selected schools.
Other programme elements	Common package of promotion and other information-based measures, speed management and enforcement, improved parking facilities, new bike share service, financial incentives.					

Figure 23: Indicative network for Longlist Option 3: RTN Access



6.4 **Longlist assessment**

6.4.1 Assessment method

Multi-criteria analysis was used to assess the potential for each of the six longlist options to contribute to the programme's investment objectives. For each investment objective, a score of 1-5 was given, with a score of 5 representing a substantial contribution to achieving the investment objective and a score of 1 representing a low contribution. A total score out of 5 for each option was derived by weighting the scores against each investment objectives according to the weightings identified in the ILM.

Quantitative indicators, similar to those used for identifying priority areas for investment (see Section 6.2) were used for scoring against each of the five investment objectives. A set of 12 quantitative indicators were selected as proxies that would assist prediction of the extent to which network development would assist achieving each investment objective (see Table 16). GIS analysis was used to estimate indicators. Further detail on the methods used to calculate indicator values is provided in Supplementary Material, Section 2.3.

Table 16: Indicators used to inform assessment of longlist options against benefits and investment objectives

Benefit	Investment objective	Indicators contributing to assessment (source)	Rationale for use of indicator and relationship to investment objective
1. Cycling plays a greater role in meeting Aucklanders' transport needs	IO 1. Triple cycle mode share from 1% to 3% of total journey to work/ education trips by 2028 (30%)	1.1. Existing cycling levels: commute mode share in areas served by new network (Census 2013)	Areas with high existing cycling mode share are likely to have relatively good existing cycling conditions and supportive demographic factors. Network options that improve facility provision in these areas may have higher potential for mode shift to cycling.
		1.2. Existing average length of commute trip (Census 2013)	Areas with lower average commute trip lengths (eg less than 7km, or approx. 30 minutes cycle time) are likely to have higher potential for mode shift to cycling for commute purposes. Network options that serve these areas may have higher potential for achieving objective.
		1.3. Auckland-wide average cycle accessibility (30mins) to jobs (MRCagney cycle accessibility model)	Network options that increase cycle accessibility to destinations (proxied by jobs) are likely to be more useful for potential cyclists and result in higher levels of mode shift to cycling.
		1.4. Average school enrolment numbers in areas served by new network (Ministry of Education)	Network options that provide facilities in areas with high school enrolments are likely to have higher potential for inducting mode shift to cycling for journey to school trips.
		1.5. Population accessible by cycle to major tertiary education campus (30mins) (MRCagney cycle accessibility model)	Network options that increase cycle accessibility to major tertiary education campuses are likely to be more useful for potential cyclists and result in higher levels of mode shift to cycling.
2. Improved access to opportunities, particularly for people with low levels of transport choice	IO 2. Triple jobs and education opportunities accessible by short cycle trips or via RTN connections by 2028 (20%)	2.1. Auckland-wide average cycle accessibility (30mins) to jobs (MRCagney cycle accessibility model)	Network options that increase cycle accessibility to destinations (proxied by jobs) are likely to be more useful in connecting people with jobs and educational opportunities.
		2.2. Average socio-economic deprivation index score for areas served by new network (University of Otago)	Network options that serve areas of high deprivation may have higher value in providing a cycling choice for people more likely to have low transport choice (those with less access to private cars and children).
		2.3. Average density of people age 0-19 years in areas served by new network (5%) (Census 2013)	Network options that serve areas with high densities of children and young people may provide more value in improving transport choice for those without ready access to private vehicles.
3. Improved environmental, place and health outcomes	IO 3. Triple cycle volumes in dense activity centres by 2028 (10%)	3.1. % New network length within 1km radius of City, Metro, Town or Local centre (Auckland Unitary Plan)	Network options that provide facilities in centres are more likely to increase cycling levels in centres where potential for mode shift to cycling has higher potential for improving local place and environmental outcomes.

Benefit	Investment objective	Indicators contributing to assessment (source)	Rationale for use of indicator and relationship to investment objective
	IO 4. Increase rate of participation in regular cycling activity from 13% to 25% by 2028 (10%)	4.1. Population within area served by new network (Census 2013)	Network options that serve areas with higher populations are likely to have more ability to attract more users.
4. Increased safety for people using bikes	IO 5. Reduce deaths or serious injuries involving people using bikes by 10 -20% by 2028 (30%)	5.1. Existing road crash density for areas treated by new network (15%) (the NZ Transport Agency Crash Analysis System)	Network options that improve cycle facility quality in areas with poor existing overall road safety outcomes may have more potential for improving cycle safety, as road environments that are unsafe in general are also likely to be perceived as unsafe for cycling.
		5.2. Existing cycle-related crash density for areas treated by new network (15%) (the NZ Transport Agency Crash Analysis System)	Network options that improve cycle facility quality in areas with poor existing road safety outcomes for existing cyclists may have more potential for improving cycle safety.

6.4.2 Results of assessment

Table 17 summarises the results of the longlist assessment. More detailed results, including scores on each quantitative indicator are presented in Supplementary Material, Section 2.4.

The key findings of this analysis are as follows:

- *Option 2: City Centre and Central Area Network* performs best, with a weighted score of 4.2 out of 5. It has the highest or equal-highest score against investment objectives 1, 4 and 5. This suggests it is most likely to achieve objectives related to increasing the role of cycling in AT system, improving the rate of participation in cycling and improving cycle safety. Two other options perform better against investment objective 2 due to serving areas with lower levels of deprivation, and areas with higher densities of children and young people. This reflects that while Option 2 serves the central area of the city with the highest overall levels of population and employment activity, network expansion in this area will also likely benefit a relatively more privileged and older population than some other options.

- *Option 6: School Access* performs second best, with a weighted score of 3.7. It performs better than Option 2 against investment objective 2 as it expands the cycle network in areas with more children and young people and with higher levels of socio-economic deprivation. However, against objectives 1 and 5, it scores more poorly than Option 2 due to serving areas with lower existing cycle mode share and lower existing cycle-related and overall road crash rates. This option also makes less of a positive change to levels of cycle accessibility. This suggests slightly less potential than Option 2 for improving cycle mode share or safety outcomes.

- *Option 3: Rapid Transit Network Access* has a similar weighted score to Option 6, scoring 3.5. Across the investment objectives it scores similarly to Option 6, except having a slightly lower score against objective 2 due to serving areas with lower densities of children and young people. It scores slightly higher than Option 6 against investment objective 3 as it focuses network expansion on Metropolitan and Town centres, where there is more potential for positive local environmental and amenity impacts from increased cycling.

- *Option 1: Enhance existing trunk routes* scores moderately, with a weighted score of 3.1. It performs well against investment objective 4 as it provides extensions to the cycling network that serve a relatively high number of residents (population within 400m of extended network). However, against all other objective it scores only moderately well. It also scores more poorly than other options against investment objective 3 due to not serving Metropolitan, Town and Local centres.

- *Option 5: Demonstration Neighbourhoods* scores less well, with a total weighted score of 2.4, well below the next highest performing option. This option performs most poorly against the safety objective (investment objective 5) due to focusing network expansion on quieter residential streets in areas with lower crash rates than other options. It also performs poorly against objective 1, as it extends the network in areas with relatively low existing cycle commuting mode share. The network expansion concept also has limited impact on improving cycle accessibility to jobs and tertiary education facilities, suggesting less potential to encourage mode shift to cycling.

- *Option 4: New Long-Distance Corridors* obtains the lowest weighted score of 2.0. It expands the network in areas with low existing cycle mode share and high average commute trip lengths, locations where there may be less potential for encouraging mode shift to cycling. This approach to network expansion also has the lowest impact on improving cycle accessibility to jobs (investment objective 1). It serves the lowest population (population within 400m of new network, investment objective 4) and provides least new network length in and around centres (investment objective 3). On the other hand, it does serve areas with the highest overall road crash rates, but relatively low cycle-related crash rates. This suggests that this network expansion may serve areas where existing transport arrangements may dissuade people from using bikes entirely.

Stakeholder feedback

Alongside the assessment of longlist options against investment objectives and feasibility criteria, feedback on the longlist options was also sought from stakeholders. A stakeholder engagement workshop was held in December 2016 with internal stakeholders including staff from AT, AC and the NZ Transport Agency and external stakeholders including Bike Auckland, Generation Zero and Greater Auckland. The six longlist options were presented and stakeholders were asked to select their top three approaches to network development.

The high level of support was given to Option 2 (Central Area network) and Option 6 (School Access). Option 5 (Demonstration Neighbourhoods) received the lowest level of support while the remaining options received a medium level of support. Some stakeholders also noted that cycling investment should be spread across the urban region.

Table 17: Longlist assessment – summary of scores (Score of 5/ Dark green = option most likely to achieve investment objective. Score of 1/ Dark Orange = option least likely to achieve investment objective)

Benefit	Investment objective	Option 1. Enhance existing trunk routes	Option 2. City centre and central area network	Option 3. RTN station access	Option 4. New long-distance corridors	Option 5. Demonstration neighbourhoods	Option 6. School access
1. Cycling plays a greater role in meeting Aucklanders' transport needs	1. Increase cycle mode share to xx% of total journey to work/ education trips by 2028 (30%)	3	4	3	1	2	3
2. Improved access to opportunities, particularly for people with low levels of transport choice	2. Increase jobs and education opportunities accessible by cycling for target customers by xx% by 2028 (20%)	3	3	4	3	3	5
3. Improved environmental, place and health outcomes	3. Increase cycle volumes in dense activity centres by xx% by 2028 (10%)	2	4	4	1	5	3
	4. Increase rate of participation in regular cycling activity by xx% by 2028 (10%)	5	5	5	1	3	5
4. Increased safety for people using bikes	5. Reduce deaths or serious injuries involving people using bikes by xx% by 2028 (30%)	3	4	3	3	1	3
Total weighted score for option (0-5)		**3.1**	**4.2**	**3.5**	**2.0**	**2.4**	**3.7**
Total indicative cost ($ for 2018-2028 programme)		c. $600 million	c. $600 million	c. $600 million	c. $600 million	c. $600 million	c. $600 million

7 PROGRAMME OPTIONS DEVELOPMENT AND ASSESSMENT

This section describes how a shortlist of cycling network investment options were developed and assessed against a 'Do-Minimum' option. It reports on the results of the shortlist assessment, including results from economic evaluation of options. The findings from this evaluation will guide development of the recommended programme.

The assessment of priority areas for investment and longlist assessment provided clear direction on the types of approaches to network development and locations within Auckland where investment is most likely to contribute to achieving investment objectives. Those results have guided the generation of a further series of shortlist options that are designed to enable further investigation of two key questions related to the transport benefits and demand implications of further investments in Auckland's cycling network:

- First, what are the benefits of investing in different parts of the city, resulting in a network with a different geographic focus?
- Second, what are the benefits of investing more or less in cycle network development, resulting in a larger or smaller network?

7.1 Process for developing shortlist options

This section explains how shortlist options were developed and assessed. It addresses:

- How findings from the longlist assessment were used to inform shortlist development
- How four shortlist options were developed to address the above questions, including:
  - How alternative geographic areas of focus were identified; and
  - How alternative investment levels were specified.
- How the Do-Minimum for cycle investment was established.
- Description and mapping of the resulting shortlist options.

7.1.1 How findings from the longlist assessment were used to inform shortlist development

The longlist assessment found that three alternative approaches to cycle network development in Auckland had most potential for contributing to investment objectives:

- Network expansion focused on a dense, connected network within the central area (area within approx. 7km from the City Centre) (longlist option 2)
- Network expansion focused on connections to clusters of schools in both central and outer-suburban areas (longlist option 2)
- Network expansion focused on short-distance connections to outer-suburban RTN stations (which tend to be located in sub-regional employment centres) (longlist option 3).

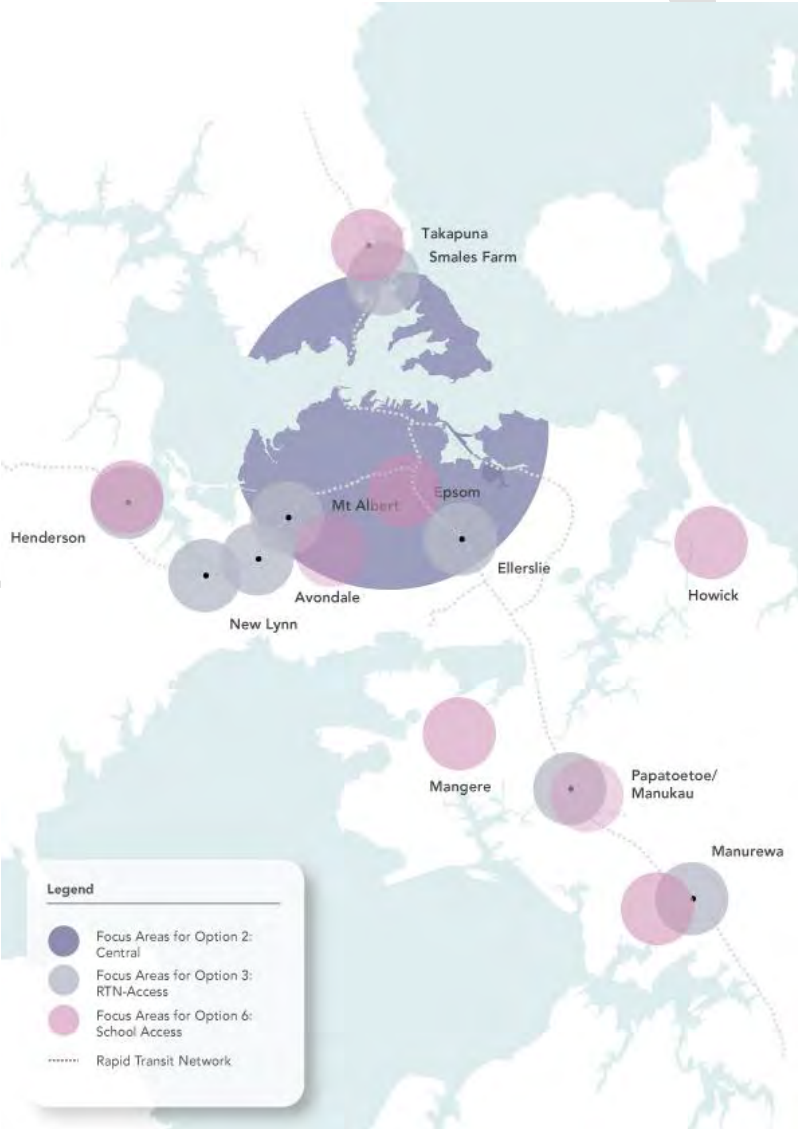
Network development that focused solely on new long-distance connections (Option 4) or demonstration neighbourhoods (Option 5) was less likely to achieve investment objectives. Network development that enhanced connections to existing major cycling infrastructure (Option 1) was found to have moderate potential to contribute to investment objectives.

Stakeholder feedback on the longlist options broadly confirmed the findings of the assessment, with highest levels of stakeholder support for network development that prioritised a connected network within the central area (Option 2) and good levels of support for network development that focused on school access (Option 6).

The indicative network development plans developed for the longlist options revealed considerable overlaps in the focus areas used for the three high-scoring longlist options. In particular, networks developed to serve RTN stations (Option 3) and school clusters (Option 6) were both centred around key suburban hubs (eg Takapuna, Mt Albert, Henderson, Papatoetoe, Manurewa,). Likewise, the network developed for the central area (Option 2) overlapped with central components of the school and RTN networks at Mt Albert, Epsom and Ellerslie.

Figure 24 illustrates the focus areas for network development identified for the three high-scoring longlist options. It shows the considerable overlaps in areas for network development for these three options. These areas were the focus for network development at the shortlist stage.

Figure 24: Areas for network investment, high-scoring longlist options



Discussion of the longlist assessment results by the Project Control Group established that the key differentiating factor for network development that needed to be tested at the shortlist stage was comparison of:

a) A central-focus to network development involving a very dense connected network in the central area (based on longlist Option 2, but also including some centrally-located components of other options)
b) A 'suburban hub' focus to network development involving networks around key suburban destinations (based on components from Option 3, RTN Access, and outer-suburban elements of Option 6, School Access).

It was also agreed that any effective final network development plan was unlikely to only include centrally-located facilities or only include outer-suburban new facilities. Achieving the full range of investment objectives was likely to require investment in both central and suburban locations (eg achieving accessibility objectives would require outer-suburban investment and achieving safety objectives would require central investment). As a result, both shortlist options would include some elements in both central and suburban locations.

7.1.2 How shortlist options were developed

A set of four shortlist options was developed that were differentiated on the two key dimensions of cost and investment location. These shortlist options addressed:

- An 'Intensified Central' or 'Suburban Hub' approach to network development; and
- Low, Medium or High levels of investment.

Option 1 is a base, low investment network, common across all options. Option 2 adds additional investment within the central area while Option 3 adds additional investment in selected suburban hubs. Option 4 combines the base network with the additional components from Options 2 and 3. In summary, the four options are:

- *Option 1 – Base Network:* a low level of investment ($300M over the 2018-2028 period) weighted heavily toward developing a connected central area network (following findings from the longlist assessment) and some complementary investment around selected high priority suburban hubs (the longlist assessment suggested this type of investment could complement central-area investment by better contributing to the accessibility investment objective).
- *Option 2 – Base + Intensified Central Network:* a medium level of investment ($600M) that included all elements of Option 1 with an additional $300M investment focused on further developing a connected central area network, with more network density in the central area and greater geographic scope than Option 1.
- *Option 3 – Base + Suburban Hubs Network:* a medium level of investment ($600M) that included all elements of Option 1 with an additional $300M investment focused on short-distance connections around selected outer-suburban hubs (Metro centres, RTN stations and schools), and some long-distance connections outside the central area. All additional investment to the base network is located in the area beyond an approximately 7km radius of the Auckland City Centre.
- *Option 4 – Base + Intensified Central + Suburban Hubs Network*: a high level of investment ($900 million) combining the base network (Option 1) with the additional elements from both Options 2 and 3.

Figure 25 illustrates the set of the options established. This set of options enables comparison of the two geographic approaches to investment (the performance of Option 2 vs Option 3) and the incremental value of additional tranches of investment (the performance and economic efficiency of Options 1 vs 2/3 vs 4).

Figure 25: Shortlist options

Option 1 allows for analysis of the performance of a lower level of investment. A single low-investment option was established (rather than a low investment option for central and distributed investment approaches), as the detailed network development process (see following Section 7.1.4) and stakeholder consultation found that there are many network elements that are common across both distributed and centrally-focused investment approaches.

Options 2 and 3 are intended to enable understanding of the trade-offs between decisions to spend more on intensifying the central area network or expanding the network to selected suburban hubs, as well as the marginal benefits of additional network expansion over and above the lower expenditure level. There is no overlap between the investment additional to the Option 1 between Options 2 and 3. Option 2 focuses entirely on additional investment within 7km of the City Centre, while Option 3 focuses additional investment entirely on outer-suburban areas.

Option 4 combines Options 2 and 3 to provide a picture of what a 'very high' level of expenditure would deliver. This option responds to feedback from stakeholders that it would be desirable to understand the impacts of a more comprehensive regional network.

How different investment levels were established

The three investment levels for the network development components of the 2018-2028 programme period were selected based on recent historic levels of investment in Auckland cycling facilities by the programme investment partners:

- *Low investment ($300m)* roughly reflects the average level of walking and cycling expenditure by both AT and the NZ Transport Agency over the last five years. This would represent a continuation of historical levels of funding, but a drop from levels of funding in the second half of the 2015-2018 UCF investment period. It is considered feasible to deliver given funding constraints identified above.
- *Medium investment ($600m)* reflects a similar level of investment by AT and the NZ Transport Agency to average annual expenditure levels by the funding partners during the 2015-2018 programme period. This level of expenditure is considered feasible to deliver.
- *High investment ($900m) reflects a level of investment* which is similar to that programmed in the last year of current UCF period. This level of funding would represent a higher level of commitment from funding partners, and may be

challenging to deliver with current industry capacity, internal planning and project management capacity within AT, and will depend on national government decisions on funding available for cycling.

7.1.3 How the Do-Minimum was established

A Do-Minimum Auckland cycling network was developed against which the performance of the four investment options in achieving investment objectives were compared. The Do-Minimum is a scenario reflecting existing and currently committed and funded cycle facilities. It involves minimal future investment in cycling facilities by any of the three investment partners (AT, NZ Transport Agency, AC), during the programme period 2018-2028. The Do-Minimum network is mapped in Figure 6 and includes facilities that are:

- Existing at the date that the ACPBC was developed (June 2017);
- Planned and funded as part of Auckland's 2015-2018 Urban Cycleway Fund programme or related minor improvements; or
- Planned and funded as part of other transport investments that will proceed regardless of this Programme Business Case. Example project of this type include:
    - Northern Connections cycle facilities alongside State Highways 1 and 18 (NZ Transport Agency)
    - Inner West Package including facilities in Grey Lynn and Point Chevalier (AT).
    - Sky Path, across the Auckland Harbour Bridge (Private delivery with AC financial underwriting).

7.1.4 How indicative networks for shortlist options were established

To enable evaluation of the options, indicative network expansion concepts were detailed for each option, drawing upon the longlist options. This involved:

1) Identifying priority suburbs/ areas for investment within each option, based on previous findings from the longlist process and assessment of priority areas for investment across Auckland
2) Mapping indicative alignments and facility types for new routes within these areas.

These indicative networks allowed for cycle demand modelling to be undertaken and for the options to be roughly costed and matched to the low/ medium/ high investment levels using standard per kilometre cost rates for four types of generic cycle facilities. These networks reflect indicative programmes that could be developed in a relatively coherent way, following network development principles articulated at the longlist stage. However, the exact location and design of new cycle facilities would have to be refined at the Indicative Business Case stage.

The overarching principle guiding the detailed option specification was to develop a 'best indicative concept' for each option. This involved selecting areas for investment and indicative locations for new network routes that would most likely contribute to achievement of the programme's investment objectives.

Identifying priority areas for investment

High priority areas for network development and inclusion in the shortlist options were identified based on three factors:

1. Findings from the assessment of priority areas for investment across Auckland (Section 6.2)

2. Findings from the longlist assessment, including identification of areas for network development that were included in multiple high-scoring longlist options (see Figure 24).
3. Consideration of the location of existing network links and opportunities to enhance network connectivity (eg 'fill gaps' or provide 'feeder' routes to long-distance pathways).

The areas that were included as the focus for network development in the shortlist options generally followed those areas identified in Figure 24 (the central area or outer-suburban areas that were included in multiple high-scoring longlist options). However, a number of additional high priority areas were included in Shortlist Option 3:

- Te Atatu Peninsula: achieved a high score in the assessment of priority areas for network development due to high existing cycle mode share, and relatively poor access to public transport options. Opportunities to link with NW cycleway investment. Included in lower-scoring Demonstration Neighbourhoods longlist option.
- Pakuranga: achieved a medium score in the assessment of priority areas for network development. However, opportunities to connect with committed cycle network investment accompanying AMETI and provide access to high-growth area around Metro Centre. This focus area was used in place of neighbouring Howick which was part of longlist Option 6.
- Onehunga: achieved a medium score in the assessment of priority areas for network development. However, opportunities to connect Manukau Road and Mangere Bridge facilities and to enhance access to RTN station.

Identifying indicative route alignments and facility types

After establishing priority investment areas for the shortlist options, indicative alignments for an expanded cycle network in these areas were mapped. Routes were selected based on best-practice cycle network planning guidelines, as used for developing indicative networks at the longlist stage (see Supplementary Material, Section 2.2).

The network maps for each of the four options are included in Supplementary Material, Section 3.2. This supplementary material also provides further detail on the rationale for inclusion of focus areas for investment within the shortlist options.

7.2 Process for assessing shortlist options

The four shortlist options were assessed using multi-criteria analysis. The high level criteria for assessment were:

- Performance against programme investment objectives – comparison of options for their potential to contribute to achievement of the five investment objectives established for the programme.
- Implementability – comparison of options for their deliverability and financial feasibility within the 2018-2028 programme period
- Economic efficiency - economic evaluation of the shortlist options was undertaken following NZ Transport Agency guidelines and based on forecast cycling demand impacts from indicative cycle network expansion plans developed for each option.

The following sub-sections outline the methods used to undertake these three types of assessment. The different assessment approaches provide a range of information to inform the development of the recommended programme:

- The assessment against investment objectives provides an indication of the extent to which the options are likely to achieve the five investment objectives. It compares the options for their impacts on cycling demand, providing for target customers, health, place, environmental and safety outcomes.
- The implementability assessment compares options for how easily they may be delivered during the programme period.
- The economic evaluation provides an indication of the likely efficiency of expenditure from the options by comparing options for their impact on cycle demand. It establishes a monetised level of programme benefits and compares levels of benefits with costs to establish an economic efficiency measure (Benefit Cost Ratio) for each option.

7.2.1 Process for assessment against investment objectives

The shortlist options were assessed for their potential to contribute to achievement of the programme benefits and investment objectives. This assessment draws on information from:

- Cycle demand modelling from the economic evaluation
- Qualitative assessment against objectives with reference to key indicators and qualitative consideration of characteristics of areas served by the indicative cycle networks developed for each option.

Table 18 outlines the indicators and additional qualitative considerations used to inform comparative assessment of the potential for each of the four shortlist options to contribute to achievement of the programme's objectives.

Table 18: Indicators and qualitative considerations used for assessment of shortlist options against investment objectives

Benefit	Investment objective	Indicators used for shortlist assessment	Other considerations for qualitative assessment
1. Cycling plays a greater role in meeting Aucklanders' transport needs	1. Triple cycle mode share from 1% to 3% of total journey to work/ education trips by 2028 (30%)	Modelled cycle commute mode share (2026) resulting from indicative networks. Number of enrolled school children/ young people within 400m buffer of indicative networks.	Levels of road and public transport congestion on corridors served by indicative networks. Levels of future development likely in areas served by indicative networks. Index of cycling network investment potential (indicators relevant to investment objective 1, see Appendix E) for areas served by indicative network.
2. Improved access to opportunities, particularly for people with low levels of transport choice	2. Triple jobs and education opportunities accessible by short cycle trips or via RTN connections by 2028 (20%)	Number of people age 0-19 living within 400m buffer of indicative networks. Number of people living within 400m of indicative networks, but beyond 800m buffer of frequent bus route or RTN station.	Connectivity of indicative cycling networks and outer-suburban RTN stations. Connectivity of indicative cycling networks to major tertiary education facilities. Index of cycling network investment potential (indicators relevant to investment objective 2, see Appendix E) for areas served by indicative network.

Benefit	Investment objective	Indicators used for shortlist assessment	Other considerations for qualitative assessment
3. Improved environmental, place and health outcomes	3. Triple cycle volumes in dense activity centres by 2028 (10%)	Modelled cycle demand across CBD cordon (from cycle demand modelling for economic evaluation). Number of jobs within 400m buffer of indicative networks.	Connectivity of indicative cycling networks to City, Metro and Town centres. Index of cycling network investment potential (indicators relevant to investment objective 3, see Appendix E) for areas served by indicative network.
	4. Increase rate of participation in regular cycling activity from 13% to 25% by 2028 (10%)	Resident population within 400m buffer of indicative networks.	Index of cycling network investment potential (indicators relevant to investment objective 4, see Appendix E) for areas served by indicative network.
4. Increased safety for people using bikes	5. Reduce deaths or serious injuries involving people using bikes by 10 - 20% by 2028 (30%)	Number of cycle-related crashes (2011-2016) within 50m buffer of indicative networks.	Index of cycling network investment potential (indicators relevant to investment objective 5, see Appendix E) for areas served by indicative network.

The indicators for each option were calculated using GIS analysis. Buffers around the indicative network development plans for each option were used to calculate the various counts (eg resident population within 400m of the indicative network).

The qualitative assessment made reference to the following data sources:

- Maps of road and public congestion (modelled 2013 and 2026 for ATAP, see Figure 8).
- Levels of likely future urban development (modelled development feasibility, see Figure 5).
- Location of Auckland's top five tertiary education campuses (by student numbers)
- Location of City, Metro and Town Centres (as defined by the Auckland Unitary Plan).

The qualitative assessment against each investment objective also assessed the location of indicative network expansion against the 'index of cycling network investment potential' scores (see Supplementary Material, Section 3.3). This index provides guidance on locations where network investment is most likely to contribute to the achievement of investment objectives, by combining a series of quantitative indicators (similar to those in Table 18), describing the characteristics of different parts of the Auckland urban area.

7.2.2 Process for implementability assessment

The implementability of each shortlist option was assessed using three criteria:

1. Impact on other transport modes – is implementation of the indicative cycle network development plan likely to introduce conflicts with the operation of other transport modes within road corridors? Such conflicts may have negative impacts on overall network efficiency or create consenting risks for the programme.

2. Deliverability – is implementation of the indicative cycle network development plan likely to be difficult within the 2018-2028 period, due to constructability or consenting challenges or dependencies with other transport infrastructure projects?

Are there opportunities to integrate network development with other planned projects?

3. Financial feasibility – is the level of planned investment likely to be affordable in the context of funding available through the NLTP and AT?

The assessment of deliverability and impact on other modes highlights locations where indicative network expansion has *potential* for accompanying negative impacts. Actual impacts on other modes will depend on detailed design considerations and impacts may be mitigated completely depending on design. Further investigation will also be required to confirm the extent of constructability challenges, once more definitive route alignments have been selected.

Assessment of the impact on other transport modes involved reference to the following mapped data:

- Road congestion– maps of the indicative shortlist networks were overlaid with maps of current and future forecast road congestion (ATAP modelled congestion in 2013 and 2026, see Figure 8). Routes that used highly congested corridors were assessed as having potential for greater impact on other transport modes, as re-allocation of road space on these corridors has potential to reduce traffic capacity and increase road congestion.
- Public transport capacity constraints - maps of the indicative shortlist networks were overlaid with maps of current and future forecast public transport capacity constraints (ATAP modelling 2013 and 2026, see Figure 8). Routes that used highly congested bus corridors were assessed as having greater impact on other transport modes, as re-allocation of road space on these corridors may affect ability to increase public transport frequencies.

Assessment of deliverability involved reference to the following information:

- Other transport infrastructure project dependencies - maps of the indicative shortlist networks were overlaid with maps of planned major transport infrastructure projects for the period 2018-2028. Cycle routes that may be affected by currently planned infrastructure projects were identified.
- Construction and consenting challenges – expert judgement and desktop visual inspection of corridors was used to identify major construction or consenting challenges that may delay or prove challenging for implantation of the indicative cycle networks. Consideration was also given to positive opportunities for integrating network development with currently planned infrastructure projects.

Assessment of financial feasibility referenced the following information:

- Comparison of the planned annual investment level for each shortlist option with indications of funding available through the NLTP for the 2018-28 period. The Draft GPS 2018/19-2027/28 (published for engagement, February 2017) indicates a range of funding for the walking and activity class of $16 million - $65 million for each of the three years, 2018/19 – 2020/21 to be allocated across New Zealand. An Auckland cycling network development programme of $60 million/ year (medium level of investment) would use approximately 50% of nation-wide funding for this activity class, assuming an NLTF FAR of 50% (with remaining 50% of investment from AT), and maximum upper bound level of expenditure for the activity class. A network development programme under the high level of investment would require $45 million from the NLTP, or 70% of nation-wide funding available.

- Comparison of the planned annual investment with recent historic levels of network investment by AT and the NZ Transport Agency. Current expenditure by the two funding partners on cycle development has been estimated at $60 million/ year, a substantial increase on recent historic levels. Shortlist option 1 with low levels of investment would see a reduction from current levels of activity while Option 4 would see a 50% increase in expenditure.

7.2.3 Process for economic evaluation

The economic assessment of the shortlist options involved two steps:

1. Predicting changes in cycle demand resulting from the development of the cycle network
2. Assessing the economic efficiency of investment under each shortlist option by comparing benefits and costs.

The supplementary report, *Auckland Cycling Programme Business Case: Demand and Economic Assessment* provides a full description of the methodology. This section provides a summary.

Cycle demand predictions

Forecast cyclist demands for the four shortlist options were obtained by using the Auckland Cycle Model, developed by Flow Transportation Specialists Ltd and previously used to evaluate impacts from other cycling investment programmes. Forecast demands were compared against modelled demands under a 'Do-Minimum' network option.

The Auckland Cycle Model is based on data from the 2013 Census and forecast travel demands from the Auckland Regional Transport (ART) model. The model was validated against over 700 observed cycle counts. The Auckland Cycle Model:

- Assigns a "Relative Attractiveness" attribute to all cycle infrastructure or routes that cyclists use, allowing cycle trips within the model to be assigned by balancing trip distance, gradient and cyclist comfort/safety, rather than assigning cyclists to the most direct or fastest route
- Responds to land use changes by for example increasing cyclist trips where existing land uses intensify and generating new cycle trips where new land uses develop. The model uses Auckland Council's 'Scenario I9' land use projections, which represents a medium growth scenario and is the currently agreed land use projection for transport investment within the Auckland region
- Responds to infrastructure changes; where a new cycle route is built, or an existing route is improved, the model identifies re-routed cycle trips as well as new cycle trips resulting from mode shift and behaviour change. This function of the model is responsive to different infrastructure types, in that higher quality cycle infrastructure separated from general traffic is more attractive to cycle trips within the model than painted on street cycle lanes.[27]

The model allows for the following types of outputs describing changes in cyclist demands resulting from network infrastructure upgrades:

[27] User responses to improved infrastructure were initially calibrated against international research and then subsequently re-calibrated against Auckland cycle trends observed between 2013 and 2016.

- Total modelled cycle trips (annual average daily) on all links within the model
- Total modelled cycle distance for the region (annual average daily).

The model provides forecasts for 2026 and 2046, with forecasts for intermediate years enabled by linear interpolation between these years.

Economic assessment

The economic assessment uses the demand predictions to calculate monetised benefits from increased cycle demand and compares benefits with shortlist option costs. The Economic assessment was undertaken using the NZ Transport Agency Economic Evaluation Manual (EEM) procedures for evaluating walking and cycling facilities in Appendix A20 and Simplified Procedure SP11.

The assessment uses the EEM's 40-year evaluation period and 6% discount rate. A ten-year construction period was applied to all four investment options, starting in January 2019. Project benefits were assumed to increase linearly from 0% in January 2019 to 100% in December 2029. This represents the gradual accumulation of project benefits as infrastructure comes online. Similarly, costs were discounted and spread over the ten year construction period.

Monetised benefits were derived for the following benefit streams:

- Health and environment benefits for new cyclist trips
- Safety benefits for improved cycle facilities (applicable to new and existing cyclists)
- Travel time cost savings for existing cyclists using improved infrastructure
- Decongestion benefits for general traffic, as a result of mode shift.

7.3 Results of shortlist assessment

The results of the shortlist assessment are presented in three parts:

- assessment against investment objectives
- implementability assessment
- economic assessment.

An overall summary assessment is also provided. Supplementary information used to inform the assessment presented in this section is included in Supplementary Material, Section 3.3.

7.3.1 Results of assessment against investment objectives

Table 19 summarises the assessment against the five established investment objectives. Each shortlist option is scored on a seven-point scale against each investment objective using the measures in Table 18. A total score is obtained by weighting the scores across the investment objectives by the weightings established in the ILM (see Section 5.1). Supplementary Material Section 3.4 provides more detailed information on analysis of options including reporting on comparative indicators and qualitative considerations that contributed to the assessment.

The assessment finds that **Option 4 (Base + Intensified Central + Suburban Hubs)** scores most highly for its potential to contribute to achievement of the investment objectives. This reflects the increased scale of network expansion under this option that enables a more complete cycling network for the Auckland urban area. Cycle demand modelling indicated that this option would increase cycle demand by 74% relative to the Do-Minimum, resulting in the highest mode shift toward cycling of all options. This suggests that it would be most successful in enabling cycling to play a more effective role in Auckland's transport system.

Higher levels of cycling demand will be accompanied by higher health, environmental and place benefits. A more complete network is also likely to be more successful in increasing Aucklanders' cycle accessibility to jobs and opportunities, and to provide more extensive coverage across the region that may encourage more widespread regular participation in cycling. The expanded coverage of the network is also likely to allow for safety improvements for cycling across more locations, reducing cycle crash risks.

Option 2 (Base + Intensified Central) and Option 3 (Base + Suburban Hubs) involve the same medium level of network investment ($600 million vs $900 million for Option 4), but focused on different geographic areas. They score similarly overall across the total range of objectives but there are some differences in performance in contributing to individual investment objectives:

- Both options score similarly for their contribution to investment objectives 1 and 3, increasing cycle mode share and cycle volumes in dense activity centres.
- Option 2 scores better than Option 3 against the cycle safety objective (investment objective 5)
- Option 3 scores better than option 2 for its contribution to transport accessibility (investment objective 2) and health benefits (investment objective 4).

These differences in performance reflect the following:

- *Mode shift and cycling's contribution to an effective transport system*: Option 2 and 3 take two different approaches to network development. Option 2 intensifies investment in central areas where existing cycling mode share is relatively high and average trip lengths are relatively short. Option 3 develops the network across a range of selected suburban areas with lower existing mode share and poorly developed existing networks, improving network quality more substantially in these areas.

  Cycle demand modelling indicated that Option 2 would deliver a 57% increase in cycle demand, by shifting more trips to cycling within the central area. Option 3 is predicted to result in a similar 52% increase in cycle demand, but by capturing increased cycling mode share across a wider area of Auckland. The relatively small size of this difference in demand impacts between Options 2 and 3 may reflect diminishing returns from intensifying the central area network, relative to the base central network established for Option 1.

- *Accessibility benefits:* Option 3 focuses investment on selected outer-suburban areas with higher densities of people with lower levels of transport choice, including children and young people, and people with poor access to frequent public transport services (compared with the central areas that are the focus of Option 2). Providing cycling networks in these locations may provide higher accessibility benefits by providing a more valuable alternative transport option in locations where options are more constrained.

  Option 3 also focuses more investment on cycle connections to RTN stations in outer-suburban locations where a combination of cycling and rail/ bus can extend the reach of the public transport system.

- *Environmental and place benefits:* Both Options 2 and 3 focus investment on serving the City Centre, Metro and town centres. This may encourage more cycling in these centres where mode shift from vehicles to cycling can have high positive impacts on local environmental and place quality due to concentrations of streetside activity. Demand modelling showed similar levels of demand into the CBD under both options.

- *Health benefits:* Option 3 provides greater network coverage across the region than Option 2 which may mean more potential for a broader customer base and higher levels of participation in cycling across the region. Option 3 also focuses network investment in areas with higher levels of health problems associated with inactivity. Higher levels of cycling participation in these areas may provide more valuable health benefits.

- *Safety benefits:* Option 2 focuses network expansion on areas of Auckland with the highest existing cycle-related crash density. These include the City Centre, Inner West, Mt Albert, Takapuna and the Eastern Bays. Improvements to the network in these areas are likely to have the most potential to improve safety outcomes for existing cyclists. The outer-suburban areas that are the focus of Option 3 investment have lower cycle-related crashes (accompanying lower overall cycling activity) but medium densities of overall road crashes. This suggests that improved cycling facilities are likely to be able to improve the safety and attractiveness of the road environment for cyclists in these areas.

Option 1 scores less well against investment objectives than other options due to a lower level of investment and reduced scale of network expansion. This reduces potential to contribute to the programme benefits. Cycle demand modelling suggest the base network is likely to result in almost achieving the target of 3% cycling mode share, and involves a significant increase from the Do-Minimum.

However, the extent of network expansion under Option 1 is unlikely to be sufficient to substantially increase cycle accessibility for target customers, with only limited expansion in parts of South Auckland, serving population concentrations with lower levels of transport choice. Option 1 lifts the number of Aucklanders living within 400m of a cycling facility (of any quality) by 10% relative to the Do-Minimum. This is unlikely to result in significant increased participation in cycling.

Option 1 focuses investment on areas with high cycle-crash densities and is likely to contribute positively to safety outcomes. Nevertheless, the extent of network expansion and safety improvements may be insufficient to achieve reductions in cycle crashes alongside uplift in cycle demand.

Table 19: Summary assessment of shortlist options against programme investment objectives

Benefit	Investment objective	Weighting	Assessment			
			Option 1 – Base Network	**Option 2 - Base + Intensified Central**	**Option 3 – Base + Suburban Hubs**	**Option 4 – Base + Intensified Central + Suburban Hubs**
1. Cycling plays a greater role in meeting Aucklanders' transport needs	1. Triple cycle mode share from 1% to 3% of total journey to work/ education trips by 2028	30%	0 Modelled cycle demand 2.8-3.4% commute mode share in 2026, 35-49% above Do-Minimum. Base network serves major jobs and education destination (City Centre) and congested corridors in central area.	++ Modelled cycle demand 3.3-4.4% commute mode share, 57 - 93% above Do-Minimum. Network expansion serves key jobs and education centres including the CBD and clusters of central area schools.	++ Modelled cycle demand 3.2-4.1% commute mode share, 52-78% above Do-Minimum. Network expansion serves key jobs and education centres including the CBD and suburban tertiary education institutes and clusters of schools.	+++ Modelled cycle demand 3.6-5.1% commute mode share, 74-122% above Do-Minimum. Most complete network, likely to result in most significant level of mode shift.
2. Improved access to opportunities, particularly for people with low levels of transport choice	2. Triple jobs and education opportunities accessible by short cycle trips for people with low levels of transport choice by 2028	20%	- Base network serves some population concentrations with low levels of transport choice, but much of network in areas with good public transport availability. Network expansion unlikely to be sufficient to significantly lift cycle accessibility.	+ Intensified central area network focuses on areas with generally good levels of transport choice and lower concentrations of children and young people. Increases cycle accessibility for populations in central areas.	++ Network expansion focuses on selected outer-suburban areas, increasing overall transport accessibility for concentrations of children and young people and those with poor access to PT.	+++ Most complete network, most likely to increase cycle accessibility for the highest number of customers, including those with lower levels of transport choice.
3. Improved environmental, place and health outcomes	3. Triple cycle volumes in dense activity centres by 2028	10%	0 Modelled daily cycle demand across CBD cordon of 15,000 trips in 2026, 23% higher than Do-Minimum. Base network focused on serving City Centre and selected Metro and town centres.	+ Modelled daily cycle demand across CBD cordon of 15,500 trips, 26% higher than Do-Minimum. Network expansion focused on intensifying connections to central area activity centres.	+ Modelled daily cycle demand across CBD cordon of 15,000 trips, 24% higher than Do-Minimum. Network expansion serves a number of outer suburban Metro and Town centres.	++ Modelled daily cycle demand across CBD cordon of 15,500 trips, 27% higher than Do-Minimum. Most complete network serves highest number of Metro and Town centres.
	4. Increase rate of participation in regular cycling activity from 13% to 25% by 2028	10%	- Provides network within 400m of 620,000 Aucklanders, 10% more than Do-Minimum. Network expansion unlikely to be sufficient to substantially lift cycling participation.	+ Provides network within 400m of 660,000 Aucklanders, 18% more than Do-Minimum. Intensifies network in central area, with higher population density and populations with shorter trip lengths more amenable to cycling.	++ Provides network within 400m of 680,000 Aucklanders, 21% more than Do-Minimum. Intensifies network in south and west with low existing cycling participation and where greater participation may have more valuable health outcomes.	+++ Provides network within 400m of 720,000 Aucklanders, 29% more than Do-Minimum. Provides most complete network across region, most likely to lift participation.
4. Increased safety for people using bikes	5. Reduce deaths or serious injuries involving people using bikes by 10 - 20% by 2028	30%	- Base network focuses on areas with highest densities of cycle-related crashes. Extent of network improvements may not be sufficient to substantially reduce crashes alongside growth in demand.	++ Central network expansion focuses on central areas with high cycle-related crash density. More extensive network and improved facilities result in increased potential for improved safety outcomes.	+ Distributed network expansion focuses on selected outer-suburban locations with lower cycle-related crash densities than Option 2.	+++ Provides most extensive network and most potential to improve safety performance of the road network.
Total score			**-0.6**	**1.6**	**1.6**	**2.9**

---	--	-	0	+	++	+++
Very minor impact, does not achieve investment objective	Minor impact, does not achieve investment objective	Unlikely to achieve investment objective	May achieve investment objective	Likely to achieve investment objective	Likely to exceed achievement of investment objective	Likely to significantly exceed achievement of investment objective

7.3.2 Results of implementability assessment

Table 20 summarises the implementability assessment of the four shortlist options. It scores each against three criteria; impact on other transport modes, deliverability, and financial feasibility. An overall implementability score (weighted equally by the three criteria) is also provided. Further detailed analysis contributing to the feasibility assessment is provided in Appendix G, including identification of specific locations where there are risks associated with impacts on other transport modes or deliverability.

Assessment of impacts on other transport modes

This assessment involved identifying locations where indicative shortlist network plans coincided with corridors with current or forecast bus capacity constraints or corridors with current or forecast severe traffic congestion. Identification of these locations indicates *potential* for negative impacts to accompany cycle network development at these locations, if road space reallocation is required. Actual impacts on other modes will depend on detailed design considerations and impacts may be mitigated completely depending on design.

Option 4 introduces the most potential for modal conflicts due to the large scale of network development. However, it is not considered that these impacts would be so severe that they are not able to be managed or mitigated.

There is some difference in the potential for impacts on other transport modes between **Option 2** and **Option 3**. While Option 2 and 3 have a common base network, Option 3 focuses additional investment on selected outer-suburban hubs while Option 2 intensifies the central area network. Option 2 would involve making more extensive use of central-area arterial roads than Option 3, including using key links in the Central Isthmus and lower North shore. This introduces higher potential for road space reallocation in these locations to negatively impact on bus operations on high-patronage arterial routes and to exacerbate general traffic congestion.

In contrast, Option 3's focus on outer-suburban hubs (eg Manurewa, Henderson) where road space is generally less constrained than in the central area, means less potential for conflict with other modes arising from reallocation of road space for cycle network development. There are likely to be less spatial constraints on network development in Option 3's outer suburban areas, with more potential for using off-road locations for route development. In addition, public transport routes are generally less intensively used in these areas and have lower patronage, meaning less impact on public transport from potential reallocation of road space.

Option 1 has least risk of impacting on other transport modes due to the smaller scale of the network development plan. Nevertheless, network development is concentrated in central areas including the City Centre and central major arterials where there is potential for conflict with high-patronage bus routes and general traffic.

Assessment of deliverability

The assessment of the deliverability of shortlist options evaluated indicative shortlist network plans for:

- Potential complexity in construction

- Potential for delay due to dependencies on other major transport infrastructure during the 2018-2028 period.

Option 4 is assessed as having the highest risks associated with delivery. This is due to the larger scale of planned network development during the 2018-28 period which introduces increased risk of construction complexity and increased dependencies on multiple major transport infrastructure projects including AMETI, SkyPath, CRL and Isthmus-Airport Mass Transit.

Option 2 has more deliverability constraints than **Option 3.** Heavy investment in the central area where there are higher demands on road corridor space is likely to face higher levels of constraints, including interactions with other transport infrastructure that may impact on timing, increased requirements for stakeholder engagement and increased design and construction complexity. Both options have potential for some construction complexity, particularly associated with building within motorway or rail corridors. Both options have some parts of their networks that are dependent on various other major infrastructure projects.

Option 1 has the lowest deliverability risk due to the smaller scale of the programme. Delivering the programme is unlikely to introduce significant challenges beyond those experience in recent delivery of cycleway programmes in Auckland.

Assessment of financial feasibility

Option 1 is most financially feasible to deliver. A programme of $300 million would involve expenditure of approximately $30 million/ year. This is less than current expenditure by AT and the NZ Transport Agency on network development in Auckland and is considered affordable by both investment partners. Indicative funding available for the walking and cycling activity class through the NLTF is $16 million - $65 million for each of the three years, 2018/19 – 2020/21 to be allocated across New Zealand. An Auckland cycling network development programme of $30 million/ year would use approximately 25% of nation-wide funding for this activity class, assuming an NLTF FAR of 50% (with remaining 50% of investment from AT), and maximum upper bound level of expenditure for the activity class.

Option 2 and 3 both involve expenditure of $600 million over 10 years. This is similar to the level of expenditure currently being delivered in Auckland by the NZ Transport Agency and AT at present. This is considered financial feasible for both funding partners, although it may place some pressure on NLTF funding available for cycling activities in other parts of New Zealand.

Option 4 is not considered to be financially feasible under current indications of future funding availability for cycling. Spending of $90 million/ year would require $45 million of NLTF funding per year, representing 70% of total funding available throughout New Zealand for the walking and cycling activity class (assuming walking and cycling expenditure at the top of the GPS funding range). This is not considered to be a realistic level of funding as it is heavily disproportionate to Auckland's population share for the country.

Table 20: Summary assessment of shortlist options for implementability

Criteria	Weighting	Assessment: Option 1: Base Network	Option 2: Base + Intensified Central	Option 3: Base + Suburban Hubs	Option 4: Base + Intensified Central + Suburban Hubs
1. Conflict with other transport modes	33%	- Potential for some sections of indicative network development plan to conflict with other modes using road corridor space. Impacts depend on detailed facility design, however may impact on congested bus corridors and congested arterial roads in the City Centre and Central area.	-- Potential for many sections of indicative network development plan to conflict with other modes using road corridor space. Increased density of network in central areas with high demands on constrained road corridors introduces additional areas for potential modal conflict compared with Option 1.	- Potential for some sections of indicative network development plan to conflict with other modes using road corridor space. Network expansion additional to the base network focuses on outer suburban areas with generally lesser demands on road corridor space than in central areas.	-- Potential for many sections of indicative network development plan to conflict with other modes using road corridor space. Option combines both Option 2 and 3 introducing potential conflicts in both central and outer suburban areas.
2. Deliverability	33%	0 Potential for complexity in construction for some on-street separated cycle paths on central arterial roads, and some potential use of motorway/ rail corridors. Few dependencies on other major infrastructure projects mean few constraints on timing of implementation.	-- Potential for complexity in construction and stakeholder engagement for intensification of central area network and use of arterial roads, and potential use of motorway/ rail corridors. Delivery of some sections of new network depends on other planned major transport projects, including CRL and Isthmus-Airport Mass Transit.	- Potential for complexity in construction for with potential use of Southern motorway/ rail corridors. Dependencies on other projects including AMETI and Isthmus-Airport Mass Transit may impact on timing of implementation.	--- Potential for complexity in construction for many sections of network on central arterial roads, and potential use of motorway/ rail corridors. Delivery of multiple sections of new network depends on other planned transport projects, including Isthmus Mass Transit corridors, AMETI and SkyPath.
3. Financial feasibility	33%	+ 50% lower level of expenditure than current year. Affordable within GPS funding ranges.	0 Similar level of expenditure to current levels by AT and the NZ Transport Agency. May place pressure on NLTP.	0 Similar level of expenditure to current levels by AT and the NZ Transport Agency. May place pressure on NLTP.	--- 50% higher expenditure compared to current levels. Will be unaffordable for both funding partners under current indications of funding availability.
Total score		**0**	**-1.3**	**-0.7**	**-2.6**

---	--	-	0	+	++	+++
Significant adverse impact with serious long term effects	Moderate adverse impact, that may be managed or mitigated	Minor adverse impact, that may be managed or mitigated	Neutral impact	Minor positive impact	Moderate positive impact, which may provide improvements and opportunities	Significant positive impact, likely resulting in long term improvements

7.3.3 Results of demand modelling and economic evaluation

Table 21 summarises the results of forecasting cyclist demand under then 2013 base case, and in 2026 for the Do-Minimum and four shortlist options. Results are reported under two demand growth scenarios to produce a range of forecast demands:

- Linear trends, where growth in cycling has been based on the observed, linear response between cycle investment and cycle demands across Auckland from 2013 to 2016, which have increased in areas where cycle infrastructure has been improved. This historic relationship has been formed in the context of Auckland's existing, relatively incomplete and disjointed cycle network.

- Expected growth, where growth in cycling is expected to accelerate in future, if significant cycle infrastructure investment across Auckland results in a more complete and connected network. This phenomenon is related to the 'safety in numbers' and 'critical mass' effects, where increasing numbers of visible cyclists encourage more users to take up cycling, and is documented by Macmillan et al (2014).[28]

Table 21: Summary cycle demand modelling results

		2026				
	2013 Base	**Do Minimum**	**Option 1. Base Network**	**Option 2. Base + Intensified Central**	**Option 3. Base + Suburban Hubs**	**Option 4. Base + Intensified Central + Suburban Hubs**
Linear Trends						
Total modelled cycle trips (annual average daily)	11,800	27,400	36,900 (+35%)	43,000 (+57%)	41,600 (+52%)	47,700 (+74%)
Total modelled cycle distance (annual average daily, km)	75,500	161,700	209,100 (+29%)	238,100 (+47%)	237,200 (+47%)	265,200 (+64%)
Approximate commute to work cycle mode share	1.1% [29]	2.1%	2.8%	3.3%	3.2%	3.6%
Expected Growth						
Total modelled cycle trips (annual average daily)	11,800	30,100	44,900 (+49%)	58,300 (+93%)	53,700 (+78%)	67,000 (+122%)
Total modelled cycle distance (annual average daily, km)	75,500	174,500	243,500 (+40%)	305,800 (+75%)	293,100 (+68%)	353,800 (+103%)
Approximate commute to work cycle mode share	1.1% [30]	2.3%	3.4%	4.4%	4.1%	5.1%

Percentages relative to Do Minimum.

The results show that under the linear trend demand scenario, cycling trip numbers are predicted to be 35% higher with implementation of Option 1, Base Network, than under the do-minimum. Options 2 (Base+ Intensified Central) and 3 (Base + Suburban Hubs) include

[28] The Societal Costs and Benefits of Commuter Bicycling: Simulating the Effects of Specific Policies Using System Dynamics Modelling; *Macmillan, Connor, Witten, Kearns, Rees and Woodward*; April 2014.
[29] From 2013 Census data
[30] From 2013 Census data

additional investment which sees further growth in predicted demand to 57% and 52%, respectively, above the do-minimum. Under Option 4, high investment cycling trip numbers are forecast to be 74% higher, relative to the do-minimum. Modelled cycle distance grows at a slightly slower rate than trip numbers for all options suggesting that new trips induced by the investment are likely to be, on average, slightly shorter than those under the do-minimum. Approximate cycling commute to work mode shares are predicted to increase from 2.1% under the do-minimum to between 2.8% and 3.6% for the Auckland region.

Under the expected growth demand scenario, demand is predicted to be higher across all options. Option 2 performs better than Option 3 as the former delivers a more connected, cohesive network within central Auckland, which is predicted to accelerate growth in demand within this area. Modelled commute mode shares are predicted to increase to between 3.4% (Option 1) and 5.1% (Option 4).

The above table additionally shows the 2013 modelled cycle trips and cycle mode share from census, demonstrating the approximate existing network conditions against which the investment options may be benchmarked. It can be seen that substantial growth in cycling trips are predicted under all four investment options relative to today, with increases in total cycle trips in the order of +200% (Low investment, linear trends) to +470% (high investment, expected growth).

Table 22 summarises the predicted benefits and costs from the four shortlisted options. Benefits are reported across four scenarios; 'linear trend demand growth' and 'expected growth demand trends' and for each demand scenario a 'flat congestion' and 'increasing congestion' approach to calculating decongestion benefits. This produces a range of benefit levels and benefit cost ratios (BCRs). Further details on the approach to developoing the two scenarios for calculating decongestion benefits are included in the supplementary Demand and Economic Assessment report.

Table 22: Summary economic evaluation results - projected benefit cost ratios for shortlist options

Benefit Stream	Option 1. Base Network	Option 2. Base + Intensified Central	Option 3. Base + Suburban Hubs	Option 4. Base + Intensified Central + Suburban Hubs
Discounted Costs				
All methods	$217 million	$432 million	$431 million	$639 million
Discounted Benefits				
Linear Trend				
Flat congestion	$505 million	$837 million	$800 million	$1,115 million
Increasing congestion	$773 million	$1,277 million	$1,227 million	$1,705 million
Expected Growth				
Flat congestion	$764 million	$1,442 million	$1,277 million	$1,938 million
Increasing congestion	$1,176 million	$2,218 million	$1,968 million	$2,984 million

Benefit Stream	Option 1. Base Network	Option 2. Base + Intensified Central	Option 3. Base + Suburban Hubs	Option 4. Base + Intensified Central + Suburban Hubs
Benefit Cost Ratio				
Linear Trend				
Flat congestion	**2.3**	**1.9**	**1.9**	**1.7**
Increasing congestion	**3.6**	**3.0**	**2.8**	**2.7**
Expected Growth				
Flat congestion	**3.5**	**3.3**	**3.0**	**3.0**
Increasing congestion	**5.4**	**5.1**	**4.6**	**4.7**

The total level of predicted benefits under all scenarios is highest under Option 4, reflecting the larger network enabled by this investment and higher levels of cyclist demand. However, the highest BCRs under all scenarios are for Option 1, Base Network, suggesting that this option produces the highest return on investment. Nevertheless, across all scenarios, BCRs between options do not vary substantially with a range of 1.7 to 2.3 (under the linear trend demand forecast and flat congestion scenario) to 4.6 to 5.4 (under the expected growth demand forecast and increasing congestion scenario).

BCRs are similar for Options 2 and 3. This reflects thatm predicted cycle demands are not dramatically different between the central and distributed approaches to investment. However, under the expected growth demand or increasing congestion demand scenarios, the BCRs of Options 2 and 3 do diverge, with Option 2's BCR higher, reflecting higher forecast cyclist demand.

Table 23 reports on the distribution of benefits across the four benfit streams. Most of the monetised benefits are attributable to health and decongestion benefits, with safety and travel time cost savings making only minor contributions to the total benefit levels.

Table 23: Projected benefits by benefit stream, Linear Trend demand scenario (discounted)

Benefit Stream	Option 1. Base Network	Option 2. Base + Intensified Central	Option 3. Base + Suburban Hubs	Option 4. Base + Intensified Central + Suburban Hubs
Health and environment benefits for cyclists	$294 m	$484 m	$468 m	$646 m
Safety benefits for cycle facilities	$11 m	$21 m	$18 m	$28 m
Travel time cost savings for cyclists	$13 m	$27 m	$19 m	$34 m
Decongestion benefits (flat congestion)	$186 m	$304 m	$295 m	$407 m
Total Benefits (flat congestion)	**$505 m**	**$837 m**	**$800 m**	**$1,115 m**
Decongestion (increasing congestion)	$454 m	$744 m	$722 m	$997 m
Total Benefits (increasing congestion)	**$773 m**	**$1,277 m**	**$1,227 m**	**$1,705 m**

To enable integration of the economic evaluation with the other criteria for shortlist assessment, the economic evaluation results are standardised to the 7-point score used for the other criteria (+3 to -3). The score for economic evaluation is calculated by averaging the BCR for each option across the four evaluation scenarios and standardising this to a score where +3= a BCR of 5 (high economic efficiency), 0= a BCR of 1 and a negative score=a BCR of less than one. The summary scores are provided in Table 24.

Table 24: Summary scores, economic evaluation

	Option 1. Base Network	**Option 2. Base + Intensified Central**	**Option 3. Base + Suburban Hubs**	**Option 4. Base + Intensified Central + Suburban Hubs**
Average BCR	3.7	3.3	3.1	3.0
Score (+3 to -3 scale)	2.0	1.7	1.6	1.5

7.3.4 Overall summary assessment

Table 25 summarises the scoring across all three types of assessment, taking the scores from the discussion in the previous sections. A total score for each option is provided, based on equal weighting across the three types of assessment; achievement of investment objectives, implementability and economic efficiency. The options are ranked from 1 to 4, with (1) being the highest scoring option.

The overall scoring shows that Options 2 and 3 stand out as performing most highly. Option 1 scores more poorly due to being less likely to achieve some of the investment objectives with the lower level of network investment (despite having the highest level of economic efficiency). Option 4 scores poorly due to lower economic efficiency associated with a high investment level programme and likely implementation challenges.

Option 2 and 3 score similarly for their contribution to the investment objectives and for economic efficiency. Option 3 scores more highly overall due to a higher implementability score. The key differences between Option 2 and 3 include:

- *Achievement of investment objectives:* While both options score the same overall for their contribution to the five objectives, there are differences in their contribution to individual objectives. In particular:
    - Option 3 has more potential for contributing to investment objective 2; improving transport accessibility for those with low levels of transport choice. This reflects more extensive network development in outer-suburban locations where public transport options are poorer and where there are denser populations of children and young people and higher levels of socio-economic deprivation.
    - Option 3 has more potential for contributing to investment objective 4; increased participation in cycling (for the purpose of achieving health benefits). This reflects the more extensive spread of the network across a greater number of Auckland areas, providing facilities accessible to more residents and the focus of investment on areas of higher socio-economic deprivation where potential for health benefits may be greater.
    - Option 2 has more potential for contributing to investment objective 5; reduced cycle crashes. This is due to focusing investment on locations where current cycle crash rates are highest.

- *Implementability:* Option 3 scores better for implementability, with network development spread across a broader area less likely than an intensified central area network to encounter challenges associated with impacts on other transport modes, including buses and general traffic on congested corridors.

- *Economic efficiency:* Demand modelling finds similar levels of cycle demand uplift for both Options 2 and 3 that is reflected in broadly similar BCRs. The modelling does, however, predict that Option 2 will result in slightly higher cycling demands and higher levels of economic benefits, particularly under scenarios of growing future congestion. This reflects that Option 2 intensifies the network in locations where average trip lengths are shorter (more amenable to cycling) and population densities are higher.

Overall, Option 3 is assessed as the highest performing shortlist option. It contributes more to a broader range of the investment objectives and is more easily implementable than Option 2.

Table 25: Summary scoring of shortlist

Criteria	Weight-ing	Assessment			
		Option 1 – Base Network	**Option 2 – Base + Intensified Central**	**Option 3 – Base + Suburban Hubs**	**Option 4 – Base + Intensified Central + Suburban Hubs**
1. Contribution to achievement of investment objectives	33%	-0.6 Likely to achieve some, but not all, investment objectives	+1.6 Likely to achieve all investment objectives. Scores higher than Option 3 for achieving safety objectives	+1.6 Likely to achieve all investment objectives. Scores higher than Option 3 for achieving accessibility and health objectives	+2.9 Likely to exceed investment objective targets across all objectives
2. Implementability	33%	-0.5 Implementation likely to involve some challenges with impacts on other modes that can be managed or mitigated. Likely to be financially affordable.	-1.3 Implementation likely to be challenged by impacts on other modes and minor construction complexity and project dependencies. Likely to be financially affordable.	-0.7 Implementation likely to involve some challenges with impacts on other modes and minor construction complexity and project dependencies. Likely to be financially affordable.	-2.6 Implementation likely to be challenged by impacts on other modes, and some construction complexity and dependencies with other transport projects. Unlikely to be affordable.
3. Economic efficiency	33%	+2.0 High level of cycling demand impact and associated economic benefits from lowest cost programme.	+1.7 Cycling demand and economic benefits increase with scale of programme. Demand and associated benefits slightly higher than Option 3 under increasing congestion and accelerated demand scenarios.	+1.6 Cycling demand and economic benefits increase with scale of programme.	+1.5 Cycling demand and economic benefits increase with scale of programme. Some diminishing returns from additional investment.
Total score	**100%**	**0.47**	**0.67**	**0.82**	**0.59**
Rank		**4**	**2**	**1**	**3**

8 RECOMMENDED PROGRAMME

8.1 Programme overview

The recommended programme for Auckland cycling during the period 2018-2028 includes two elements:

1. Development of the Auckland cycling network
2. A package of other initiatives to complement network development.

The recommended programme for network development has been established on the basis of findings from the shortlist assessment. The package of complementary initiatives is based on the initial assessment of policy tools (Section 6.1) and further analysis included in Supplementary Material, Section 4.1. The following sections summarise the recommended programme.

A number of components of cycle-related investment and policy-intervention for Auckland are excluded from the scope of the recommended programme for the ACPBC:

- Network development components excluded from scope:
  - Network development is for the existing urbanised area of Auckland. Cycle network development for future urban areas is assumed to be funded and planned through the 'Supporting Growth' planning and business case process.
  - Cycle network facilities that have no substantial transport function (eg do not serve commute or other everyday trips) are excluded. This means facilities such as mountain bike trails, bridalways and recreational cycle facilities are excluded. It is acknowledged, however, that all cycle facilities will have significant recreational use.
  - Recommended network development includes guidance for the NZ Transport Agency Highway and Network Operations-led investment in stand-alone cycle infrastructure projects within State Highway corridors but excludes recommendations on network development that may accompany major State Highway upgrade projects.

- Complementary initiatives excluded from scope: a number of potential policy tools that may impact on cycling uptake or cycling safety have been excluded. Section 6.1 outlines the types of policy tools identified as relevant to the ACPBC and those excluded. Policy tools outside the jurisdiction of the investment partners, tools that are unlikely to have a major impact on achievement of investment objectives or tools that have been recently the subject of decision-making processes are excluded from scope.

8.1.1 Recommended approach to development of the Auckland cycling network

Target customers and trip types for network development

Development of the Auckland cycling network needs to provide for a broad range of customers, to maximise potential for increased cycling uptake. This will require high-quality facilities that reduce real and perceived safety risks.

Investment in new cycling network facilities should also target serving particular trip types that are more amenable to cycling and trip types where mode shift to cycling would benefit the wider transport system. This will mean targeting investment to serve the following trip types:

- Short-medium distance trips (1-7km, or less than 30 minutes easy cycling time) where cycling provides a viable transport choice relative to other modes.
- Short-distance trip-legs (1-3km) that connect with longer-distance journeys using RTN modes.
- Trip types that have potential to encourage mode shift from private vehicles or public transport on congested corridors (eg peak period commute trips).

Some investment in new cycling network development should target serving populations with lower levels of transport choice, as providing a cycling option to these populations (eg children and young people, or those with poor access to good public transport) is likely to provide additional value to these user groups in increasing their accessibility to jobs and education opportunities.

Planning and design principles for network development

Network development in Auckland should follow best-practice cycle network planning principles (see Supplementary Material, Section 2.2.2). This means:

- Selecting routes that provide direct access to key destinations and follow corridors of high (current or latent) demand
- Selecting routes that link with other parts of the network to form a coherent and legible network
- Establishing an appropriate network density, with a finer-grained network in areas of higher demand
- Selecting routes that are attractive for users and that offer a pleasant, interesting, safe and secure environment
- Selecting routes that minimise major gradient changes.

The indicative network development maps for the recommended programme and network concepts developed for the longlist and shortlist assessment processes have followed these principles.

Facilities should be appropriate to the route and surrounding context. The indicative network development plan uses four generic facility types that are appropriate for different contexts:

- Mixed traffic cycle facilities (eg traffic calming or 'local path' treatments) – appropriate for low traffic volume, low traffic speed streets.
- On-street painted cycle lanes – appropriate for medium traffic volume/ speed streets.
- On-street separated cycle paths – appropriate for high traffic volume/ speed streets.
- Off-street dedicated or shared cycle paths – appropriate where routes pass through parks or reserves.

Recommended level of investment in network development, 2018-2028

The recommended level of investment in network development is $60 million per annum (or $600 million over the ten-year programme period). This includes AC and the NZ Transport Agency co-funding of AT-led investment within local road corridors and the NZ Transport Agency funding of the NZ Transport Agency Highway and Network Operations investment within stand-alone cycle facilities within state highway corridors (eg Seapath). The recommended level of investment is similar to that currently being undertaken by AT and the NZ Transport Agency during the 2016/17 year.

This level of investment is considered to be sufficient to develop a network of appropriate scale and quality to achieve the programme's investment objectives. A lower level of investment ($300 million) with limited expansion of the cycling network, is unlikely to achieve investment objectives.

Economic evaluation found that this level of investment would be economically efficient, with a BCR in the range of 1.9 to 4.6. While incremental analysis of BCRs found that a higher level of investment ($900 million) would also provide additional net benefits, the higher level of investment is considered less implementable and not affordable within the context of national and local funding availability.

'Early start' focus areas for 2018-21 network development

The recommended focus areas for 'early start' during the 2018-21 period are based on the areas and indicative networks identified for shortlist Option 3 (Base + Suburban Hubs). This follows the shortlist assessment that found this approach to investment would achieve the investment objectives, be implementable and economically efficient. The indicative network planning for this option found that approximately 150km of high-quality facilities could be implemented within the $600 million budget over 10 years.

Table 26 identifies focus areas for an early start on network development during the first three years of the programme, 2018-21. It also identifies indicative investment levels for each area. It is not expected that all construction will necessarily be completed within these areas within the first three years of the programme. These areas are based on high priority components of the base network (shortlist option 1) that are implementable in the early years of the programme and have few dependencies with other major planned transport infrastructure projects or land-use changes.

Table 26: 'Early start' focus areas for network development, 2018-21

Area	Indicative cost	Network development approach	Complementary activities
City Centre and Fringe	$$$	Provide for city centre access on key demand corridors. City centre gridded network <250m spacing. Minor improvements in the recently developed network. Increase overall transport capacity on congested corridors. Integration with rapid transit stops/stations. Fix cycle safety blackspots.	Marketing and promotion Public cycle parking Investigate cycle share Speed management Cycle lane enforcement Wayfinding and signage
Inner West	$	Enhance links to NW cycle path. Improve local neighbourhood links to schools, town centres – demonstration neighbourhood approach.	Marketing and promotion Public cycle parking Investigate cycle share Speed management Cycle lane enforcement

Area	Indicative cost	Network development approach	Complementary activities
Central Isthmus	$$$	Provide for city centre access on key demand corridors Begin east-west connections Grid spacing 600-800m Connect main routes with neighbourhood traffic calming/ greenways, particularly around school clusters Integration with rapid transit stops/stations Fix cycle safety blackspots.	Marketing and promotion Public cycle parking Investigate cycle share Speed management Cycle lane enforcement Wayfinding and signage
Sandringham	$	East-west link, crossing main trunk north-south routes and linking to MAGS.	Speed management
Devonport/ Belmont	$$	Links to Devonport and Bayswater ferry services. Complete main spine link from Takapuna to Devonport. Improved access to local schools. Connect to existing north-south local path along the western side of the peninsula.	Public cycle parking Wayfinding and signage Speed management
Glenn Innes - Panmure	$	Enhance connections to Tamaki – Glen Innes Path	Public cycle parking
Mangere East	$$$	Link with recent investment. Provide access to town centres, RTN stations, Middlemore Hospital and schools. Connect trunk routes with neighbourhood traffic calming.	Marketing and promotion Public cycle parking Speed management Wayfinding and signage
Te Atatu Peninsula	$$	Improve neighbourhood cycling – demonstration neighbourhood approach Enhance links with NW cycleway.	Marketing and promotion Public cycle parking Speed management
Henderson	$$	Provide short trip access (less than 15mins cycling) to metro centre, RTN station "Last Mile" connections from existing cycle paths to centre and RTN station Provide links to cluster of high enrolment schools. Connect existing routes with neighbourhood traffic calming/ greenways Provide enhanced connections to NW cycleway	Marketing and promotion Public cycle parking Speed management Wayfinding and signage

'Later start' focus areas for 2022-28 network development

Table 27 identifies recommended focus areas for the later seven years of the programme. These areas follow those identified for Shortlist Option 3 and are recommended for later implementation due to interactions with other major transport projects or having slightly lower potential to contribute to investment objectives. The table also lists complementary initiatives for each area. Some areas with lower existing cycle mode share and less developed existing networks will require higher levels of complementary marketing and public engagement to support network development. These areas include parts of South and West Auckland.

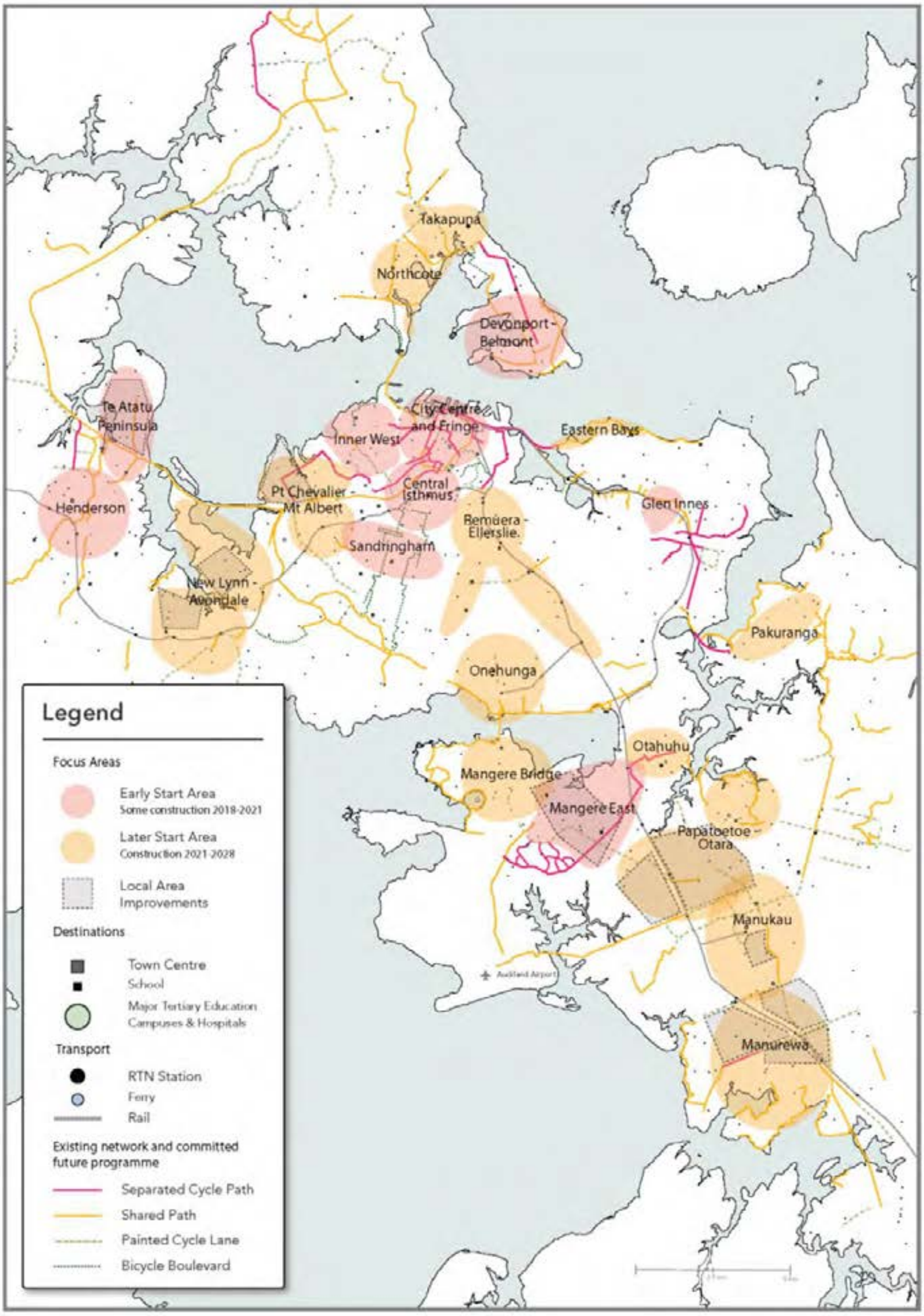
Table 27: 'Later start' focus areas for network development, 2022-28

Area	Indicative cost	Network development approach	Complementary activities
Point Chevalier - Mount Albert	$$	Links between town centres, RTN station, parks and schools, leveraging recent investments. East-west link, connect into Central Isthmus grid.	Marketing and promotion Cycle lane enforcement Speed management
New Lynn - Avondale	$$$	Links along and between main trunk roads. Enhance links to NW cycle path.	Speed management Public cycle parking

Area	Indicative cost	Network development approach	Complementary activities
		Improve local neighbourhood links to schools, town centres – demonstration neighbourhood approach. Link with Waterview and New Lynn paths. Provide access to metro centre and RTN stations. Provide links to schools.	Wayfinding and signage
Remuera - Ellerslie	$$	New trunk route providing access to City Centre via Newmarket. North-south connections to trunk route to Onehunga and beyond.	Cycle lane enforcement
Onehunga – Mt Wellington	$$	Linking to town centre, several schools. Focus on north-south connections and into fine grain suburban street grid.	Speed management
Eastern Bays	$	Provide for city centre access on key demand corridors Upgrade existing sub-standard facilities. Fix cycle safety blackspots.	Public cycle parking
Manukau	$$$	Integrate with Metro centre streetscape upgrades Focus on access to RTN station, Metro centre and links over SH 1 and SH20 motorways Upgrade some existing cycleways.	Marketing and promotion Public cycle parking Speed management Wayfinding and signage
Otahuhu	$$	Separated routes on busy roads through the town centre and on toward Mangere and to train station. Local paths improvements facilitating access to schools.	Speed management Public cycle parking
Papatoetoe - Otara	$$$	Provide access to town centre, RTN station and schools. Links between centres over SH 1 motorway. Connect trunk routes with neighbourhood traffic calming/ greenways.	Speed management Public cycle parking Wayfinding and signage
Mangere Bridge	$$	Link with recent investment. Connect trunk routes with neighbourhood traffic calming/ greenways. Provide access to schools, town centres and RTN stations. Develop long distance path: Airport to City.	Marketing and promotion Public cycle parking Speed management Wayfinding and signage
Manurewa	$	Provide access to town centre, RTN station and schools. Connect trunk routes with neighbourhood traffic calming/ greenways.	Marketing and promotion Public cycle parking Speed management Wayfinding and signage
Pakuranga	$$	Link with planned AMETI cycleway investment, passes several major schools. Grossamer Drive and Ti Rakau Drive connector routes linking major roads with separated facilities. Pass two schools, improve access to others and residences. Provide access to town centre, RTN stations and schools.	Public cycle parking
Northcote - Glenfield	$$	Construction of Seapath link with Skypath (only Skypath is included in the Do-Minimum). Feeder routes to Seapath.	Wayfinding and signage
Takapuna	$	Provide access to Takapuna metro centre and Smales Farm/ Akoranga RTN stations. Enhance links to clusters of high enrolment schools.	Public cycle parking

The following maps illustrate the location of network development for the recommended programme.

Figure 26: Recommended focus areas for network development, 2018-28



8.1.2 Recommended initiatives to complement network investment

Alongside implementing the recommended approach to cycle network development, it is also recommended to invest in a package of infrastructure, service, regulatory, enforcement and information-based initiatives that can complement network development and contribute to the programme objectives.

Assessment of a range of policy interventions (see Section 6.1) found that while network development will be critical for achieving the programme's objectives, it will also be more effective if complemented by a package of additional interventions that can be led by the programme investment partners. Interventions that influence the uptake of cycling and cycle safety through means other than improving the cycle network are widely shown internationally to form a part of successful cycling policy packages.

The recommended package of complementary initiatives is summarised in Table 28. The total indicative cost of the package is $35 million over 10 years (note this is in addition to the $600 million for cycle network proposed in section 10.1 above) with the most substantial costs associated with marketing, promotion and events ($20 million), cycle training programmes ($10 million) and public cycle parking ($5 million). The recommended programme involves modest increases to existing budgets for marketing, promotion and events, cycle training and public bike parking and new expenditure on investigation of bike share. The level of spending on complementary initiatives does not include expenditure for implementing Bike Share. Capital and operating costs for this initiative may be significant (in the order of $40 - $90 million over 10 years) and further investigation is recommended ahead of funding decisions on this initiative.

Table 28: Recommended package of initiatives to complement network development, 2018-28

Initiative	Recommended approach	Indicative investment 2018-28
Public cycle parking (AT lead)	Deliver targeted development of cycle parking facilities. Potential for installation of approx. 5,000 additional short-stay parking spaces. Further investigation of secure, long-stay parking at RTN stations.	$5 million
Public bike share scheme (AT lead)	Undertake a feasibility study on a bike share scheme for central Auckland to further understand potential benefits costs, success factors and constraints. Implementation of any scheme is likely to be most effective later in the programme period, after improvements to the central area network are complete.	$0.5 million (investigation) $10-$20 million+ (initial capital costs) $3-7 million p.a. (operating costs)
Bikes on buses	Further investigation of feasibility and benefits. Initial trial on two suburban bus routes.	Unknown.
Speed management on urban streets (AT lead)	Incorporate cycle route priorities on the urban network into AT's Speed Management Implementation Plan.	NA.
Road rule changes (NZ Transport Agency lead)	AT to further investigate responses to the proposed road rule changes. Some concerns about current proposal outstanding.	NA.
NZ Police enforcement – road speeds and driver-cyclist interactions (NZ Police lead)	Continue working with Police on speed enforcement at high-risk locations, areas of increased cycling including schools, town centres and commuting routes. Continue to promote greater use of enforcement technology (fixed speed cameras).	Unknown.
Cycle lane enforcement (AT lead)	AT to deliver ongoing enforcement of vehicle use of on-street dedicated cycle paths. Opportunities for integration with parking enforcement.	Unknown.
Marketing, promotion and events	A continuation and targeted escalation of marketing, promotion and events efforts should be applied for the 2018-2028 programme, specific to	$1.7 – $2.0 million p.a. ($20 million over 10-year programme)

Initiative	Recommended approach	Indicative investment 2018-28
(AT lead, NZ Transport Agency co-funding)	local conditions and in unison with development of the cycle network and other initiatives such as changes to road rules. Increase funding from current $1.7 million to $2.0 million per annum.	
Travel behaviour change (AT lead, NZ Transport Agency co-funding)	Continuation of current schools and business travel behaviour change programmes.	Integrated with marketing and promotion budget.
Cycle training (AT/ NZ Transport Agency Lead) ,	Cycle training should be developed alongside improvements to the cycle network between 2018-2028. Education efforts should be focused on a comprehensive, widely operational programme for children and adults, as being investigated by the Transport Agency. Training initiatives should be targeted to areas with cycle infrastructure and not delivered in isolation, but rather delivered as part of a wider programme of events, campaigns and road safety initiatives.	$1 million p.a. ($10 million over 10-year programme)
Cycle way-finding signage and maps (AT and the NZ Transport Agency)	The implementation of comprehensive signage system is recommended that positively reinforces the development of the cycle network. In parallel, investigate wayfinding facilitation using the latest technology to ensure relevance with the largest group of actual and potential users is maintained.	Unknown. Signage generally included in network development costs.

8.2 Programme implementation strategy and trigger points

8.2.1 Timing of network development and complementary elements of the programme

The recommended programme proposes ongoing investment over the ten-year period providing for incremental development of the cycling network and ongoing complementary initiatives such as promotional and marketing activities.

It is recommended that further cycle network investment is made ahead of any substantial increase to spending on marketing or training initiatives or implementation of new services such as bike share. Experience in international contexts suggests that provision of high quality cycling network infrastructure is a pre-requisite for effective implementation of bike share. Similarly, investments in promotion and training are likely to be more effective in promoting behaviour change if high quality, safe network infrastructure that is attractive to a wide range of users is available.

8.2.2 Role of investment and delivery partners

The recommended programme will be led by AT, and co-funded by the NZ Transport Agency through the NLTF. This includes network and complementary initiatives. Components of network development using state highway corridors will be led by the NZ Transport Agency's Highway Network Operations division.

8.2.3 Cycling network implementation

The recommended programme involves spreading network development investment across the ten-year programme period. This allows for incremental development of the network and reduces any delivery risks associated with construction industry or internal AT planning capacity constraints.

It is likely that initial implementation of the 2018-28 network development programme during the 2018/19 and 2019/20 will be affected by ongoing implementation of the UCF programme from the 2015-18 funding period. A number of large-scale projects from the UCF programme remain to be implemented after 2017/18 and may impact on the capacity of AT and the industry to deliver a full $60million programme during years 1 and 2.

Implementation of network development will need to be aligned with other major transport projects and land-use changes. Currently planned major projects that are likely to impact on the timing of elements of the network include:

- CRL – impacting on some City Centre routes
- Isthmus-Airport mass transit – impacting on City Centre and Central Isthmus routes
- AMETI – impacting on network development in Pakuranga
- Skypath – impacting on timing of network development in the North Shore
- Airport access projects on State Highways 20A/B.

There will be ongoing opportunities for integrating network development with routine road renewals activities. These opportunities may reduce the cost of delivery and as a result it is recommended that AT seek to identify opportunities to align network development with road renewals where it will not affect delivery timeframes by more than 1 year in either direction. However, it is recommended that the sequencing of cycle network development is not dictated by road renewals programmes as this risks implementing projects of lower priority earlier (only because they coincide with routine renewals timetables).

Planned major land-use changes that may influence the timing of implementation include Panuku initiatives for town and metro centre revitalisation projects. These present opportunities for integrating delivery of cycle networks alongside other streetscape upgrades.

8.2.4 Monitoring achievement of objectives

The implementation of the programme will need to be accompanied by ongoing monitoring against the achievement of the project benefits and five investment objectives. This will require ongoing data collection, analysis and reporting and collection of new data.

Data sources for monitoring programme performance will include:

- AT cycle counter data – the current network of cycle counters will need to be expanded to enable a more comprehensive region-wide picture of cycling demand. Introduction of counters before implementation of new facilities is recommended for monitoring demand changes arising from facility upgrades.

- AT Active Mode Survey – it is recommended that AT's current annual Active Mode Survey is continued and enhanced to gain information about perceptions of cycling and levels of population participation in cycling.
- Census data – analysis of 5-yearly census data will be required to assess performance against mode shift targets.
- Crash data – ongoing monitoring and reporting of cycle-related crash data from the NZ Transport Agencys Crash Analysis system will be required to assess performance against safety objectives.
- Construction cost rates – ongoing monitoring and reporting of facility out-turn construction costs will assist in ongoing planning of network implementation.

In addition, it is recommended that AT and the NZ Transport Agency identify and pursue opportunities to undertake post-implementation reviews of recent cycle facility investments to understand how they have performed against objectives and identify learnings for planning, designing, and modelling future projects.

8.2.5 Reviewing the ACPBC

It is recommended that the ACPBC is reviewed on a three-yearly basis in line with planning and funding timetables. This will provide for opportunities to incorporate findings from post-implementation reviews and adjust recommended focus areas and approaches to network development and complementary initiatives to best achieve programme objectives.

9 RECOMMENDED PROGRAMME – ASSESSMENT

This section provides an assessment of the recommended programme, based on three criteria:

- Programme outcomes – how the programme meets the desired investment objectives.
- Risks – areas of risk for the programme including technical, stakeholder and financial risks.
- Value for money – expected economic efficiency of the investment.

This section draws on the assessment of shortlist options provided in Section 7.3, and particularly the results for shortlist option 3 which forms the basis for the network development component of the recommended programme.

9.1 Programme outcomes

Table 29 summarises the assessment of the recommended programme against the programme's investment objectives and desired benefits. The programme is likely to achieve the full range of investment objectives through provision of an expanded high-quality cycle network for Auckland that makes cycling more attractive, safer cycling facilities that reduce crash risks and a complementary package of promotion, training, enforcement and other initiatives.

Table 29: Summary assessment of recommended programme against programme benefits and investment objectives

Benefit	Investment objective	Assessment
1. Cycling plays a greater role in meeting Aucklanders' transport needs	IO1. Triple cycle mode share from 1% to 3% of total journey to work/ education trips by 2028 (30%)	++ Modelled cycle demand from network development results in 3.2 – 4.1% commute mode share, 50 - 90% above mode share under the Do-Minimum and exceeding the target. Initial network expansion focused on central areas with high congestion levels and populations with shorter trip lengths, more amenable to mode shift. Later network expansion targets selected outer-suburban areas in South and West with relatively high population densities and connections to RTN stations, schools and town centres. Complementary promotion, training and other initiatives will further encourage mode shift.
2. Improved access to opportunities, particularly for people with low levels of transport choice	IO2. Triple jobs and education opportunities accessible by short cycle trips for people with low levels of transport choice by 2028 (20%)	++ Network expansion targets selected outer-suburban areas in South and West Auckland with high population densities, densities of children and young people and areas with poor access to frequent public transport. Network development will increase overall transport accessibility for residents of these locations. Network development focuses on serving major employment centres (City Centre, Metro centres) and clusters of high-enrolment schools, increasing access to jobs and education opportunities.

		Modelled cycle demand shows strong increases in demand in South and West Auckland, areas with generally lower levels of transport accessibility. Targeted promotion, training and other initiatives will enhance accessibility benefits provided by network development by increasing customer awareness of new facilities.
3. Improved environmental, place and health outcomes	IO3. Triple cycle volumes in dense activity centres by 2028 (10%)	+ Modelled daily cycle demand across CBD cordon of 15,000 trips, 24% higher than Do-Minimum and more than triple 2013 levels. Initial network expansion focused on improving access to City Centre. Later network development targeted at outer-suburban Metro and Town centres.
	IO4. Increase rate of participation in regular cycling activity from 13% to 25% by 2028 (10%)	++ Provides network within 400m of 680,000 Aucklanders, 21% more than Do-Minimum. Intensifies network in south and west with low existing cycling participation and where greater participation may have more valuable health outcomes. Modelled cycle demand shows increase in average daily cycle trips from 12,000 in 2013 to 27,400 in 2026 under the Do-Minimum scenario and to between 42,000 and 54,000 under the recommended programme. Complementary training and promotion activities will encourage broader participation in cycling.
4. Increased safety for people using bikes	IO5. Reduce deaths or serious injuries involving people using bikes by 20% by 2028 (30%)	+ Initial network investment focused on City Centre and central area with highest rate of existing cycle crashes. Outer-suburban investment targeted at locations with relatively high overall road crash rates. Complementary speed management and police enforcement programme will contribute to improved safety outcomes.

0	+	++	+++
May achieve investment objective	Likely to achieve investment objective	Likely to exceed achievement of investment objective	Likely to significantly exceed achievement of investment objective

The assessment provides an indication of the likelihood of achieving the investment objectives. If finds high confidence that investment objectives 1 and 2 will be achieved or exceeded by the programme. Demand modelling shows that the indicative network for the recommended programme will increase mode share to at least 3% by 2028, achieving the mode share target under investment objective 1. It also shows that cycling demand is predicted to grow particularly strongly in Central, South and West Auckland, reflecting improved transport accessibility for areas with lower levels of transport choice (contributing to investment objective 2).

Table 30 summarises cycle demand modelling results across different parts of the Auckland urban area for shortlist option 3 (which forms the basis of the network development components of the recommended programme). It shows that cycle demand is forecast to increase across all areas, with particularly strong growth in daily trips in Central Auckland (over 7,000 additional trips) and South Auckland (4,400 additional trips). On a proportionate basis, growth is highest in South Auckland (+149%) and West Auckland (61%). These results use the conservative linear growth demand scenario.

Table 30: Modelled cycling demand (linear growth demand scenario) for Shortlist Option 3/ Recommended Programme by Auckland urban area, 2026 (average daily cycle trips)

	2013 Baseline	2026		Difference (do-min vs programme)	
		Do-Minimum network	Option 3/ recommended programme	Daily trips	%
North shore	2,600	5,150	5,850	700	14%
Central	6,500	15,950	23,100	7,150	45%
West	1,250	3,300	5,300	2,000	61%
South	1,400	2,950	7,350	4,400	149%
Total	**11,750**	**27,350**	**41,600**	**14,250**	**52%**

Growth in cycling demand in central areas will ensure cycling plays a more important role in the city's transport network, taking pressure off congested central area road and public transport networks (contributing to investment objective 1). Growth in demand in West and South Auckland and improved network facilities in these areas will improve transport accessibility for these areas with lower levels of transport choice (contributing to investment objective 2).

The assessment also finds that investment objectives 3, 4 will likely be achieved. Demand modelling shows that cycling volumes in the City Centre will be 24% above Do-Minimum levels in 2026 and more than triple volumes in 2013. This will contribute to investment objective 3 for increased cycling in centres. Demand modelling shows average daily cycle trips will be 52% to 78% higher than under the Do-Minimum scenario in 2026 that will be reflected in increased population participation in cycling (contributing to investment objective 4).

Improved cycle safety outcomes are also likely from the programme. Network development has been focused on areas with higher cycle-related or overall road crash rates. This provides confidence that network improvements in these areas will improve safety outcomes for cyclists (investment objective 5). The indicative network plan for shortlist option 3/ the recommended programme involves construction of at least 150km of high-quality, safe cycling facilities and associated intersection upgrades targeted at areas with high crash rates. This will add to a network of approximately 380km of facilities assumed under the Do-Minimum scenario to provide a total network of approximately 530km of dedicated cycling facilities by 2028.

Analysis of the location of indicative network improvements under the recommended programme and road crash records finds that network improvements will provide safer cycling facilities on corridors where 110 cycle-related crashes and 900 total road crashes have been recorded over 5 years between 2011 and 2016. This suggest considerable potential for safer facilities at these locations to reduce crash rates.

The network development components of the programme are likely to contribute most to the achievement of all investment objectives. However, complementary promotion, training, enforcement and other policy tools will also contribute to achieving investment objectives and realising desired programme benefits.

In particular, the following complementary initiatives are likely to positively contribute to programme outcomes:

- Increased provision of public cycle parking – will contribute particularly to investment objectives 1 (increased cycle mode share) and 3 (increased cycling activity in city and town centres) by increasing the convenience of parking bikes in town centres and providing improved parking facilities for connections with public transport.
- Enhanced speed management on priority cycle routes including selected speed limit reductions – will contribute to investment objective 5 (safety) by reducing the risk of serious or fatal crashes for cyclists. Speed management will also increase the attractiveness of the cycling environment contributing to investment objectives 1 and 2.
- Marketing, promotion and events – will contribute to all investment objectives. Promotion accompanying network investment will enhance impacts on investment objectives 1, 2, 3 and 4 by increasing awareness of new facilities. Safety-related marketing and information campaigns will contribute to investment objective 5.
- Cycle training – will contribute particularly to investment objective 4 (increased participation in cycling) by reducing confidence-related barriers to cycling. Cycle training will also contribute to investment objective 5 by improving safety awareness among cyclists and drivers.

9.2 Programme risk

This section summarises risks associated with implementing the programme and achieving programme outcomes.

9.2.1 Risks associated with implementing the programme

Table 31 provides details on the major risks associated with delivering the planned programme. These are predominantly related to delivering network development components, rather than delivery of complementary initiatives. The table also summarises how risks have been addressed to date, in development of the PBC.

Table 31: Risks associated with programme delivery and implementation

Risk	Description	Risk mitigation included in this PBC
Network construction risks		
General cost inflation for civil construction	Cost inflation will drive up the cost of delivering cycle facilities, limiting the amount of network that can be delivered for a fixed budget.	Standard cost rates used to develop an indicative network plan use conservative (high) cost rates drawn from recent facility delivery in Auckland.
Capacity constraints in the industry leading to timeframe / cost risk, eg availability of consultants and contractors to design and build facilities.	Capacity constraints may limit the quantity of cycle facilities that can be delivered within the timeframe;	The recommended programme involves investment levels that are considered feasible. Capacity constraints can be overcome in the

		medium term by recruiting and training.
Trade-offs with other modes using transport corridors	Implementation of cycling facilities on constrained road corridors likely to be impacted by decisions on road space allocation with other modes (eg parking, bus lanes, general traffic lanes).	Implementability assessment at shortlist stage includes assessment of impacts on other modes from network development.
Financial risks		
Availability of AT funding in the context of other transport priorities	Shifts in priorities for funding across transport modes will mean funding levels in this PBC will not be provided for cycling.	Final AT budget will be determined through future LTP processes.
Availability of NLTP funding	Shifts in priorities for funding across transport modes will mean funding levels in this PBC will not be provided for cycling.	Financial feasibility assessment has included comparison of planned investment levels with indicative funding provision for the Walking and Cycling activity class within the draft GPS.
Stakeholder/ public risks		
Consultation and engagement processes impact on cost and rate of delivery	Delivery of individual cycling projects requires substantial consultation resources. Relatively small cycle projects require same level of consultation as large projects.	Recommended programme recommends packaging network development works into larger programmes that may result in streamlined consultation processes compared to consultation on a project-by-project basis.
Environmental risks	Delivery of individual cycling projects may be delayed by consenting issues associated with impacts on local environments (eg SeaPath and impact on coastal environment, removal or relocation of trees on local roads).	Network development does not include substantial portions of network in environmentally sensitive locations.

9.2.2 Risks associated with achieving programme outcomes

Table 32 provides information on risks for achieving the desired benefits and achieving the investment objectives of the programme.

Table 32: Risks associated with achieving programme outcomes

Risk	Description	Risk mitigation included in this PBC
Cycle demand risks		
Predicted level of increased cycle demand accompanying provision of	Cycle demand modelling over-estimates impact of new facilities on increased cycling uptake.	Cycle demands for the 2013 base model have been validated against over 700 observed counts in

improved facilities does not eventuate.		Auckland. Prediction of future demands has been calibrated with observed Auckland trends between 2013 and 2016.
New transport technologies may result in reduced demand for cycling.	Mobility as a service and other new transport technologies may impact on the relative attractiveness of transport modes. Earlier availability of connected / autonomous vehicles may reduce demand for cycling; conversely, more integrated multi-modal 'mobility as a service' changes may increase attractiveness of cycling for some trips.	Demand forecasts have been made under base assumptions that do not expect these changes in the 2018-2028 period.
Safety risks		
Provision of high quality new facilities does not impact positively on safety outcomes.	New network facilities do not reduce crash risk through poor design, or failure to address major crash causes.	Network planning has assumed costs for high-quality facilities (eg separated facilities on high traffic roads). Final safety outcomes will depend on detailed facility design and intersection treatments.
Increased overall cycle crashes.	Increased cycle demand outweighs any reduction to cycle crash rate to result in overall increase in cycle crashes.	Analysis of safety outcomes following infrastructure investment in international contexts has found evidence that major increases in cycle demand are not necessarily accompanied by a corresponding increase in cycle crashes.

9.3 Value for money and sensitivity analysis

The economic evaluation of shortlist options (see supplementary report, *Demand and Economic Assessment*) calculates economic benefits and BCRs for all four shortlisted options. The network development component of the recommended programme closely follows the indicative network developed for shortlist option 3 and this provides information on the economic efficiency of the recommended programme.

Table 33 summarises the economic evaluation results for shortlist option 3 under four different scenarios. The four scenarios reflect changes to two variables influencing the results:

- Linear vs expected demand growth: linear growth assumes growth in cycling demand based on the observed, linear response of cycling demand to facility investment experienced in Auckland during 2013-2016. Expected growth assumes accelerated demand growth during the 40-year evaluation period, based on 'safety in numbers' and 'critical mass' effects accompanying development of a more complete and connected cycling network.

- Flat vs increasing congestion: flat congestion calculates decongestion benefits using a flat $ rate for each vehicle-km removed from the network during the 40-year evaluation period. Increasing congestion calculates decongestion benefits using an increased rate after 2026 to reflect forecast increases in Auckland road congestion (based on recent outputs from three sub-regional traffic assignment models).

The resulting four scenarios result in a range of projected benefit levels and accompanying BCRs. This reflects uncertainty in forecasting future transport outcomes.

Table 33: Projected benefits, costs and BCRs for network development component of recommended programme

Benefit stream	Scenario 1: linear demand growth, flat congestion	Scenario 2: linear demand growth, increasing congestion	Scenario 3: expected demand growth, flat congestion	Scenario 4: expected demand growth, increasing congestion
Health and environmental benefits	$468 m	$468 m	$760 m	$760 m
Safety benefits	$18 m	$18 m	$20 m	$20 m
Travel time cost savings for cyclists	$19 m	$19 m	$19 m	$19 m
Decongestion benefits	$295 m	$722 m	$477 m	$1,168 m
Total benefits (discounted)	**$800 m**	**$1,227 m**	**$1,277 m**	**$1,968 m**
Total costs (discounted)	**$431 m**	**$431 m**	**$431 m**	**$431 m**
BCR	**1.9**	**2.8**	**3.0**	**4.6**

The economic evaluation shows that the major economic benefits are from health benefits accompanying increased cycling activity and decongestion benefits from mode shift away from private vehicles. It finds that under all scenarios benefits are likely to exceed costs, with a BCR range of 1.9 to 4.6.

The sensitivity analysis finds that benefit levels are very sensitive to both the demand growth assumptions and the decongestion rate used. Using expected demand growth rather than linear demand growth results in increasing forecast health and environmental benefits from $468 million to $760 million, substantial increases to decongestion benefits and minor increases to safety benefits.

Using higher decongestion benefit rates results in benefits from this stream increasing from $800 million to $1,227 million under a linear demand growth scenario and from $1,277 million to almost $2 billion under an increasing congestion scenario.

The Economic evaluation report also sensitivity tests BCRs for higher or lower construction costs, testing +/-25% changes in construction costs. Under the linear demand growth, flat congestion scenario, lower construction costs would see the BCR increase from between 1.7-2.3 to 2.3-3.1. Increasing construction costs by 25% reduces the BCRs across the four options to between 1.4-1.9.

Economic evaluation has not been completed for the complementary package of activities to network development. Detailed economic evaluation at the PBC-stage is not considered appropriate given the lower level of investment in these activities relative to network investment within the programme.

9.4 Assessment profile

An assessment profile of H/H/M-L has been determined for the programme using the Transport Agency's Investment Assessment Framework as detailed below:

Strategic fit of the problem, issue or opportunity that is being addressed: H

The programme strongly supports the draft GPS strategic priorities for New Zealand's transport system. It contributes to economic growth and productivity by providing increased transport choice and increased transport capacity on congested corridors within the Auckland urban area, New Zealand's major growth location. Network investment increases transport capacity and choice on key links to the Auckland City Centre, New Zealand's highest productivity employment centre and major centre for tertiary education. It enables cycling to play a more important role in Auckland's overall transport network, improving the efficiency of the network while reducing adverse environmental and health effects.

It contributes to the GPS priority for road safety and to the objectives of Safer Journey's – New Zealand Road Safety Strategy and the Cycling Safety Action Plan. Cycle crashes comprised 7% of fatalities and 10% of serious injuries during the period 2011-2016 on Auckland roads (excluding motorways). Safer facilities improve overall road safety outcomes and address perceptions of cycling as unsafe which is identified by the GPS as the major barrier to increased uptake of cycling.

Effectiveness of the proposed solution: H

The programme effectively responds to the identified problems and supports the strategic goals of central and local government. Substantial improvements to Auckland's cycling facilities accompanied by a package of promotion, enforcement, speed management and training initiatives will result in increased cycling uptake and improved safety.

Network investment has been carefully targeted at locations where increased cycling uptake can most efficiently increase transport capacity on congested corridors, improve access to jobs and education and have positive impacts on local environments. High-quality, safe facilities targeted to high-crash locations will contribute to achieving safety goals.

Benefit and cost appraisal: M-L

The programme is assessed as having a medium to low economic efficiency, based on an indicative BCR range of 1.9 to 4.6. Substantial increases in cycling demand are predicted using the Auckland Cycling model, resulting in major health and decongestion benefits. The cycle demand impacts and accompanying economic benefits from improved network facilities are based on an indicative network plan involving approximately 150km of new facilities. Conservative cost rates for high-quality facilities have been used, and lower out-turn costs may enable accelerated or extended implementation of network facilities.

10 PROGRAMME FINANCIAL CASE

This section highlights the affordability of the programme, and what elements are to be funded by the partnering organisations.

10.1 Indicative cost

The total indicative cost of the programme over the 2018-28 period is$635 million and includes:

- Network development: $600 million
- Complementary initiatives: $35 million.

10.1.1 Cost of network development

The cost of cycle network development components of the recommended programme is estimated at $600 million over the 2018-2028 period. It is recommended that this expenditure is evenly phased over the programme period. However, the exact phasing will be determined during the construction planning phase which occurs after the development of the PBC.

During programme development, indicative standard cost rates for cycle network facilities were established to understand the extent of network development this level of investment may enable. The cost rates were established by AT and the NZ Transport Agency with reference to costs for recent cycle facilities constructed in Auckland. A conservative approach was taken to cost estimation, with 'high' values selected from a range of per kilometre cost rates observed across multiple projects. The cost rates are in 2017, with no allowance made for future cost escalation. Table 34 summarises the standard cost rates and the length of different facility types enabled by an annual $60 million investment. Actual facility costs and length of network enabled by the investment will depend on detailed design and location considerations.

Table 34: Indicative standard cost rates for constructing different types of cycle facilities

Facility type	Cost rate ($million / km)	Example of recently completed/ under construction Auckland project	Length of facility enabled by annual investment of $60 million (km)
On-street separated cycle path	3.8	Great North Road – K Road to Williamson Avenue	16
Shared path (with moderate bridges)	6.3	Glen Innes – Tamaki Drive path	10
Bicycle Boulevard	2.6	Herne Bay to Westhaven path	23
On-street painted lane	0.2	Carrington Road	300

10.1.2 Cost of complementary initiatives

The indicative cost of initiatives to complement network investment is provided in Section 8.1.2. The total cost of complementary initiatives over the ten-year programme period is estimated at $35 million, with spending evenly distributed over the period at approximately $3.5 million per annum. The most substantial costs are for the following initiatives:

- marketing, promotion and events ($20 million)
- cycle training programmes ($10 million)
- public cycle parking ($5 million).

The recommended programme involves modest increases to existing budgets for marketing, promotion and events, cycle training and public bike parking and new expenditure on investigation of bike share. The level of spending on complementary initiatives does not include expenditure for implementing Bike Share. Capital and operating costs for this initiative may be significant (in the order of $40 - $90 million over 10 years) and further investigation is recommended ahead of funding decisions on this initiative.

10.2 Funding arrangements

10.2.1 Funding cycle network development and maintenance

Current arrangements for funding cycle network development include:

- AT and the National Land Transport Fund (NLTF) co-funding facilities on the local road network, with NLTF funding provided at a Funding Assistance Rate (FAR) to AT of 50%.

- NZ Transport Agency fully-funding facilities located within State Highway corridors from the NLTF.

- The NZ Government's Urban Cycleway Fund (UCF) offering additional central government assistance to AT for implementation of selected facilities. Recent funding arrangements have seen funding split roughly 1/3 AC, 1/3 NLTF, 1/3 UCF for completion of an agreed package of projects during the 2015-2018 period.

Indicative network development plans for the 2018-28 recommended programme show that most network expansion will be focused within local road corridors. Some parts of the network may involve construction within State Highway corridors, including:

- Seapath (Harbour Bridge to Esmonde Road) – SH1 corridor

- Southern Corridor (Newmarket to Papatoetoe) – various alignment options including within the SH1 corridor.

- Airport to Puhinui -SH20B corridor.

It is assumed that cycle facilities within State Highway corridors will be fully funded by the NZ Transport Agency through its Highway Network Operations division. For the bulk of the network on local roads the following two funding scenarios are possible:

1. AT/ NLTF co-funding of facilities at the current FAR

   And/or

2. AC/ NLTF/ UCF co-funding of facilities, as has occurred during the 2015-18 programme period (approximately 33/33/33 split).

Final funding arrangements will depend on future government decisions about the continuation of the UCF.

There may be opportunities to consider private-sector contributions to cycle network development in selected locations with high levels of property development. These opportunities should be considered on a case-by-case basis. Locations where AC agency, Panuku, is planning redevelopment may present opportunities. Locations where indicative network development plans may be integrated with Panuku and private-sector redevelopment activity include Manukau Centre, Takapuna Centre, Papatoetoe Centre, Onehunga and Northcote.

This PBC excludes consideration of cycle network development within future urban growth areas. It is expected that cycle network development in these areas will be funded in an equivalent way to local road infrastructure, with AT and developer contributions.

10.2.2 Funding complementary activities

Current arrangements for funding complementary initiatives includes:

- AT receives NLTF subsidy for provision a programme of minor cycling works that funds ad hoc installation of cycle parking, cycle promotion, marketing and events activities, cycle training, travel behaviour change programmes and wayfinding and signage.
- The NLTF (through the road policing activity class) funding NZ police traffic speed enforcement.
- The NZ Transport Agency funding selected road rule awareness and transport promotion campaigns.

Complementary initiatives for the 2018-2028 programme are proposed to be funded in the same way, continuing current arrangements.

10.3 Affordability

The affordability of the programme depends on the following:

- Level of funding available from AT (dependent on AC's Long Term Planning budget-setting process being undertaken during 2017 for the 2018-21 period, and in subsequent years for later parts of the programme).
- Level of funding available from the NLTF (dependent on the government's three-yearly GPS and level of funding allocated to the Walking and Cycling activity class and on NZ Transport Agency NLTP development processes).
- Level of funding available through other government funding sources such as continuation of the UCF (dependent on government decisions).

The proposed level of investment for network development is considerably higher than that provided for Auckland in years prior to 2015, however, is roughly equivalent to the level of cycle network investment currently being delivered by the investment partners in Auckland for the 2015-18 programme.

The Draft GPS 2018/19-2027/28 (published for engagement, February 2017) provides an indication of likely funding availability through the NLTF. It indicates a range of funding for the walking and activity class of $16 million - $65 million for each of the three years, 2018/19 – 2020/21 to be allocated across New Zealand. An Auckland cycling network development programme of $60 million/ year would use approximately 50% of nation-wide funding for this activity class, assuming an NLTF FAR of 50% (with remaining 50% of investment from AC, and maximum upper bound level of expenditure for the activity class. This would see Auckland receive disproportionate level of funding for cycling, relative to its national share of population (50% vs. c. 34%).

Under the Draft GPS funding ranges, a $60 million annual programme may present affordability challenges from the perspective of NLTF funding availability. This will depend on demand for cycleway funding from other regions in New Zealand and demands for NLTF funding from other activity classes that could see expenditure for walking and cycling reduced to as low as $16 million annually across New Zealand.

PART C – DELIVERING AND MONITORING THE PROGRAMME

This section of the document outlines how the preferred programme will be delivered through the project partners and the key activities to take the next steps for the programme forward.

11 MANAGEMENT CASE

The following sections discuss the key management case questions.

11.1 Programme governance

The Programme of investment is a partnership between Auckland Transport, Auckland Council and the NZ Transport Agency. Each of the three organisations have roles in planning, funding and delivering initiatives of the recommended programme. While funding, planning and delivery is expected to involve a partnership between the three organisations, AT plays the most central role in coordinating cycle network planning and will deliver the bulk of the programme.

Successful delivery will require the continuation and evolution of the successful collaborative partnership and working arrangement between Auckland Transport, Auckland Council and the NZ Transport Agency that has been developed through the 2015-2018 Urban Cycleway Programme of investment, and completion of the Strategic Case and Programme Business Case.

The proposed governance structure for the programme is shown in Figure 27.

11.2 Programme delivery

11.2.1 General approach

The approach to delivery is to follow the NZTA Business Case process. Indicative Business Cases (IBC) will be developed for each priority area followed by Detailed Business Cases (DBC). The IBCs will identify trip generators and travel demand in each of the priority areas and potential routes for cycling investment. Early engagement with stakeholders and the public will be used to gather data and preferences for cycling routes in each area. Detailed Business Cases will identify the exact route for cycling investment, the level of service and the type of cycling facility required.

A detailed construction plan will be developed for the network established in the IBC and DBC. The construction plan will draw lessons from previous delivery to ensure that projects are progressed in efficient and strategic ways.

The construction plan will be developed with Panuku and other partners to ensure that the investment in specific networks are coordinated with their work. This will be revised throughout the span of the construction plan.

11.2.2 Monitoring of the Programme Timing and Triggers

Revisiting timings will be an on-going part of the IBC/DBC process. Progression of elements in packages will allow more effective monitoring and identification of triggers.

The approach to delivering the programme must be flexible, due to the geographic scale and impacts of other delivery priorities within Auckland. Decisions will have to be made on prioritising programme components depending on the pressure experienced at the time.

11.2.3 Delivery Responsibilities and Resourcing

Delivery of components of the programme will be undertaken by appropriate delivery teams within the partner organisations and funded between Auckland Council, Auckland Transport and NZ Transport Agency, on a proportional cost, depending upon the nature of the project.

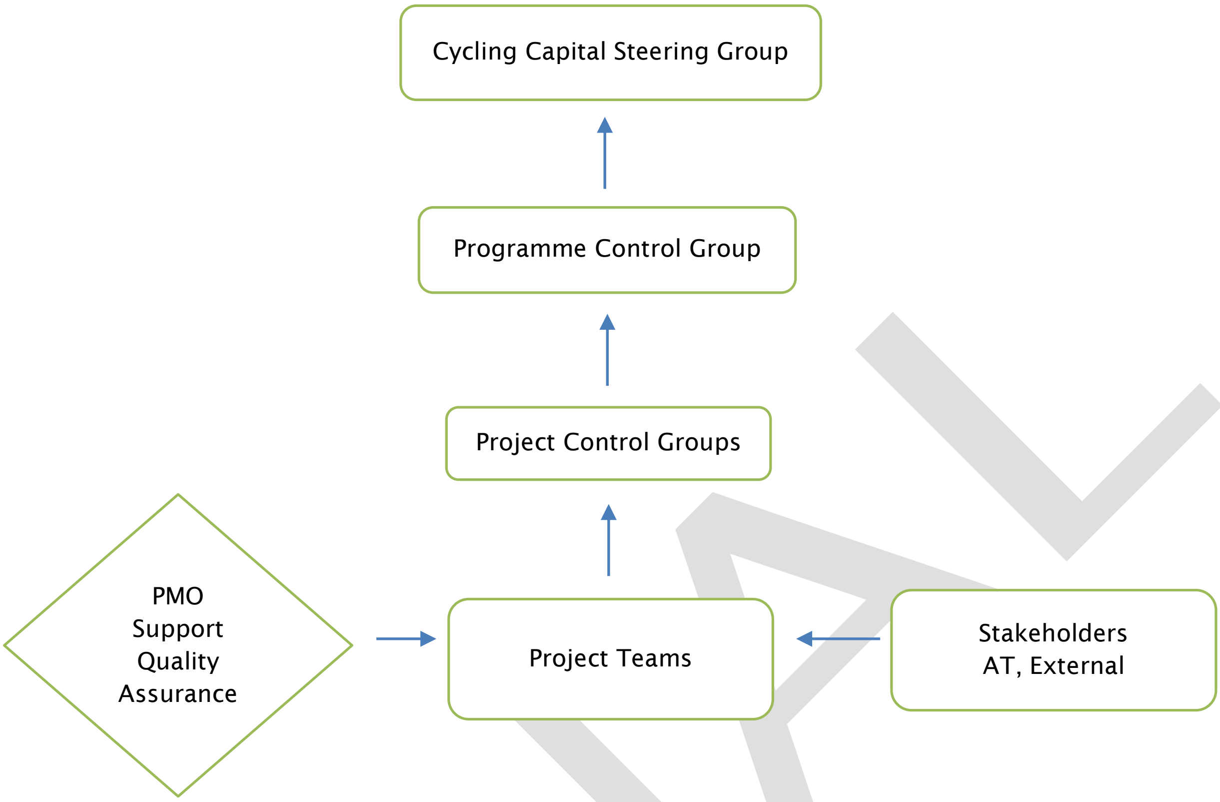
The initial focus for the Programme will be to:

- focus on next stages of the IBCs
- identify the most optimal delivery programme, eg packaging of works
- link to other stakeholder works – working with delivery partners regarding sequencing.

AT has identified the project funding for priority IBCs in the current RLTP through the transport planning budget allocation and will provide the required future budgets in the 2018 RLTP refresh.

The proposed on-going programme management structure to deliver the programme is shown in Figure 27.

Figure 27: Typical Project Delivery Structure for a Walking and Cycling Infrastructure Project



11.3 Stakeholder engagement and communications plan

The stakeholder engagement and communications plan is critical to the success of the 2018-2028 proposed cycling programme. Outlined below is not the plan itself, rather an overview of the principles, key issues and general approach to engagement for this strategy. This draws on lessons learnt from delivery of the 2015-18 programme. It sets the framework out of which will come a more detailed plan and ultimately communications plans for individual projects.

11.3.1 Engaging early

It is important to note that improvements to the cycling infrastructure will benefit people living locally and throughout the region. The project team will engage early with all interested and affected stakeholders so the improvements can best address their needs while achieving the strategic transport objectives of the project partners.

On a project level, the project team will first undertake extensive internal engagement with Auckland Council, NZ Transport Agencies and other CCOs. This will enable the project partners to inform external stakeholders of any constraints or issues pertinent to the project.

11.3.2 Key stakeholders

Key stakeholders will be engaged prior to the general public as they can help to improve the projects. Mana whenua are key stakeholders in the implementation of the strategy and will be engaged by AT staff in partnership with the NZ Transport Agency and Auckland Council.

Local Board members are also key stakeholders and will be engaged early on the strategy itself as well as the individual projects. Local Board members have valuable local knowledge and insights that will be invaluable to the successful implementation of Auckland's Cycling Programme.

In addition, a large number of other key stakeholder groups represent parties who are affected by, or have an interest in, this strategy and its implementation are key stakeholders. These include, but are not limited to Bike Auckland, business associations, resident's associations, Heavy Haulage, Walk Auckland, educational institutions and community groups.

AT's Consultation and Engagement team will facilitate the identification and engagement with these stakeholders.

11.3.3 The public

The people living in the community will play a crucial role in shaping the implementation of these improvements. Where possible, AT will undertake a number of public feedback phases where people can input into the project early and throughout the iterative process. AT will employ a behaviour change programme where appropriate to build demand for cycling, interest in the projects and meaningful engagement with the projects.

The information will be clear, accurate and disseminated widely so as many people as possible are aware of the public consultation. Not only will this help to improve the projects, but it will build excitement and anticipation for people who will see a vision of Auckland with improved cycling infrastructure.

11.3.4 Promoting the existing and future cycling improvements

A big component of the plan will be to celebrate the existing and future cycling infrastructure through positive PR, events and other communications channels. These activities will help illustrate the life cycle of a project from inception to completion and the reasons why AT and project partners are in investing in cycling.

11.4 Programme performance and review

Monitoring plans, using the NZ Transport Agency template, will be completed for each package of projects. The plans will cover what monitoring tools will be required for each project, and when. The monitoring tools used for evaluating project benefits are:

- Permanent automatic cycle counters – one to be installed per project depending on location
- Temporary automatic cycle counters
- Manual counts of pedestrian and cyclists using camera footage, capturing age, gender and whether riding on footpath, cycle facility (if existing) or road
- Intercept surveys with pedestrians and cyclists to capture satisfaction with cycle facilities

- Traffic volumes and speed where speed calming measures are implemented as part of a project

These tools are used during baseline and follow-up analyses.

In addition to project-specific monitoring, AT undertakes cycle and pedestrian monitoring across the region. There are now over 30 permanent automatic cycle counters throughout the region. A selection of these counters are used to assess performance against the Council-agreed Statement of Intent targets. There are currently two targets relating to counts; one for the Auckland region using 14 counters, and one for the city centre using 13 counters.

It has been noted that there are many regions within Auckland which do not have any counters and is something that needs to be addressed. AT proposes to put in place a more equitable dispersal of the counters to give a better reflection of cycling across the region.

the NZ Transport Agency also request that a manual count of people cycling in and out of the city centre during the morning peak be undertaken. The purpose is to document the proportion of cyclists who are female; the theory being that more women cycling means that cycling is becoming safer.

Another Council-agreed Statement of Intent target is the kilometres of cycle facilities built. This only includes cycle facilities built through the dedicated Walking & Cycling programme. It does not include cycle facilities built by the NZ Transport Agency, Auckland Council, Local Boards or other parts of Auckland Transport. Kilometres built is tracked via a Construction Monitor. Regular communication with the Programme Manager and Project Managers is essential for ensuring accuracy of this monitor. It is proposed that a new SOI target be developed to monitor the work of delivery partners in this programme.

ATAP Update March 2018

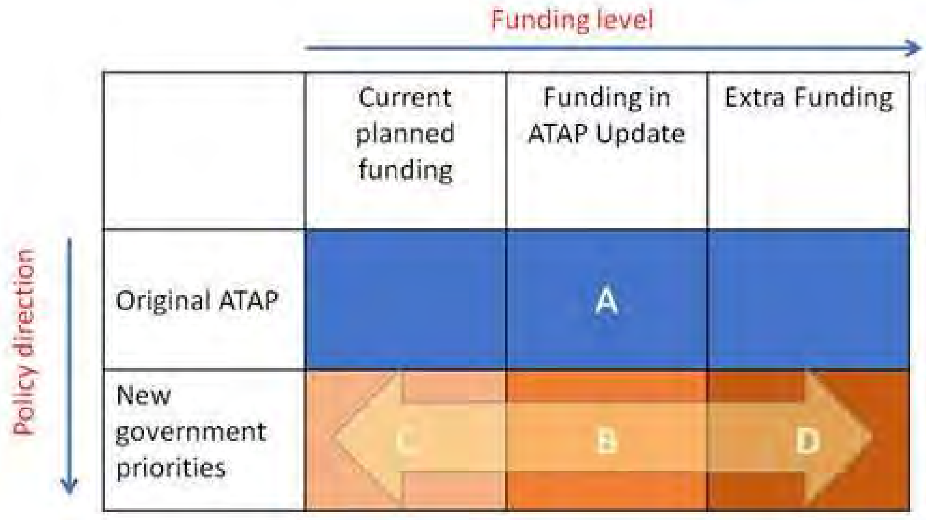
Comparison of 2016 and ATAP Scenarios for 2026

ATAP Scenarios

Changes from earlier ATAP proposal (Scenario A)

- Adds
  - Mt Roskill-Airport LRT
- Changes
  - NW Busway to LRT extended along the whole corridor rather than just part
- Removes
  - Mill Road /Papakura Expressway
  - Some greenfield related projects
  - East West Link
  - Papakura to Drury motorway widening

Now becomes Scenario B



Accelerating the development of Auckland's rapid transit network, (defined as the ATAP Strategic Public Transport Network) particularly to unlock housing and urban development opportunities

	2016?	Scenario A	Scenario B
Number of households within 800m of rapid transit stop			
Qualitative assessment of relative opportunities for housing and urban development	Rating and some text		

Enabling a faster rate of housing growth particularly in new housing areas

	2016?	Scenario A	Scenario B
What proportion of approved housing growth areas are served by transport infrastructure?			Rating and text to provide comparison with Scenario A

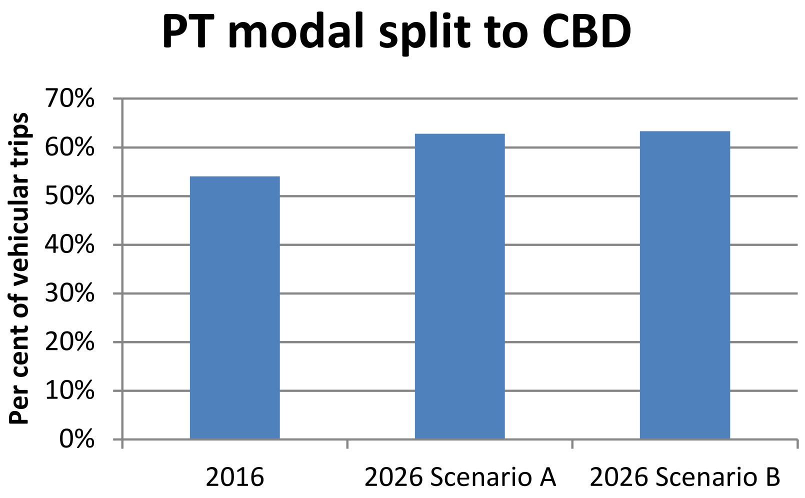
Possibly some general commentary on the results from this and previous slide

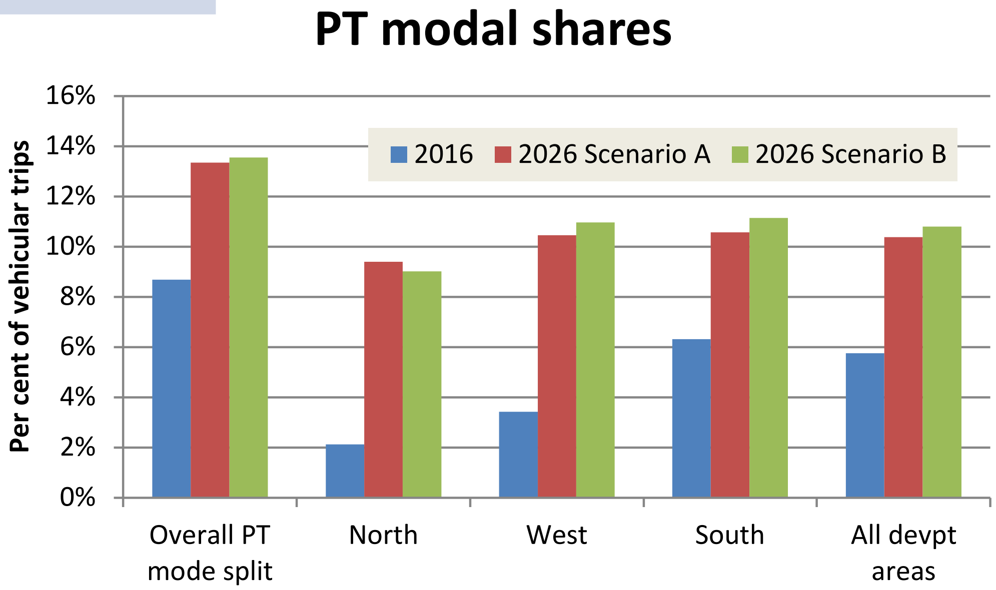
HB1-461

Public transport mode share

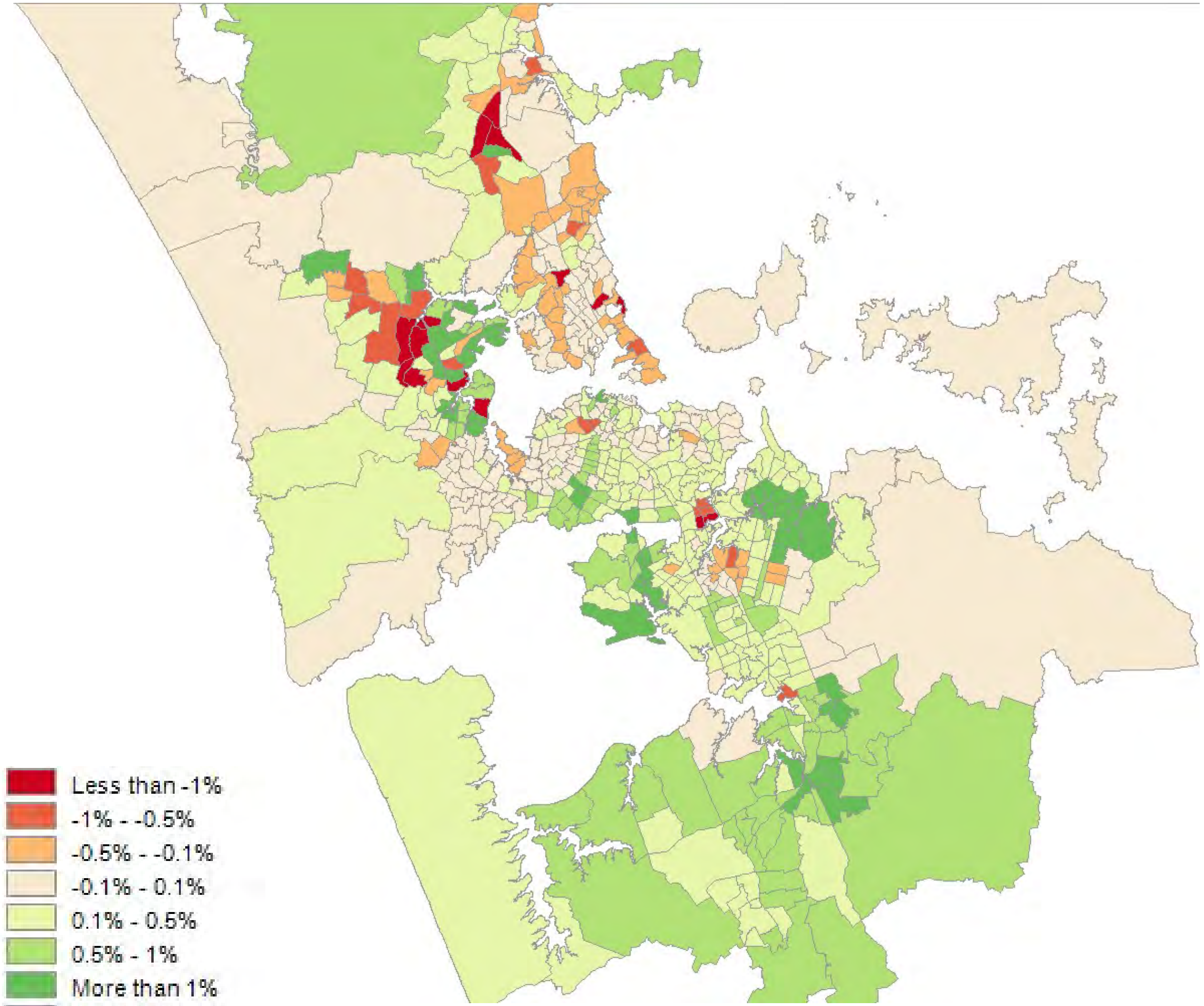
	2016	Scenario A	Scenario B
Total PT mode share	8.7%	13.4%	13.6%
PT mode share to CBD	54.0%	62.8%	63.3%
PT mode share for trips from development areas (1)			
North	2.1%	9.4%	9.0%
West	3.4%	10.5%	11.0%
South	6.3%	10.6%	11.2%
Combined	5.8%	10.4%	10.8%

- Increase in pt modal shares compared to 2016
- Scenario B typically has higher pt share overall and to CBD
- Scenario B lower for North growth area but higher for West and South
  - However differences relatively small compared to change from 2016





Changes in PT mode share 2026 AM Scenario B – A (percentage points)



- General picture:-
  - Increases in south and Isthmus
  - Some reductions in north including growth areas
  - West more mixed but with increases in growth areas and decreases elsewhere.

Encouraging walking and cycling and making these active modes safer for Aucklanders

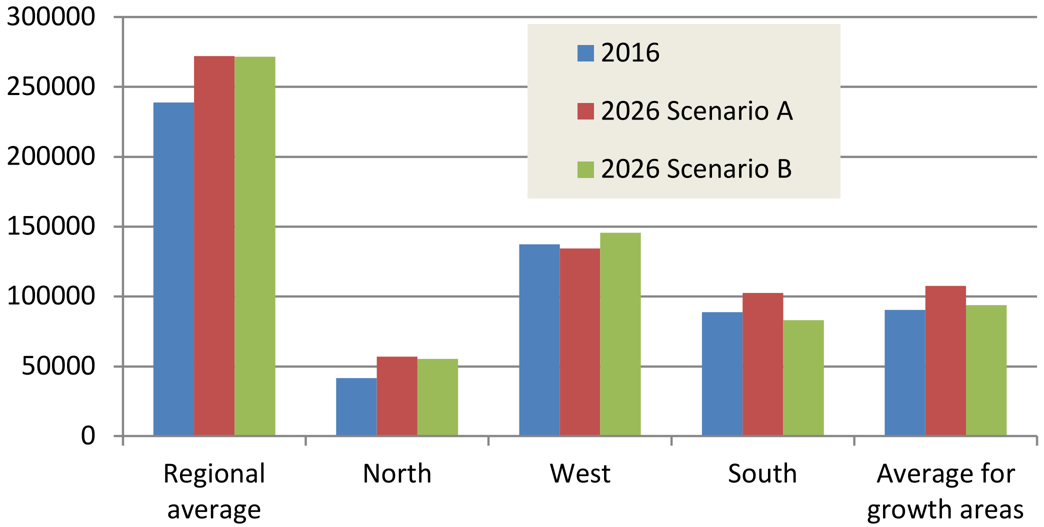
	2016	Scenario A	Scenario B
Active mode share	15.1%?		

Simple column graph

Addressing projected declines in access to jobs for people living in large parts of the west, and some parts of the south - jobs accessible by car

	2016	Scenario A	Scenario B
No	238804	272039	271572
Per cent of regional total	34.6%	33.8%	33.7%
Northern growth areas	41556	56880	55324
Western growth areas	137375	134330	145564
Southern growth areas	88828	102674	83005
Average for growth areas	90434	107613	93898
CBD access to workforce	599683	667938	681756

Employment accessibility for car trips



- Car accessibility higher in absolute terms for 2026 ATAP options compared to 2016 although lower shares of total regional jobs
- Scenario B has little impact on overall car accessibility to employment compared to A
- However at more detailed level, lower accessibility in growth areas overall with Scenario B
  - Lower in South and slightly lower in North
  - Higher in West

- CBD access to workforce higher in 2026 than 2016 and also higher with Scenario B

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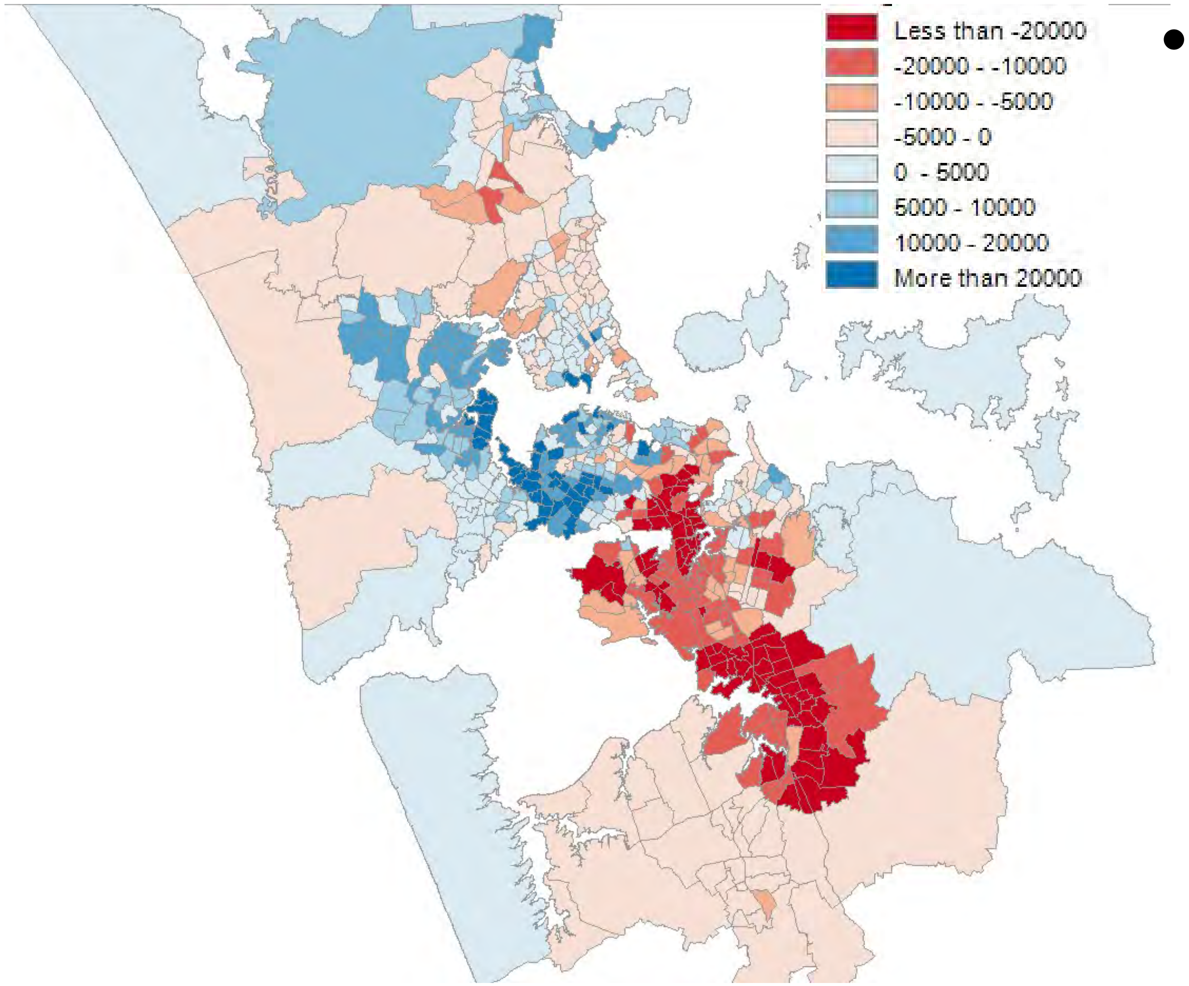
Jobs accessible by car– Detailed Maps

Change in car accessibility to employment 2026 AM (Scenario B - A)

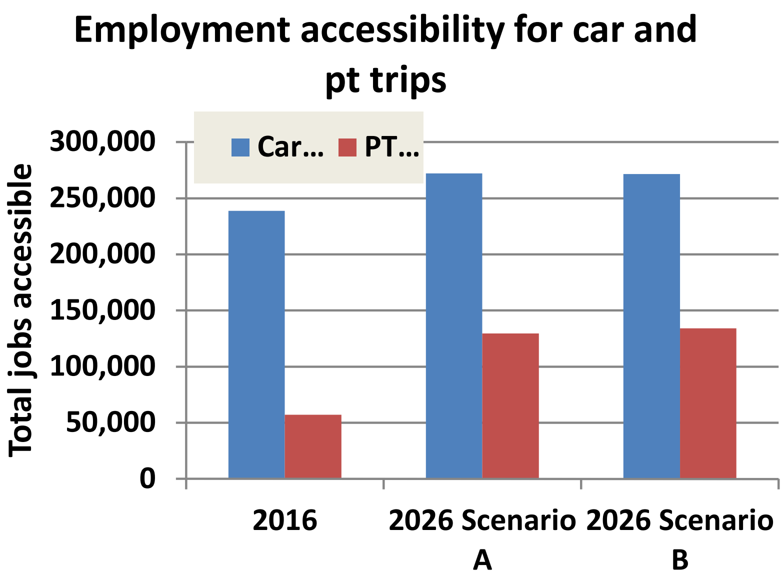


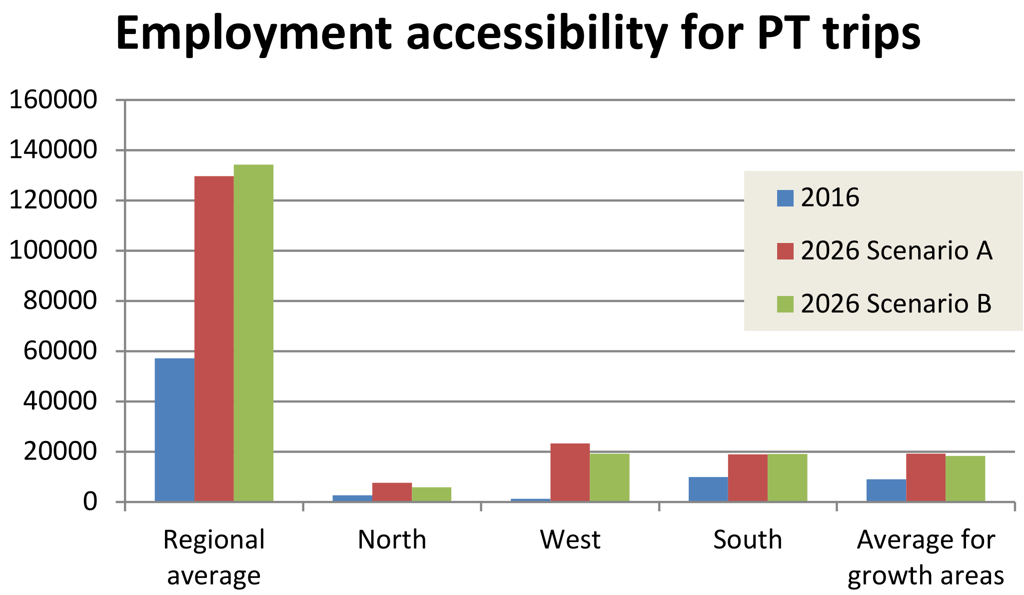
- Compared to Scenario A, Scenario B gives:-
  - higher car accessibility in central and western Isthmus and west
  - lower accessibility to south
  - Position to north largely unchanged

Addressing projected declines in access to jobs for people living in large parts of the west, and some parts of the south - jobs accessible by PT

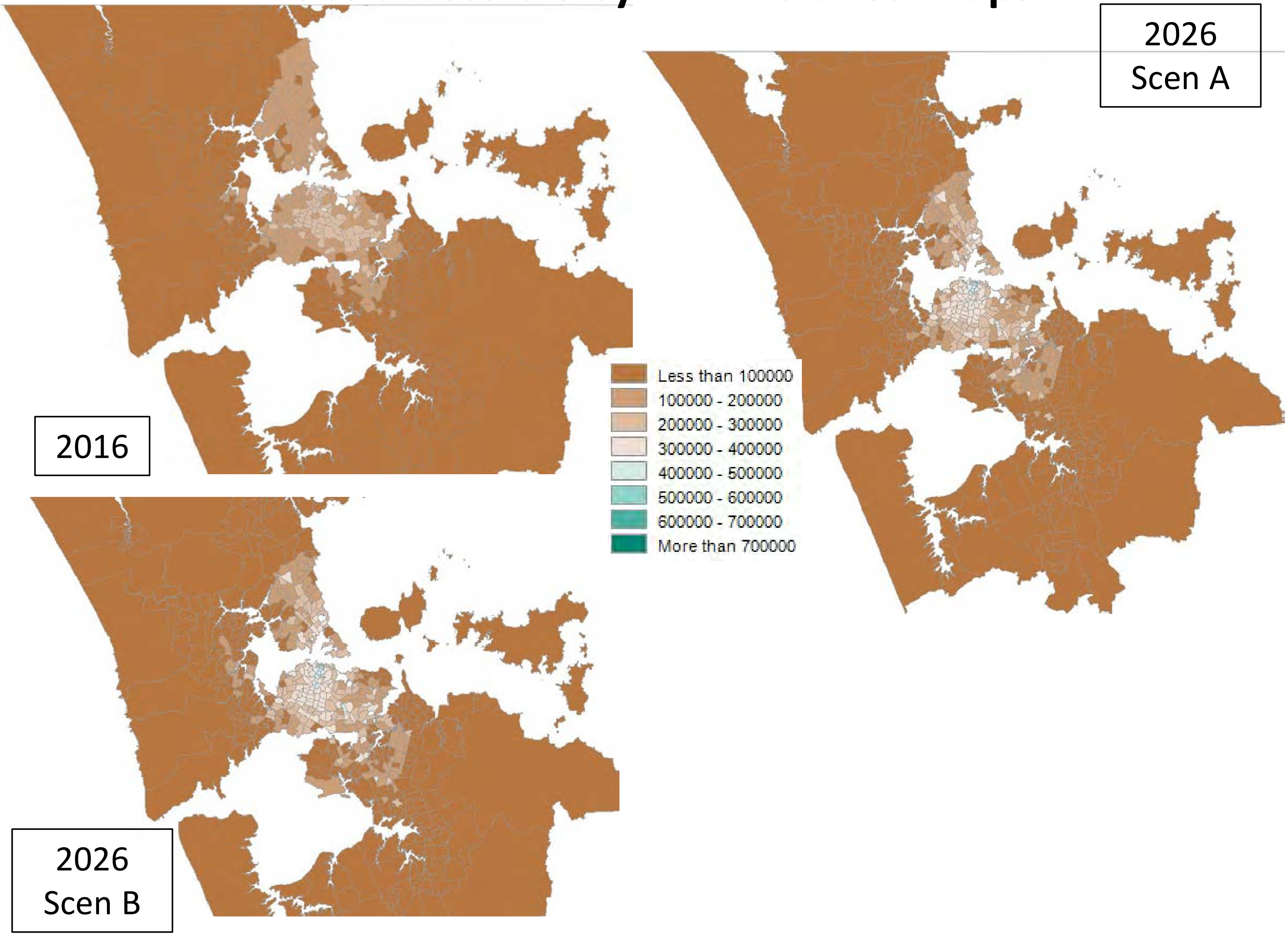
	2016	Scenario A	Scenario B
No	57149	129681	134296
Per cent of regional total	8.3%	16.1%	16.7%
Northern growth areas	2668	7604	5834
Western growth areas	1332	23264	19185
Southern growth areas	10001	19007	19091
Average for growth areas	9104	19220	18405
CBD access to workforce	293693	438441	452165

- Substantial increase in PT accessibility to 2026
- Scenario B typically better than A at a regional level but has lower accessibility for development areas.
- Although gap narrowing PT accessibility still well below car accessibility

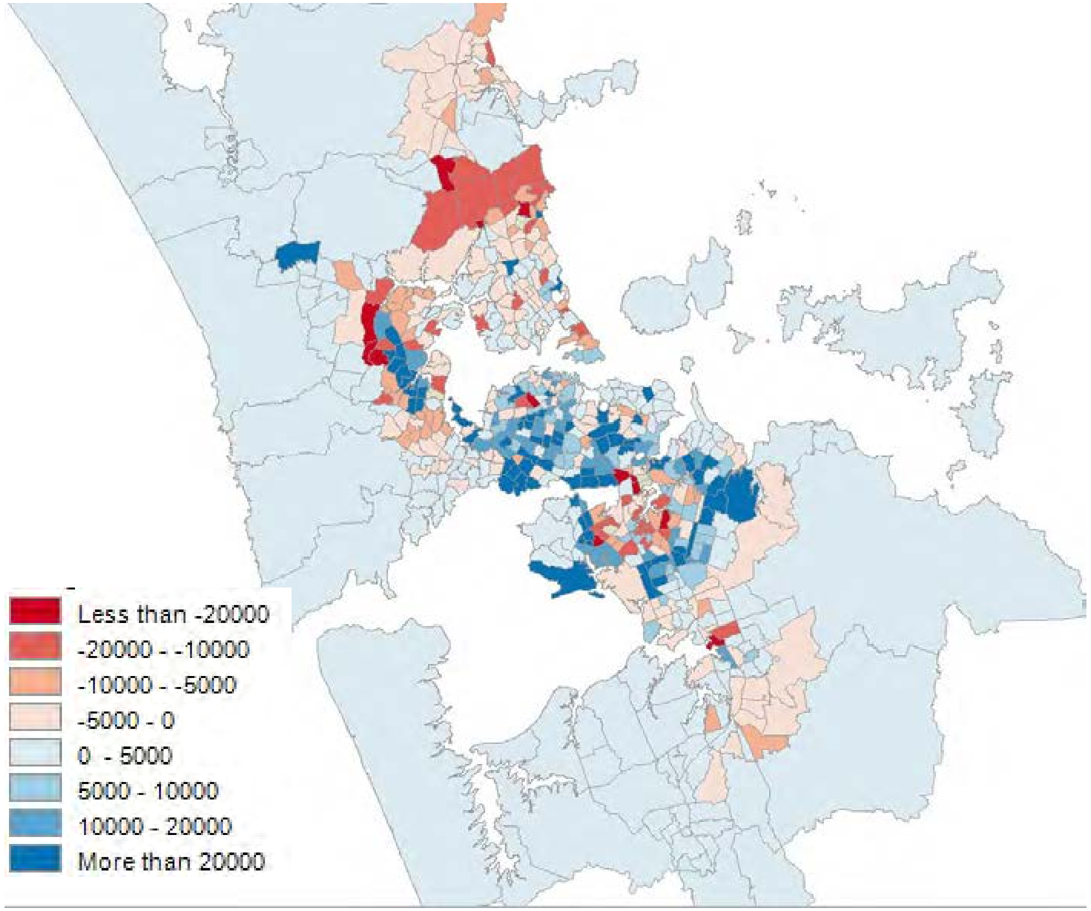




Jobs accessible by PT – Detailed Maps



Change in pt accessibility 2026 AM Scenario B - A

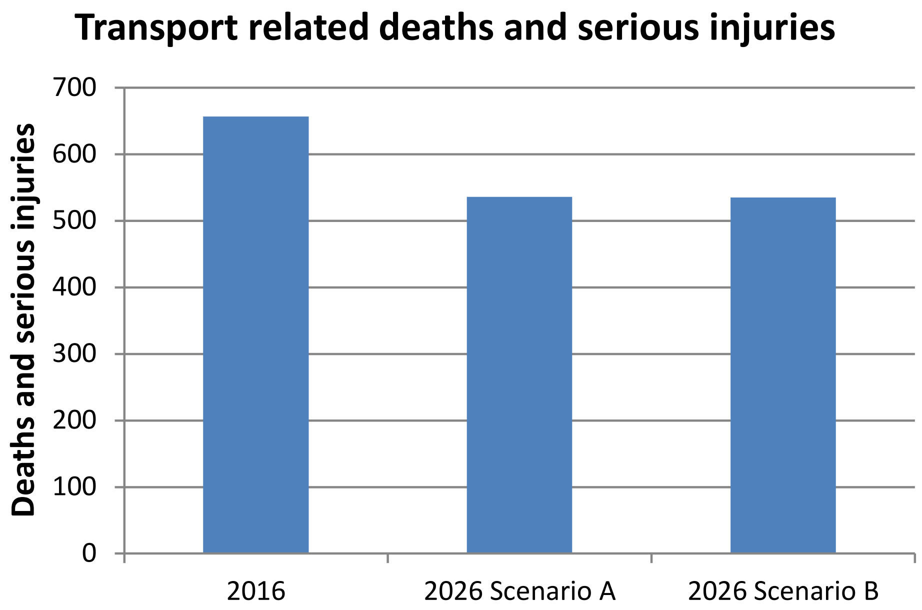


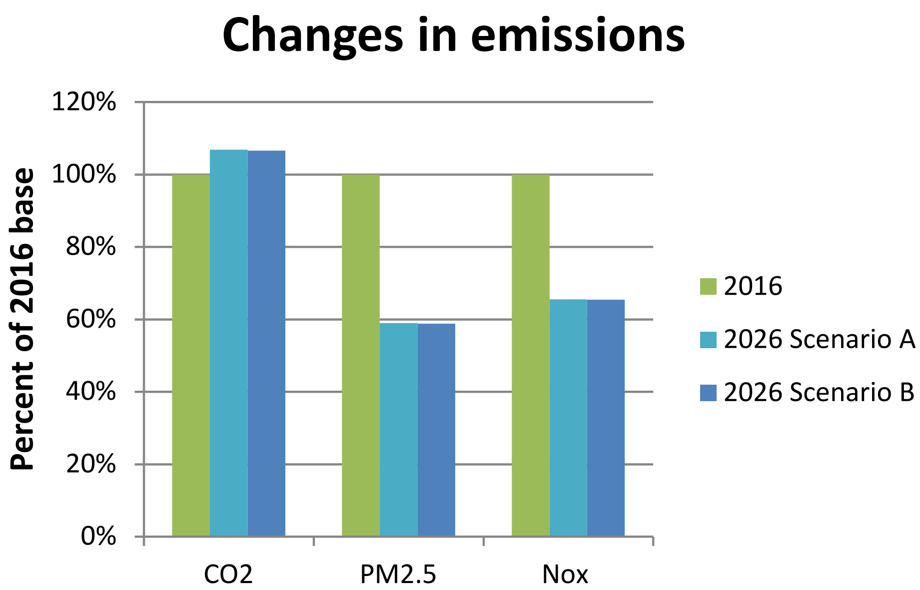
- Position is a more mixed than for cars with more substantial increases and decreases
- Improvements with link to the airport and to the north-west
- Isthmus in general seems to improve especially to south and west
- Declines for Mangere/ Otahuhu and general slight decline for North Shore

Delivering health, safety and environmental improvements

	2016	Scenario A	Scenario B
Total walking & cycling trips			
Deaths and serious injuries	657	536	535
CO2 (tonnes per day)	9066	9691	9664
PM2.5 (tonnes per day)	1.88	1.11	1.11
Nox (tonnes per day)	30.2	19.8	19.8

Differences between Scenarios A and B very small

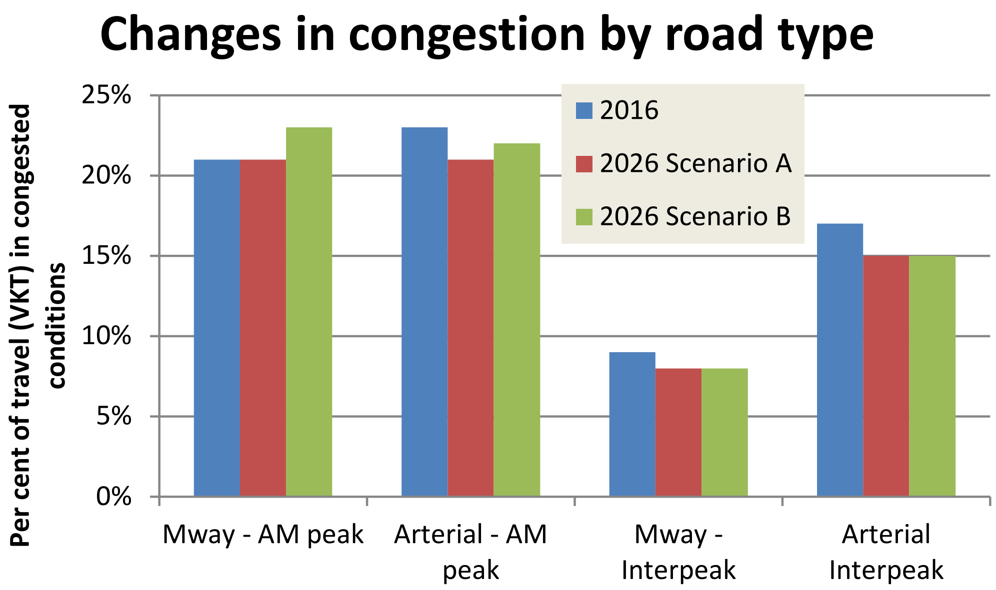




Addressing increasing congestion on the motorway and arterial road network, particularly at inter-peak times-all vehicles

	2016	Scenario A	Scenario B
Mway - AM peak	21%	21%	23%
Arterial - AM peak	23%	21%	22%
Mway - Interpeak	9%	8%	8%
Arterial Interpeak	17%	15%	15%

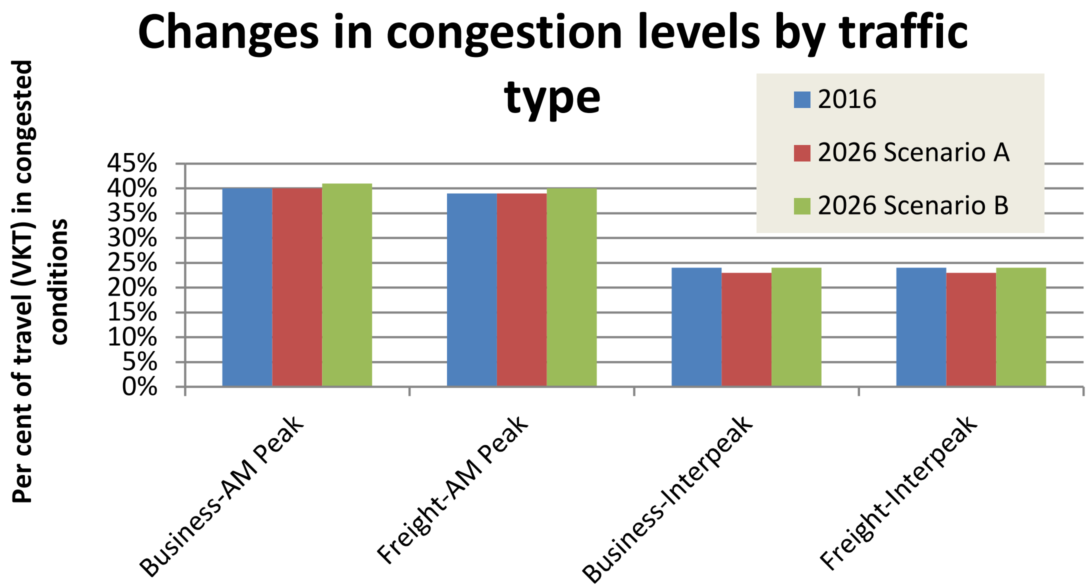
- Some improvements in congestion between 2016 and Scenario A
- Scenario B slightly worse than Scenario A in the AM peak but similar in the interpeak



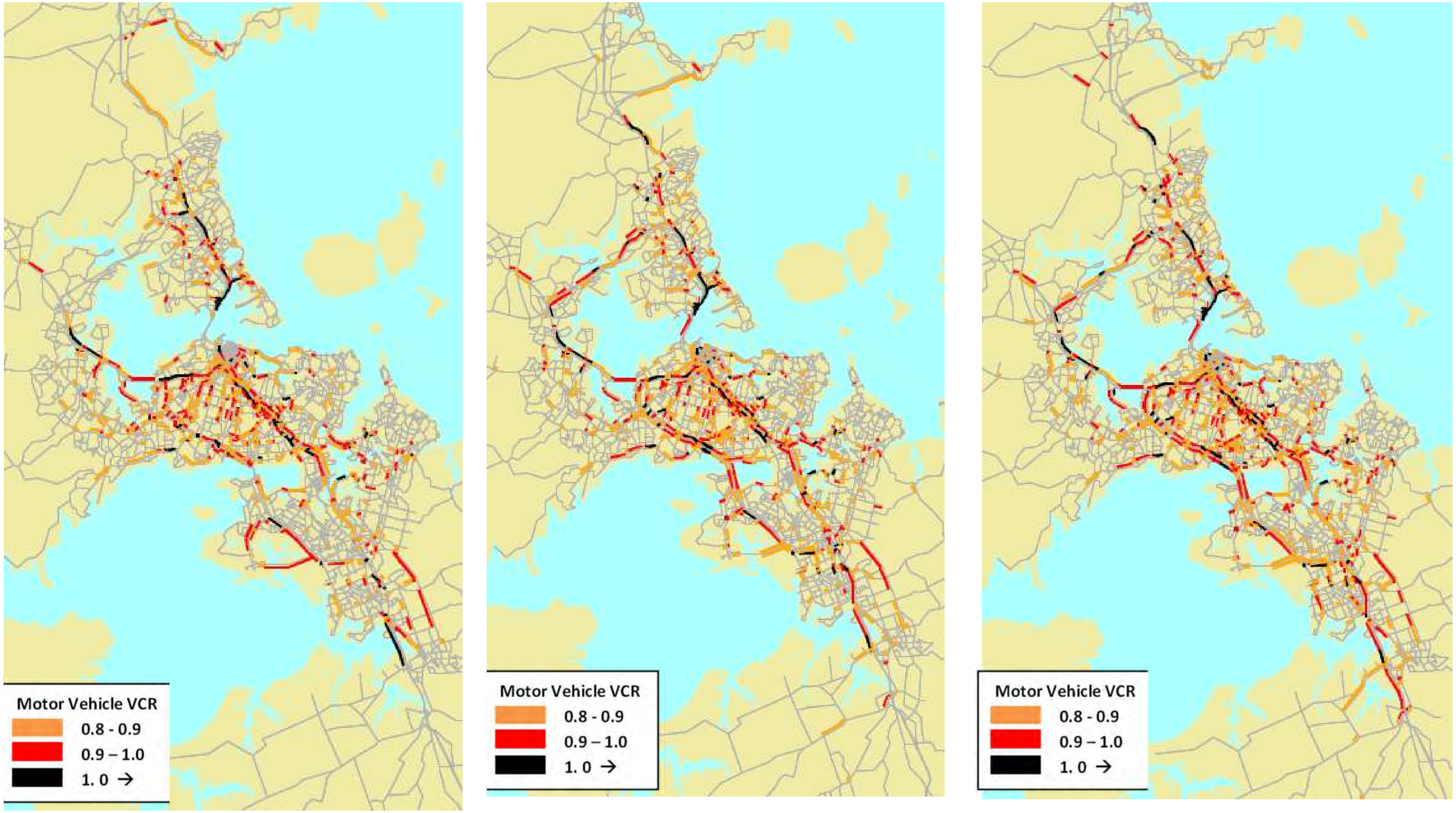
Addressing increasing congestion on the motorway and arterial road network, particularly at inter-peak times- freight and business users

	2016	Scenario A	Scenario B
Business-AM Peak	40%	40%	41%
Freight-AM Peak	39%	39%	40%
Business-*Interpeak*	24%	23%	24%
Freight-Interpeak	24%	23%	24%

- Relatively little change in congestion levels for freight and business users between 2016 and 2026
- Scenario B slightly worse than Scenario A but differences small.



Network Deficiencies (am peak)



2016 | Scenario A | Scenario B

In both scenarios high level of congestion across the network in the AM peak

With Scenario B higher congestion in the south in and around Papakura and on SH1 to the south

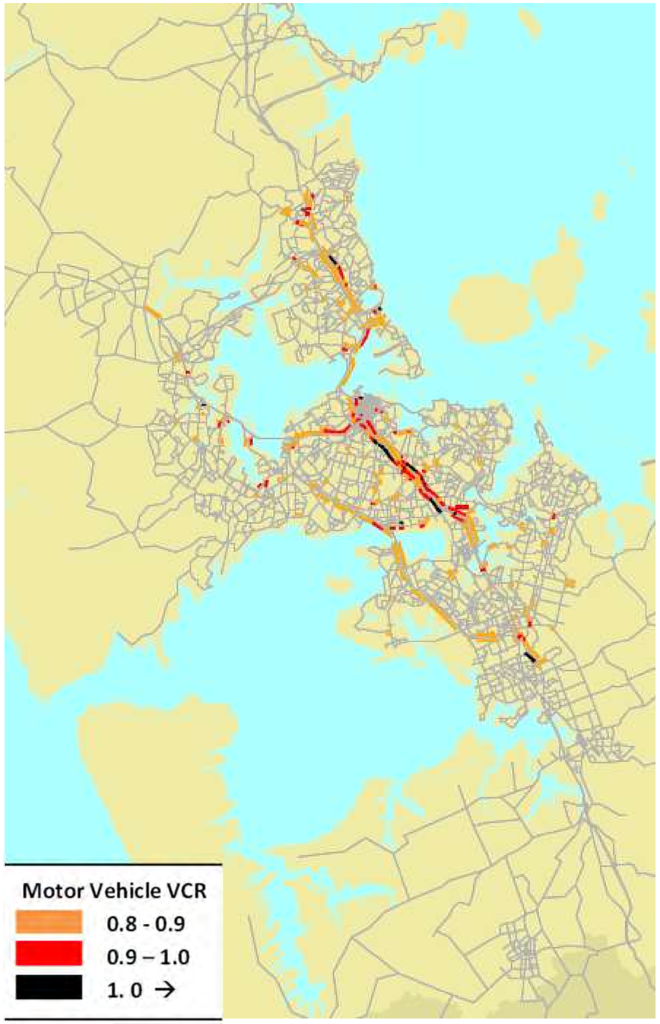
Some reduction in congestion levels on SH18 between Westgate and Albany with Scenario B

Elsewhere minor changes in congestion patterns on major routes and elsewhere but probably broadly similar overall effects.

Network Deficiencies (inter peak)

2016

Scenario A



Scenario B

Congestion in interpeak much less of a problem than in the peak
With Scenario B some reduction in congestion on SH20
Differences elsewhere very limited

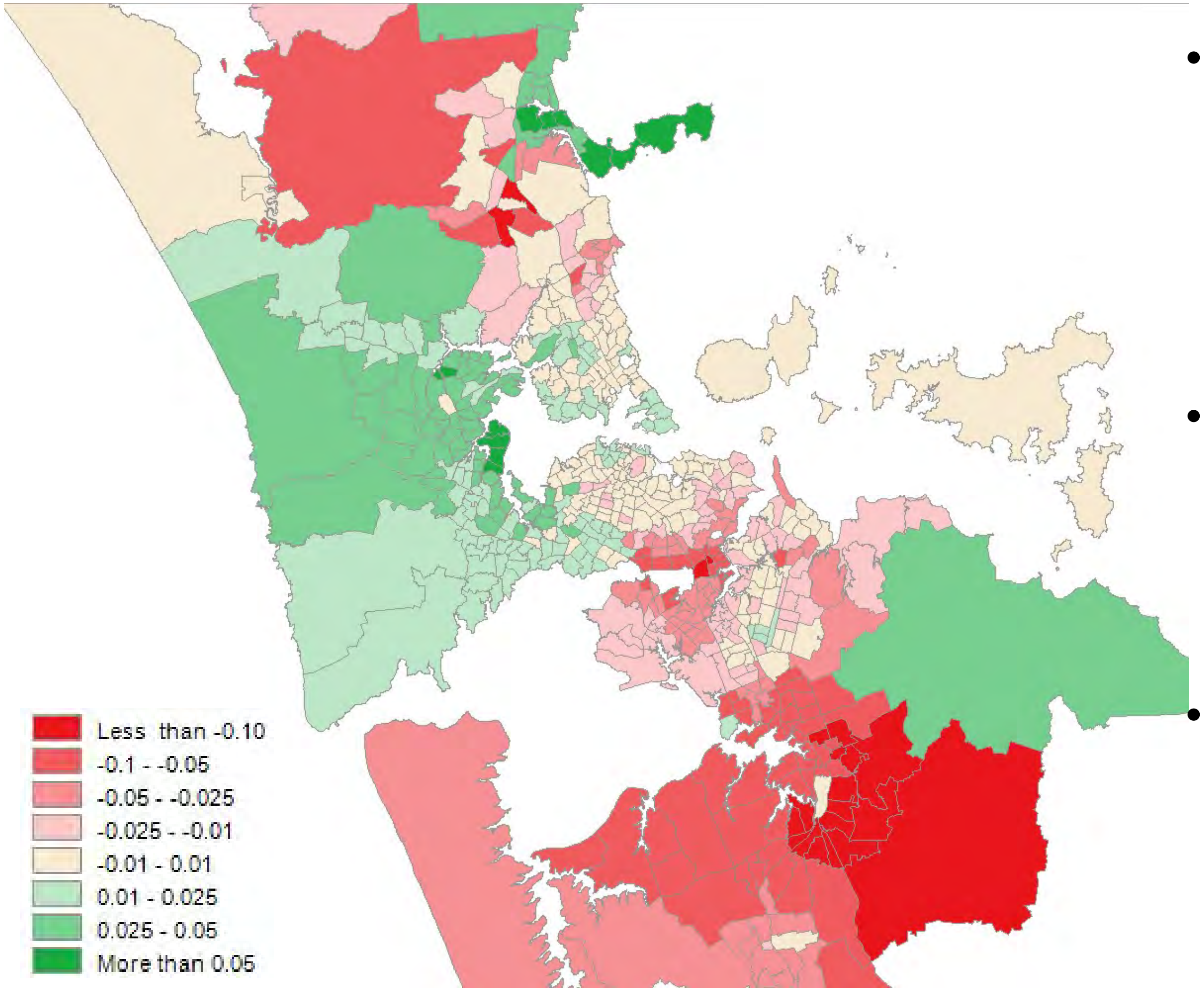
Ensuring the indicative package delivers the best possible value for money - quantified costs and benefits

	Scenario B v Scenario A
Benefits	
Costs	
Relationship between monetarised benefits and costs	

Because we have benefits for a single year or at least not a full set of years, it is not really possible to generate a measure that is consistent with a standard BCR. This will need to be presented carefully to avoid confusion

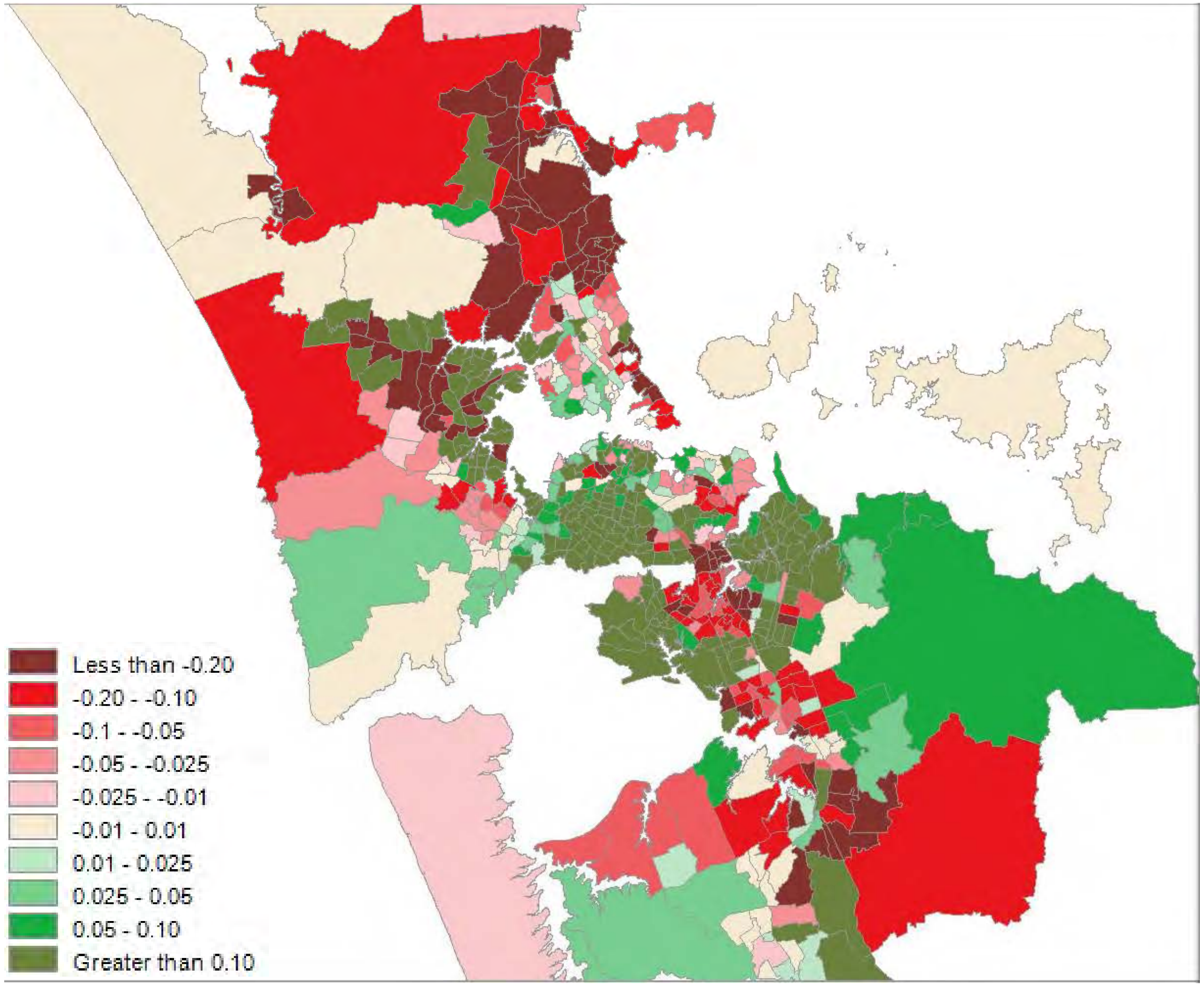
I also think that it is helpful to generate the quantified monetarised results (in whatever form separately to the wider assessment taking into account the other range of impacts presented in earlier slides. The final slide would bring these together.

Distribution of generalised cost benefits ($ per trip) cars 2026 AM Scenario B v Scenario A



- Generalised cost benefits or disbenefits per trip typically small
  - In the range -$0.10 to +$0.05
- Areas benefitting are to the north west including the growth areas and also areas like Whangaparaoa
- Areas disbenefitting are in south of Isthmus, further south including southern growth areas and also growth areas to north.

Distribution of generalised cost benefits ($ per trip) PT 2026 AM Scenario B v Scenario A



- Generalised cost benefits or disbenefits per trip typically larger than for cars, especially where services are changed.
- High proportion of benefits/disbenefits at extremes of range
- Areas benefitting include most of Isthmus, Howick and airport-Manukau corridor
- Impacts elsewhere more mixed.

Ensuring the indicative package delivers the best possible value for money - overall assessment
Impacts of Scenario B v Scenario A

- Modal splits – Impacts small but positive
- Car accessibility – Overall impacts very small but with some overall decline. Improvement for west growth area offset by declines for north and south
- PT accessibility – overall impact positive although declines for growth areas
- Environmental impacts – little difference
- Congestion – slightly worse, especially for peak
- Economics?
- Overall findings?

HB1-479

Auckland Cycling & Micromobility Programme Business Case

Cycling Demand and Economic Assessment

February 2022

flow
TRANSPORTATION SPECIALISTS

Project: Auckland Cycling & Micromobility Programme Business Case

Title: Cycling Demand and Economic Assessment

Document Reference: P:\ATSP Auckland Strategy and Policy\093 Auckland Cycling PBC Refresh\4.0 Reporting\R1A220202 Cycling PBC Demand & Economics.docx

Prepared by: Michael Jongeneel

Reviewed by: Terry Church

Revisions:

Date	Status	Reference	Approved by	Initials
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EXECUTIVE SUMMARY

Flow Transportation Specialists (Flow) has been commissioned by Auckland Transport to assess the predicted cycling outcomes from the Auckland Cycling Programme Business Case (the Cycling PBC). We present results for

- 4 short list investment strategies
- the emerging preferred investment scenario (plus several "stretch" investment scenarios).

This report presents forecast outcomes in terms of

- predicted cycling demands and mode shares for each investment strategy/scenario
- the economic costs and benefits of each investment strategy/scenario.

Short list investment strategies

Four short list investment strategies have been assessed, including

- Strategy 1: regional route focus
- Strategy 2: Rapid Transit Network (RTN) focus
- Strategy 3: focus on school clusters
- Strategy 4: focus on centres.

Flow was responsible for assessing cycling outcomes for strategies 1 and 4, using the Auckland Cycle Model (ACM) developed and maintained by Flow. WSP assessed strategies 2 and 3, due to the focus of these strategies being about public transport and school nodes, rather than longer cycling trips. Flow was also responsible for the economic evaluation of all 4 strategies.

Key outcomes for each investment strategy are summarised below.

Table ES1: Short List assessment – Estimated annual cycle-km travelled (million cycle-km)

	Existing	2028 predicted	2038 predicted
Base case	56	n/a	n/a
Future without PBC investment	n/a	95	120
Strategy 1 – regional focus	n/a	140	180
Strategy 2 – RTN focus	n/a	105	130
Strategy 3 – school clusters	n/a	105	130
Strategy 4 – centres focus	n/a	230	160

The benefit cost ratio (BCR) of each investment strategy is summarised below.

Table ES2: Short list cycling benefit cost ratios

	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Discounted benefits (NPV)	$1,910 m	$566 m	$290 m	$1,351 m
Discounted costs (NPV)	$1,443 m	$753 m	$322 m	$803 m
Benefit cost ratio	**1.3**	**0.75**	**0.90**	**1.7**

It is important to recognise that the assessment of each investment strategy (eg school clusters) considered the effects of that strategy only in terms of the corresponding trip types (ie cycle trips to/from schools). In practice, each investment strategy would also result in co-benefits related to the other 3 investment strategies, which are combined through the preferred investment scenario. As a result, the assessment of each individual strategy is considered conservative.

Emerging preferred investment scenarios

Our assessment considered the following cycle investment scenarios, which includes not only an Emerging Preferred network, but also several "stretch" scenarios.

- Future Reference Case: all existing infrastructure, plus investment in cycling funded within the RLTP (but excluding the existing Cycling PBC investment)
- RLTP: as above, but including the existing $306 million funding allocation for the Cycling PBC
- RLTP+: as above plus other planned, but unfunded, investment in cycling
- RLTP++: as above but with an extended $600 million Cycling PBC investment. The first of several "stretch" investment scenarios
- RLTP+++: as above but with an extended $900 million Cycling PBC investment. The second "stretch" investment scenario
- Future Connect: completion of the strategic cycling network defined in Auckland Transport's Future Connect
- "Cycletopia": a "complete network" scenario where every origin and destination is connected by best practice cycle infrastructure.

Estimated cycle mode shares (for all trip types, by distance) for each scenario are shown below. These should be viewed in light of the 7% cycle mode share target by 2030 set by Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan.

Table ES3: Emerging Preferred assessment – Estimated cycling mode share (all trip types, by distance)

	Existing	2028 predicted	2038 predicted
Base case	0.4%	n/a	n/a
Future reference case	n/a	1.0%	1.2%
RLTP (as above + $306m Cycling PBC)	n/a	1.3%	1.5%
RLTP+ (as above + planned routes)	n/a	2.1%	2.3%

Table ES3: Emerging Preferred assessment – Estimated cycling mode share (all trip types, by distance)

	Existing	2028 predicted	2038 predicted
RLTP++ (as above with $600m Cycling PBC)	n/a	2.3%	2.6%
RLTP+++ (as above with $900m Cycling PBC)	n/a	2.6%	2.9%
Future Connect	n/a	3.7%	4.2%
Cycletopia	n/a	5.8%	6.6%

Our assessment indicates that investment in cycling infrastructure alone will not be sufficient to meet the cycling mode share targets of Auckland's Climate Plan. Further investment in non-infrastructure elements will be required, such as cycling education and promotion. In addition, interventions that discourage car use such as congestion charging and car parking restrictions will be required.

We have additionally assessed the BCRs for 3 of the investment scenarios, and sensitivity tested 2 of these ranges for each investment scenario. The BCR assessed and range include:

- 2.9 for the $306 million investment scenario (with a range of 2.2 to 3.7)
- 2.8 for the $900 million investment scenario (with a range of 2.0 to 3.4)
- 1.2 for the Future Connect investment scenario (sensitivity test ranges not assessed).

CONTENTS

APPENDICES

1 INTRODUCTION

1.1 What this report is about

Flow Transportation Specialists (Flow) has been commissioned by Auckland Transport to assess the predicted cycling outcomes from the Auckland Cycling Programme Business Case (the Cycling PBC). We present results for

- 4 short list investment strategies
- the emerging preferred investment scenario (plus several "stretch" investment scenarios).

This report presents forecast outcomes in terms of

- predicted cycling demands and mode shares for each investment strategy/scenario
- the economic costs and benefits of each investment strategy/scenario.

2 SHORT LIST ASSESSMENT

2.1 The strategies assessed

The short list assessment considered the following cycle investment strategies.

Table 1: Short list strategies considered

Extent of Investment	Strategy Description
	**Strategy 1: regional focus** Focuses investment on filling gaps in the regional cycle network (from Future Connect), plus key major route connections to regional routes. Shown in red in the figure to the left.
(Not mapped)	**Strategy 2: Rapid Transit Network (RTN) focus** Focus investment on short connecting links to key RTN stations (rail, ferry and Northern Busway stations), with a focus on trips within a 15-minute cycle trip of the stations. Cycle demands for Strategy 2 were assessed by WSP. Refer to WSP's reporting for the methodology applied.

Table 1: Short list strategies considered

Extent of Investment	Strategy Description
	**Strategy 3: school focus** Focuses investment on clusters of schools, enabling short trips to schools within each cluster from the surrounding residential catchment. School clusters are shown in red in the figure to the left. Cycle demands for Strategy 3 were assessed by WSP. Refer to WSP's reporting for the methodology applied.
	**Strategy 4: focus on centres** Focuses investment on Metro Centres and Town Centres, enabling short trips to each centre from the surrounding residential areas. Shown in red in the figure to the left.

2.2 Cycle demand assessment

Flow was responsible for developing cycle demand estimates for strategies 1 and 4, with WSP responsible for cycle demand estimates for strategies 2 and 3. Accordingly, this report summarises the methodology used for strategies 1 and 4. However, we provide predicted cycle demand estimates for all 4 strategies in this document where available, for completeness.

2.2.1 Methodology

We have used the Auckland Cycle Model (ACM) to assess cycling and e-bike demands in the first instance. The ACM estimates future cycling and e-bike demands, and responds to anticipated future changes in

- Infrastructure – the ACM recognises that people are more likely to ride bikes and e-bikes if quality cycle infrastructure is provided along their route
- Future e-bike uptake – the ACM assumes that over time, the accessibility of e-bikes will increase, giving more people the option to cycle more often, and greater distances

- Trip characteristics – the ACM recognises that shorter trips are more likely to be carried out on a bike, as are trips to work and school, and trips without steep gradients
- The underlying demand for travel – the ACM is informed by the regional transport model, being Auckland's Macro Strategic Model (MSM)
- Land use growth – the ACM is informed by Auckland Council's land use forecasts

The ACM uses outputs from the MSM and as a result often omits shorter trips under 1-2 km (which don't necessarily feature in the MSM). Strategy 3 however has an investment focus on cycling trips to schools, and these trips are often short trips of 1-2 km in length. Similarly, Strategy 2 has a focus on cycling components of public transport trips, and the ACM is unable to represent these cycling legs. Recognising this, WSP has developed demand estimates for strategies 2 and 3 using a first principles approach.

The ACM has been independently peer reviewed, with this process summarised in Appendix A.

2.2.2 Predicted cycling outcomes

The following table presents modelled cycling statistics for the Auckland region. Data presented reflects predicted annual totals, which average out variations between days and seasons. The data presented is for

- the estimated annual km cycled across the network
- estimated mode shares (for trips to work, by trip numbers).

Outcomes for each investment strategy have been benchmarked against existing cycling outcomes for the Auckland region, and predicted future outcomes without the PBC investment.

Table 2: Estimated annual cycle-km travelled (million cycle-km)

	Existing	2028 predicted	2038 predicted
Base case	56	n/a	n/a
Future without PBC investment	n/a	95	120
Strategy 1 – regional focus	n/a	140	180
Strategy 2 – RTN focus	n/a	105	130
Strategy 3 – school clusters	n/a	105	130
Strategy 4 – centres focus	n/a	230	160

Table 3: Estimated cycling mode share (commute to work trips, by trip number)

	Existing	2028 predicted	2038 predicted
Base case	1.1%	n/a	n/a
Future without PBC investment	n/a	2.7%	2.8%
Strategy 1 – regional focus	n/a	4.3%	4.5%
Strategy 2 – RTN focus	n/a	Not assessed	

Table 3: Estimated cycling mode share (commute to work trips, by trip number)

	Existing	2028 predicted	2038 predicted
Strategy 3 – school clusters	n/a	Not assessed	
Strategy 4 – centres focus	n/a	4.0%	4.1%

It is important to recognise the limitations of the cycle demand assessment applied to each strategy. Strategies 1 and 4 were assessed using the ACM. The ACM is able to represent "complete trips", such as cycle commute trips from home to work. It is however unable to represent very short cycle trips such as trips to schools, or cycling components of multimodal trips such as cycle trips to an RTN station.

Conversely, the first principles approach used to assess Strategy 2 includes only trips to RTN stations, and omits any trips to other destinations that may be enabled by the investment around RTN stations (such as a commute to work trip that passes close to an RTN station). Similarly, the Strategy 3 assessment considers only trips to schools, and omits any other trip types that may benefit by investment in cycle infrastructure around school clusters.

In practice, investment in any one of the 4 investment strategies (work trips, RTN trips, school trips or centre trips) will result in co-benefits related to the other 3 investment strategies. The co-benefits are not included in the tables presented above.

2.3 Economic evaluation

2.3.1 Economic benefits of the investment

The economic evaluation has been carried out in accordance to Waka Kotahi's Monetised Benefits and Costs Manual (MBCM).

The following benefit streams have been assessed for each short list strategy

- health benefits for cyclists – the public health benefits associated with increased physical activity. These have been assessed by comparing the forecast annual km cycled with and without investment and applying benefit rates from the MBCM to the increase in distance (km) cycled.
- health benefits for pedestrians – the public health benefits associated with increased physical activity. These have been assessed only for strategies that provide new walking facilities, such as new shared paths along State Highway corridors. As above, standard benefit rates from the MBCM have been applied to the estimated increase in distance (km) walked
- general traffic reduction benefits – the travel time and vehicle operating cost benefits to general traffic that remains on the road network, when some users shift from driving to cycling. Emissions and crash benefits of removing those vehicle trips from the network are also captured. The method involves comparing the annual distance (km) cycled with and without investment, applying diversion factors to account for the proportion of car-km removed from the network, and applying standard MBCM benefit rates to these car-km removed
- perceived travel time benefits for cyclists – travel time savings, weighted by the MBCM's Relative Attractiveness scale, which accounts for cyclist perceptions of comfort/time on cycle

infrastructure. This relatively minor benefit stream typically accounts for 10% of cycling project benefits. As a result, we have not calculated this directly, but estimated it based on 10% of the cycling health and general traffic reductions calculated above

- crash reduction benefits – the economic benefits of reductions in crashes following road safety improvements delivered by the project. This benefit stream typically accounts for approximately 5% of cycling project benefits, and we have estimated it based on this proportion.

The economic evaluation methodology is documented more fully in Appendix B.

Table 4 presents a summary of the discounted benefits for each short list strategy.

Table 4: Discounted economic benefits, short list strategies (Net Present Value – NPV)

Benefit stream		Discounted benefit			
		Strategy 1	**Strategy 2**	**Strategy 3**	**Strategy 4**
Cycling	Health benefits	$789 m	$194 m	$100 m	$558 m
	Perceived travel time benefits	$154 m	$47 m	$23 m	$112 m
	Safety benefits	$77 m	$24 m	$12 m	$56 m
Pedestrians	Health benefits	$136 m	$21 m	$21m	$64 m
General traffic	General traffic reduction benefits	$754 m	$279 m	$134 m	$561 m
Total benefits		**$1,910 m**	**$566 m**	**$290 m**	**$1,351 m**

We note that the estimation of economic benefits for each strategy is approximate, in that some benefit streams are estimated. Other, relatively minor, benefit streams have been omitted, such as general traffic and pedestrian safety benefits from investment in cycling infrastructure. We consider this level of detail appropriate for the short listing process.

2.3.2 Economic costs of the investment

Project capital costs have been supplied by the project team and include implementation costs of

- $1,850 million for Strategy 1
- $965 million for Strategy 2
- $413 million for Strategy 3
- $1,029 million for Strategy 4

These capital costs have been assumed to accrue evenly over a 10-year period, from 2022 to 2031. Ongoing maintenance and operational costs have been excluded from the short list assessment.

Discounted over the 40-year evaluation period, the above costs sum to a Net Present Values of

- $1,443 million for Strategy 1
- $753 million for Strategy 2
- $322 million for Strategy 3
- $803 million for Strategy 4.

2.3.3 Benefit cost ratios

Based on the discounted benefits and costs presented above, the project is estimated to have the following benefit cost ratio (BCR).

Table 5: Short list cycling benefit cost ratios

	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Discounted benefits (NPV)	$1,910 m	$566 m	$290 m	$1,351 m
Discounted costs (NPV)	$1,443 m	$753 m	$322 m	$803 m
Benefit cost ratio	**1.3**	**0.75**	**0.90**	**1.7**

All four short list strategies have BCRs close to 1. Strategies 1 (regional network) and 4 (centres) have the highest estimated BCRs however.

3 EMERGING PREFERRED ASSESSMENT

3.1 The investment programmes assessed

Our assessment considers the following cycle investment scenarios, which includes not only an Emerging Preferred network, but also several "stretch" scenarios.

Table 6: Investment scenarios considered

Investment scenario	Description
	**The Future Reference Case** All existing cycle infrastructure, plus future cycling projects already funded within the Regional Land Transport Plan (RLTP) excluding the PBC. The RLTP investment notably includes ◆ Auckland Transport's Pop-Up Protection programme of improvements to existing painted cycle lanes ◆ completion of the Urban Cycleways Programme ◆ priority routes within the Connected Communities programme ◆ funded sections of Te Whau pathway ◆ the Lake Road and Māngere West cycling improvements projects ◆ cycling components of the Penlink, AMETI, Lincoln Road and Papakura to Drury projects Note that the Future Reference Case scenario differed slightly from the Future Without PBC Investment scenario used in the long list assessment. The Reference Case was refined between the 2 processes to better reflect funded background investment.
	**The RLTP scenario** The same as the Future Reference Case scenario, plus the $306 million investment for the Cycling PBC already within the RLTP (red links in image to the left). Notable investment includes ◆ Kitchener Road ◆ Hobsonville Road ◆ Rosebank Road ◆ Favona Road ◆ Roscommon Road/Mahia Road

Table 6: Investment scenarios considered

Investment scenario	Description
	**The RLTP+ scenario** The same as the RLTP scenario, in addition to all other proposed cycle projects that are not currently funded within the RLTP. This list notably includes (shown red to the left): ◆ the remainder of the Connected Communities programme ◆ cycling components of the Airport to Botany and 20Connect projects ◆ cycling components of the Drury to Bombay, Pukekohe expressway and Dominion Road light rail projects ◆ completion of the Northern Pathway project This scenario represents the Cycling PBC's default level of investment
	**The RLTP++ scenario** The first of several "stretch" investment scenarios. The same as the RLTP+ scenario, in addition to a further investment in the Cycling PBC ($600 million total investment, additional investment shown in red to the left)
	**The RLTP+++ scenario** The second of several "stretch" investment scenarios. The same as the RLTP++ scenario, in addition to a further investment in the Cycling PBC ($900 million total investment, additional investment shown in red to the left)

Table 6: Investment scenarios considered

Investment scenario	Description
	**Future Connect scenario** The third of several "stretch" investment scenarios. The same as the RLTP+++ scenario, in addition to all other strategic cycling routes identified by Auckland Transport's Future Connect network (including Regional, Major and Connector route types)
(Not mapped)	**Cycletopia scenario** A "complete network" where every origin and destination is connected by best-practice cycle infrastructure and where every city street is cyclable by people with a range of abilities. Not necessarily a realistic investment scenario, but used as a benchmark to consider what's theoretically achievable within Auckland.

3.2 Cycle demand assessment

3.2.1 Methodology

We have used the ACM to assess cycling and e-bike demands in the first instance. As set out in Section 2.2.1 above, the ACM uses outputs from the regional transport model (MSM) and as a result often omits shorter trips under 1-2 km. Recognising this, we have developed estimates of cycling trips to school and to Rapid Transit Network (RTN) stations using a first principles approach.

The methodology is documented more fully in Appendix A.

3.2.2 Predicted cycling outcomes

The following table presents modelled cycling statistics for the Auckland region. Data presented reflects predicted annual totals, which average out variations between days and seasons. The data presented is for

- the estimated annual distance (km) cycled across the network
- the estimated annual reductions in emissions (as a result of predicted reductions in private car travel)
- estimated cycling mode share (for all trip types, by distance travelled).

Table 7: Estimated annual cycle-km travelled (million cycle-km. Values in brackets relative to future reference case)

	Existing	2028 predicted	2038 predicted
Base case	56	n/a	n/a
Future reference case	n/a	180	220
RLTP (as above + $306m Cycling PBC)	n/a	230 (+50)	285 +(65)
RLTP+ (as above + planned routes)	n/a	370 (+190)	460 (+240)
RLTP++ (as above with $600m Cycling PBC)	n/a	420 (+240)	520 (+300)
RLTP+++ (as above with $900m Cycling PBC)	n/a	470 (+290)	580 (+360)
Future Connect	n/a	670 (+490)	830 (+610)
Cycletopia	n/a	1,040 (+860)	1,290 (+1,060)

Table 8: Estimated annual emissions reductions (tonnes of CO_2e)

	2028 predicted	2038 predicted
Future reference case	n/a – the below are measured relative to this scenario	
RLTP (as above + $306m Cycling PBC)	3,200	3,000
RLTP+ (as above + planned routes)	13,000	12,000
RLTP++ (as above with $600m Cycling PBC)	18,000	16,000
RLTP+++ (as above with $900m Cycling PBC)	22,000	20,000
Future Connect	44,000	41,000
Cycletopia	97,000	89,000

Table 9: Estimated cycling mode share (all trip types, by distance)

	Existing	2028 predicted	2038 predicted
Base case	0.4%	n/a	n/a
Future reference case	n/a	1.0%	1.2%
RLTP (as above + $306m Cycling PBC)	n/a	1.3%	1.5%
RLTP+ (as above + planned routes)	n/a	2.1%	2.3%
RLTP++ (as above with $600m Cycling PBC)	n/a	2.3%	2.6%
RLTP+++ (as above with $900m Cycling PBC)	n/a	2.6%	2.9%
Future Connect	n/a	3.7%	4.2%
Cycletopia	n/a	5.8%	6.6%

Improvements in cycling outcomes between today and the future Reference Case are predicted due to background investment in cycling. This background investment includes all cycling projects with committed funding identified in the Auckland RLTP 2021-31, including

- completion of the Auckland Urban Cycleways programme
- priority routes within the Connected Communities programme
- funded sections of Te Whau pathway
- cycling components of the Penlink, AMETI, Lincoln Road and Papakura to Drury projects
- Auckland Transport's pop-up protection programme.

Each of the 6 investment scenarios is predicted to result in an increase in cycling demand and positive cycling outcomes. These increases are relative to their respective level of investment.

The forecast cycle mode shares fall below the targets set by Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan. Those regional targets are (for all trips, by distance)

- 7% bike and e-bike mode share by 2030
- 9% bike and e-bike mode share by 2050.

Similarly, the forecast cycle mode shares fall below the e-bike mode share potential estimated by Waka Kotahi's Research Report 674, of

- 8% e-bike mode share for urban areas within 5 km of the city centre
- 5% e-bike mode share for suburban Auckland locations.

These comparisons provide some level of confidence that the model is not predicting unrealistically inflated cycle mode shares, relative to Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan, or Waka Kotahi research. Conversely, our modelling suggests that infrastructure improvements alone will not be sufficient to achieve the outcomes anticipated by our Climate Plan. Further investment in measures that encourage mode shift will be necessary, including for example congestion charging.

It should be recognised that the ACM has been calibrated based on the observed response in Auckland to recent cycling investment. That level of investment, and the associated demand response were very small relative to the levels of investment assessed above, particularly compared to the more extreme investment scenarios. In effect, the ACM is being used to test scenarios far beyond its calibrated parameters, and there is a risk in doing so. The actual cycling outcomes, should for example Auckland Transport complete the Future Connect cycle network, may be significantly different to the modelled forecast.

3.2.3 Cyclable catchments

The ACM has also been used to quantify the proportion of Auckland's population predicted to live within a 15-minute safe cycle trip of at least 1 key social destination. We have used the following definitions in this process

- a 15 km/h average cycle speed has been assumed, meaning a 15-minute catchment includes trips within 3.75 km

- key social opportunities have been assumed to include any MSM zone with 1,000 jobs or more, the city centre, Metro Centres and Town Centres
- Population forecasts are from Auckland Council's scenario I11.6 forecasts
- Safe cycle infrastructure has been assumed to include all protected cycle lanes, off road cycleways and quality shared paths.

The results are presented in Table 10.

Table 10: Auckland's population living within a 15-minute, safe cycle ride of key social opportunities

	2018	2028	Proportion of regional total
Base case	192,000	n/a	12%
Future reference case	n/a	452,000	24%
RLTP (as above + $306m Cycling PBC)	n/a	635,000	34%
RLTP+ (as above + planned routes)	n/a	863,000	47%
RLTP++ (as above with $600m Cycling PBC)	n/a	953,000	52%
RLTP+++ (as above with $900m Cycling PBC)	n/a	1,023,000	55%
Future Connect	n/a	1,357,000	73%
Cycletopia	n/a	1,594,000	86%

Note that even with the "Cycletopia" investment scenario, less than 100% of Auckland's population is predicted to fall within a 15-minute, safe cycle ride of key social opportunities. This is because some of Auckland's future population falls outside the boundary of the ACM. As a result, actual population proportions may be slightly higher than those reported above.

3.3 Economic evaluation

3.3.1 Economic Do Minimums

We have assessed the economic impact of 3 investment scenarios:

- The $306 million investment scenario
- The $900 million investment scenario
- Future Connect

Two different "Do Minimum" scenarios have been used to assess the economic benefits of the investment scenarios:

- The $306 million investment scenario has been assessed by comparing it to the future Reference Case that includes all other cycling investment with committed funding in the RLTP (refer Table 6, page 11). This has allowed us to isolate the predicted benefits of the $306 million investment from the background investment in cycling

- The $900 million and Future Connect investment scenarios have been assessed against the RLTP+ scenario (refer Table 6, page 11). This has allowed us to isolate the predicted benefits of these 2 investment scenarios from the additional planned but unfunded background investment in cycling, such as the cycling components of the A2B project.

3.3.2 Economic benefits of the investment

The economic evaluation has been carried out in accordance to Waka Kotahi's Monetised Benefits and Costs Manual (MBCM).

The following benefit streams have been assessed for the project

- perceived travel time benefits for cyclists – travel time savings, weighted by the MBCM's Relative Attractiveness scale, which accounts for cyclist perceptions of comfort/time on cycle infrastructure
- health benefits for pedestrians and cyclists – the public health benefits associated with increased physical activity
- general traffic reduction benefits – the travel time and vehicle operating cost benefits to general traffic that remains on the road network, when some users shift from driving to cycling. Emissions and crash benefits of removing those vehicle trips from the network are also captured
- crash reduction benefits – the economic benefits of reductions in crashes following road safety improvements delivered by the project

Table 11 presents a summary of the discounted benefits. Further detail of how these have been developed is included in Appendix B.

Table 11: Discounted economic benefits (Net Present Value – NPV)

Benefit stream		RLTP ($306m investment)	RLTP+++ ($900m investment)	Future Connect
Cycling	Health benefits	$439 m	$1,252 m	$3,005 m
	Perceived travel time benefits	$38 m	$111 m	$251 m
	Safety benefits	$15 m	$47 m	$142 m
Pedestrians	Health benefits	-	-	$13 m
General traffic	General traffic reduction benefits	$268 m	$797 m	$1,836 m
	Emissions reduction benefits[1]	$8 - $12 m	$23 - $36 m	$53 - $84 m
Total benefits		**$768 - $772 m**	**$2,230 - $2,243 m**	**$5,300 - $5,331 m**

[1] The MBCM requires a low and high range to be given for emissions benefits, reflecting low and high shadow costs for CO_2 emissions

3.3.3 Economic costs of the investment

Project capital costs have been supplied by Auckland Transport and include $306 and $900 million for those respective investment scenarios, and $5 billion for Future Connect. Capital costs have been assumed to accrue linearly over a 10-year period, from 2022 to 2031.

Ongoing maintenance and operational costs have been assumed to be 0.5% of the implementation costs (ie $1.5 million per year for the $306 million investment scenario).

Discounted over the 40-year evaluation period, the above costs sum to Net Present Values of

- $269 million for the $306 million investment scenario
- $792 million for the $900 million investment scenario
- $4,399 million for Future Connect.

3.3.4 Benefit cost ratios

Based on the discounted benefits and costs presented above, the investment scenarios are estimated to have the following benefit cost ratios (BCR).

Table 12: Estimated benefit cost ratios

	RLTP ($306m investment)	RLTP+++ ($900m investment)	Future Connect
Discounted benefits (NPV)	$768 - $772 m	$2,230 - $2,243 m	$5,300 - $5,331 m
Discounted costs (NPV)	$269 m	$792 m	$4,399 m
Benefit cost ratio	**2.9**	**2.8**	**1.2**

3.3.5 Benefit cost ratio ranges

The BCRs calculated above include only benefits due to investment in separated cycle facilities. They omit any additional benefits associated with Local Area Network (LAN) components of each investment scenario. The LANs include comprehensive traffic calming within targeted communities, to ensure local streets are cyclable. LANs typically result in benefits for cyclists and pedestrians, as well as road safety benefits for general traffic. While a proportion of the estimated costs have been set aside for the LANs, these have not been included in the estimated project benefits, as the location and scope of the LANs have not yet been determined.

This section considers the effects that including the LANs in the benefits calculation may have on the overall BCRs. The LAN components make up 23% of the estimated costs for the $306 million programme, and 17% of the costs for the $900 million programme. As a result, we have estimated the effect of the LANs on the BCR by factoring up the estimated benefits by these proportions.

Following our economic evaluation, Auckland Transport also advised that the estimated costs of each investment scenario were expected to increase by 35% to 40%. This section also considers the effects this cost increase would have on the BCR, by factoring down the benefit component of the BCR accordingly (ie maintaining the same overall programme budgets, but delivering less km of infrastructure).

The results of these tests are summarised in Table 13 below.

Table 13: Estimated benefit cost ratio ranges

Costs	LAN benefits	RLTP ($306m investment)	RLTP+++ ($900m investment)
Low (original cost estimate)	Excluded (default)	2.9	2.8
	Included	3.7	3.4
High (updated cost estimate)	Excluded	2.2	2.0
	Included	2.6	2.2

The BCR ranges for each investment scenario include

- 2.2 to 3.7 for the $306 million investment scenario
- 2.0 to 3.4 for the $900 million investment scenario.

APPENDIX A demand estimates

Methodology

The Auckland Cycle Model (ACM) has been used to develop estimates of average weekday peak period cyclist trips with and without the project. The ACM estimates future cycling demand and

- reflects predicted land use (according to Auckland Council's scenario I11.5 land use forecasts)
- reflects cyclists' route choice – with cyclists generally opting to travel via a slightly longer route if it provides a higher standard of infrastructure, or less adverse gradients
- reflects realistic cycling trip lengths – with longer trips less likely to be undertaken by bicycle than shorter trips, with a probability distribution applied that is based on the existing Auckland cycle trip length distribution
- reflects realistic cycle trip types – with trip types such as home-to-work and home-to-education more likely to be undertaken by bicycle than trip types such as trips for employer's business
- reflects anticipated future growth in e-bike availability
- is responsive to changes in cycle infrastructure (in terms of both demands and trip assignment), in that high quality cycle infrastructure between any two nodes will result in more trips between those nodes being undertaken by bicycle, than a scenario with poorer quality cycle infrastructure
- reflects both utility and recreational cyclist components.

The ACM is informed by the Auckland Macro Strategic Model (MSM), and its development is documented more fully in a Model Development Report[2].

For the economic evaluation of the project, 2028 and 2038 forecast models have been used.

The model represents morning and evening peak period (two hour) cyclist demands for each forecast year. Estimates of daily cyclist demands have been derived by factoring the morning and evening peak period forecasts. A factor of 2.0 has been used in this process. This factor reflects the level of off-peak and weekend profiles currently observed on a range of routes across Auckland. We note that higher factors tend to apply to cycle routes that have a higher proportion of recreational trips, such as Tamaki Drive, while lower factors apply on routes with more commuter focus such as the Northwestern Cycleway.

Peer review of cycle model

The ACM was independently peer reviewed[3] by QTP for the SeaPath DBC in 2018. That review focused on the model's ability to predict future cycling trips across the Waitemata Harbour, but also scrutinised the model's general construction and appropriateness to assess cycle infrastructure in general. Key findings of the peer review included:

[2] Flow Transportation Specialists. September 2018. Auckland Cycle Model – Model Development Report
[3] QTP. September 2018. SeaPath DBC – Economics and Modelling Peer Review

- that the ACM has been built using unconventional methods, but that it has demonstrated powerful ability to accurately predict forecast cycle demands in the short term. We note that there is no established convention on cycle demand forecasting, however
- that the model is limited by its coarse zone size, with this being based on the MSM zones. This issue is addressed by disaggregating the MSM's 550 zones into over 800 smaller zones, with this process focusing on areas of particular interest to Auckland Transport projects, such as the city centre and Metropolitan Centres. In the case of the PBC, the zone structure is considered less critical, as the PBC's focus is on strategic, regional investment at the MSM zone level
- that the model does not well reflect education trips, due to the short length of these trips. Recognising this, the model has not been used to assess trips to schools for the PBC (or for other short trip types)
- that the model uses a "network effects" module, which results in an S-shaped response to cycling network investment (with predicted demands increasing exponentially at lower levels of investment, before plateauing). The peer reviewer noted that there is no evidence to support this non-linear trend

The peer review concluded that the ACM provides a much-improved ability to forecast future cycle demands, relative to the previous methods of the MBCM's Simplified Procedures 11 and Waka Kotahi's Research Report 340.

Subsequent to the peer review, the ACM has been used to evaluate a number of Auckland Transport, Waka Kotahi and Auckland Council projects, including

- Waka Kotahi's Northern Pathway project
- cycling components of Auckland Transport's Connected Communities programme
- Auckland Council's te Whau Pathway
- Auckland Transport's Glen Innes to Tamaki Drive shared path, Pt Chevalier to Herne Bay cycleway, Avondale to New Lynn shared path, and other components of the Auckland Urban Cycleways programme

Finally, we note that the ACM was referenced extensively in Waka Kotahi Research Report 676 (Latent demand for walking and cycling, March 2021). That report recommended a range of cycle demand estimation tools be used in the future, with urban area cycle models being recommended for projects that are expected to result in fundamental changes in travel behaviours and that cost in excess of $20 million. The Auckland Cycling PBC falls within this category.

Future micro-mobility impacts

The cycle demand component was based on outputs from the ACM, calibrated based on observed cycle data from 2016. In the period since, e-bikes have gained in popularity significantly. Evidence to support this includes

- Waka Kotahi's Research Report 674 "*Mode shift to micromobility*" (February 2021), which concluded that if appropriate infrastructure is provided, e-bike trips could account for up to 8% of all trips within a 5 km radius of Auckland's City Centre, and 5% in more suburban areas of the city

- 2018 data collected by the University of Auckland[4], which observed that 31% of peak period trips on the Northwestern Cycleway were by e-bike (but only 15% on Tamaki Drive, which did not have safe cycle infrastructure at that time)
- Waka Kotahi's research[5] indicating that 11% of bikes sold in New Zealand in 2019 were e-bikes
- Data collected by Auckland Transport[6] indicating that in 2020, 25% of regular bike riders in Auckland used e-bikes
- Most micro-mobility hire companies have e-bikes and e-scooters, rather than pedal bikes/scooters.

The evidence points to a rapidly increasing rate of e-bike ownership and use, from near-zero in 2016 when the ACM was calibrated, to the observed rates above. Reflecting this, we have made the following assumptions in our demand assessment

- 40% of cycle trips in Auckland will be by e-bike (or similar micro mobility device) in 2028
- 60% of cycle trips in Auckland will be by e-bike (or similar micro mobility device) in 2038

Waka Kotahi's Research Report 674 reviewed both New Zealand and international literature to consider the effect of e-bikes on trip lengths. Waka Kotahi's conclusion was that e-bikes enable trip lengths two to three times longer than traditional pedal bikes. We have taken the low end of this range, and assumed that e-bikes enable trips that are double (two times) the length of traditional pedal bike trips.

Similar trends have been observed for e-scooters and other "wheeled pedestrian modes", however there is less data available to support this. Data collected by Flow on Tamaki Drive in 2018 found that approximately 20% of pedestrian trips on this route during the peak periods were by "wheeled pedestrians". Waka Kotahi's Research Report 674 concluded that given appropriate infrastructure, e-scooters could account for 1% to 3% of all trips outside of Auckland's City Centre (and approximately double that within the City Centre).

E-scooters also differ from bikes and e-bikes, in that they are often used for the first/last mile of public transport trips. Given these differences, and the uncertainty around e-scooters, we have not modified the ACM to incorporate e-scooter trips.

School trips

While we have used the Auckland Cycle Model (ACM) to assess cycling and e-bike demands in the first instance, the ACM is based on car and public transport trips from the regional MSM model. As a result, it generally omits shorter trips under 1-2 km, particularly effecting school trip estimates. Recognising this, we have developed estimates of cycling trips to schools using a first principles approach.

School trips have been estimated according to the following process:

[4] Wild, K. & Woodward, A. (2018). *Electric city: E-bikes and the future of cycling in New Zealand*. University of Auckland Medical and Health Sciences
[5] Khoo, J. (March 2021). Can active modes supercharge our health outcomes?
[6] TRA for Auckland Transport. (June 2021). *Measuring and growing active modes of transport in Auckland*

- the 2018 census indicates that there were 386,000 school students across Auckland in 2018. 2028 and 2038 student numbers have been derived by applying predicted population growth, from Auckland Council's I11.6 land use forecasts
- the existing cycle to school mode share in Auckland is approximately 1% (from census data). At the upper end of the spectrum (the "cycletopia" scenario), a 40% mode share has been assumed. In supporting this figure, we note that several Auckland schools already achieve a 20%-30% cycle mode share[7], without safe infrastructure. Internationally, higher mode shares have been achieved where best practice infrastructure is provided[8]. Mode shares for intermediate investment scenarios have been linearly interpolated between these 1% and 40% figures, relative to their modelled cycle trips from the ACM
- an average cycle trip length to school of 1 km has been assumed.

For the $306 million investment scenario, this process has resulted in 64,800 daily cycle-km to/from schools in 2028: 386,000 students x 117% population growth x 7.2% mode share x 1 km x 2 trips (ie return).

RTN trips

The ACM considers "complete trips" from origins to destinations (such as home to work). It is unable however to consider cycling legs of multimodal trips, such as a short cycle trip to an RTN station that is part of a longer RTN trip. Recognising this, we have developed estimates of cycling trips to RTN stations using a first principles approach.

Trips to RTN stations have been estimated according to the following process:

- the existing cycle mode share to Auckland RTN stations (1st mile trip) is approximately 1%, from Auckland Transport data. The existing cycle from RTN station mode share is 0% (the last mile trip)
- for the "cycletopia" scenario, a 1st mile mode share of 20% has been applied, and a last mile mode share of 5%. This is on the basis of
    - existing cycle mode shares to Devonport ferry terminal of between 7% (2013) to 16% (2015)
    - first and last mile mode shares to train stations in Copenhagen of 27% and 10%, respectively[9]
    - first and last mile mode shares to train stations across the Netherlands of 43% and 14%, respectively[10]
- these mode shares have been applied to the forecast 2028 and 2038 annual RTN boardings across the Auckland network, from Auckland Transport data

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[7] 34% recorded at Pasadena Intermediate 2017, 24%-29% at Belmont Intermediate 2011-2017
[8] For trips of 5km or less, 46% of primary school and 84% of secondary school trips in the Netherlands are by bike. Hoe gaan kinderen naar school? (How do Children travel to school?); van Goeverden and de Boer; Technische Universiteit Delft; November 2008
[9] https://cyclingsolutions.info/bike-plus-train-an-attractive-model/
[10] https://link.springer.com/article/10.1007/s11116-019-10061-3

- an average cycle trip length to/from RTN of 2 km has been assumed.

For the $306 million investment scenario, this process has resulted in 16,000 daily 1st-mile cycle-km to RTN stations in 2028: 99,600 morning period boardings x 4.0% 1st-mile mode share x 2 km x 2 trips (ie return).

Pedestrian demand estimates

Pedestrian demand estimates have been developed for the Future Connect investment scenario, which proposes new walking and cycling facilities along a significant section of SH20. Average demands of 160 pedestrians per day have been applied to this route, based on average recorded pedestrian counts on existing Auckland State Highway shared paths within similar environments as SH20, and accounting for projected population growth within the Māngere area.

APPENDIX B economic evaluation methodology

General methodology

This section quantifies the transportation economic benefits of each investment option.

The economic evaluation has been based on procedures from Waka Kotahi's Monetised Benefits and Costs Manual (MBCM). It has used predicted forecast 2028 and 2038 cycle demands from the ACM. ACM outputs from modelled scenarios both with and without the investment have been compared to isolate predicted benefits. Benefits for intermediate years have been interpolated and extrapolated from the two forecast years.

The project has been assessed with a standard 40-year evaluation period, and a 4% annual discount rate.

The evaluation applies a 10-year construction period beginning in January 2022 and ending December 2031. During this construction period, we have assumed that 10% of the programme will be completed each year, so that benefits accrue at that 10% rate per year. Ie

- no benefits in the first year of implementation, 2022
- 10% of benefits in 2023
- 20% of benefits in 2024
- through to 90% of benefits in 2031
- 100% of benefits from 2032 onward

The economic evaluation has been carried out using the MBCM's update factors relevant at the time of the assessment (November 2021), including

- 1.57 for travel time benefits
- 1.04 for walking and cycling benefits
- 1.14 for safety benefits
- 1.26 for road traffic reduction benefits
- 1.15 for emissions reduction benefits.

We note that Waka Kotahi released revised updated factors on 15 December 2021. The revised factors will not have a material effect on the BCRs, increasing them by approximately 2%.

Benefit streams

The following benefit streams have been assessed for the project

- perceived travel time benefits for cyclists – calculated using ACM outputs and applying MBCM travel time cost rates
- health benefits for cyclists – calculated using outputs from the ACM, and applying MBCM health benefit rates
- health benefits for pedestrians – calculated using estimated pedestrian demands on new pedestrian routes, and applying MBCM health benefit rates

- safety benefits for cyclists – calculated using outputs from the ACM, and applying MBCM cycling safety benefit rates
- general traffic reduction benefits – calculated using outputs from the ACM, and applying a composite road traffic reduction benefit rate from the MBCM to account for vehicle travel time, operating cost, crash cost and emissions benefits

Further detail on each of the above benefit streams is provided in the following sections.

Cyclist perceived travel time cost savings

Perceived cyclist travel time cost savings associated with the project have been evaluated, based on outputs from the ACM. The evaluation has applied the MBCM's Relative Attractiveness rating to weight travel time by the perceived cost on each route according to that route's infrastructure standard. The travel time costs on each modelled link included in the ACM have been aggregated across the Reference Case and Option networks, using fixed trip matrices, and compared to determine user cost savings for existing users. These have then been applied to predicted new users on the network, using the rule of half.

We have applied average cycle speeds of 17 km/hr across the network, based on the existing average cycle speed recorded in the NZ Household Travel Survey.

In 2028 for example, for the $306 million investment scenario

- The ACM predicts cyclists will travel 239,482 daily cyclist-km across the 2028 Reference Case network. When adjusting this for Relative Attractiveness on each link and the average speed above, the daily perceived travel time is 9,543 cyclist-hr
- With the project, and with fixed Do Minimum cycle demands, the perceived daily travel time reduces to 9,265 cyclist-hr, a saving of 278 daily cyclist-hr, shared by 6,741 existing daily trips that are predicted to use the project links
- A further 9,586 new daily trips are predicted to use the project links in 2028, in response to the investment. To these users, half of the above perceived travel time cost savings, per user, have been applied. Ie: 278 / 9,265 x 9,586 x 0.5 = 198 cyclist-hr per day
- The total perceived travel time saving is 278 + 198 = 476 cyclist-hr per day
- The above 476 daily cyclist-hr has been monetised, by applying a weighted travel time cost of $7.44/hour[11], the relevant MBCM update factor of 1.57, and multiplying by 365 days per year: 476 x $7.44 x 1.57 x 365 = $2,027,871 per year in 2028.

When also applied to the 2038 model outputs and discounted, the net discounted travel time cost savings are $38 million for the $306 million investment scenario, or approximately 5% of the overall project benefits.

[11] $7.80/hr for cycle commuting purposes and $6.90 for other cycling purposes, applying a 60%/40% utility/recreational split

Health benefits for people on bikes and e-bikes

This benefit stream calculates the health benefits gained from additional cycling activity. Cyclist health benefits have been calculated for the full length of each new cyclist trip. This quantity has been obtained directly from the model, with the total length of cyclist-km travelled under the Reference Case and Option scenarios compared, and the difference being the total distance of new cyclist-km trips. The estimated increase in school and RTN cycle-km has also been added to this figure.

The MBCM applies cycling health rates of

- $2.20 per cycle-km, for traditional pedal bicycles
- $1.00 per e-bike-km

The economic evaluation has applied a composite value of the above, based on the following estimated e-bike proportions

- 40% of bike trips estimated to be by e-bike (or similar device) by 2028
- 60% of bike trips estimated to be by e-bike (or similar device) by 2038

The MBCM requires cycling health benefits to be capped, with maximum annual benefits of $2,500 per year for pedal bike riders. This cap was developed on the basis that 50% of New Zealanders already achieve Ministry of Health physical exercise guidelines, so this 50% would not gain additional health benefits from cycling more. The cap is accordingly equal to 50% of the estimated $5,000 benefit of making an inactive person active. A lower cap of $2,000 per e-bike riders is given by the MBCM.

The above caps are not practical to apply however, as they apply to *people*, from a public health perspective. Transport planning generally however deals with *trips*, and the two (people versus trips) do not necessarily align. In the case of a street with on average of 100 daily cycle trips, these may be undertaken by several hundred individual people, some cycling twice a day and others only very occasionally.

Instead, we have capped the cycling health benefits by simply factoring these down by 40% (ie capping them at 60%), reflecting the 40% of Aucklanders who already meet the Ministry of Health's daily exercise guidelines. The assumption here is that 40% of new cycle trips will be undertaken by the 40% of Auckland's population that already meet daily exercise guidelines, and who therefore gain no personal health benefit from the new cycle trip.

Discounted over the 40-year evaluation period of the project, this benefit stream equates to $439 million for the $306 million investment scenario, or approximately 57% of the overall benefits.

Health benefits for pedestrians and wheeled pedestrians

The MBCM also allows health benefits to be calculated for new pedestrian trips, at a rate of $4.40 per new pedestrian-km travelled. As with the cycling health benefits above, this benefit stream reflects the health benefit gained by increased walking activity.

The MBCM does not however provide a health benefit rate for wheeled pedestrian trips, such as e-scooter trips. In lieu of this, we have applied the e-bike health benefit rate of $1.00 per km. We have weighted the two benefit rates assuming 20% of pedestrian trips will be via wheeled modes in 2028, and 40% in 2038. This assumption is on the basis of 20% of pedestrian trips on Tāmaki Drive being via wheeled modes when surveyed in 2018, and the expectation that access and availability of e-scooters and other wheeled pedestrian devices will increase over the coming years. Conversely however, we are aware that e-scooter use on Tāmaki Drive is likely higher than on other Auckland routes.

The MBCM also applies a cap to pedestrian benefits, of $1,250 per person per year. We have again applied this by capping pedestrian health benefits by 60%.

Pedestrian benefits have only been calculated for investment scenarios that include new pedestrian links, and only for that length of new pedestrian link. For the Future Connect scenario for example, this included significant lengths of new walking routes along SH20.

In total, discounted pedestrian health benefits are estimated to be $13 million for the Future Connect investment scenario, or approximately 0.2% of the overall project benefits.

Safety benefits for cyclists

The MBCM allows cycle safety benefits to be calculated for both new and existing cycle trips, where an improved cycling facility is provided. These may be calculated either per cyclist-km travelled on new facilities, or alternatively per cyclist in the case of "hazardous sites". The project does not specifically address hazardous sites, so the per cyclist-km method has been applied.

The calculation of this benefit stream follows the MBCM process, and applies the rate of $0.05 per cyclist-km travelled on improved routes. Forecast estimates of cyclists on each of the improved routes have been obtained directly from the ACM.

Over the 40-year evaluation period, the cycling crash cost savings discount to $15 million for the $306 million investment scenario, or approximately 2% of the project benefits.

The method above is based on MBCM Simplified Procedures 11 (SP11), which is intended for investment programmes of under $15 million. The Auckland Cycling PBC significantly exceeds this. In our experience however, carrying out a site-specific cycling crash analysis for an area-wide cycling investment programme is likely to result in comparable crash reduction benefits.

General traffic reduction benefits

Decongestion benefits are expected to be a significant portion of the overall project benefits, as the proposed investment scenarios would each provide alternatives to private car travel on currently congested Auckland road corridors. As a result, any mode shift in favour of active modes will reduce existing (or forecast future) congestion on the road network.

The MBCM decongestion value for Auckland is $1.94 per vehicle-km removed from the network during the commuter peak periods (Table 42, updated to current values). This region-wide value was developed in 2008 and does not necessarily recognise the levels of congestion currently experienced on central Auckland streets affected by the project, nor does it reflect how this congestion is expected to change over time. Nonetheless, without the benefit of a local traffic model to develop area specific decongestion values, we have applied the MBCM default value to the commuter peak periods, and omitted any inter peak decongestion benefits.

We note that where local traffic models have been available to assess specific projects elsewhere in Auckland, the resulting commuter peak period decongestion values have ranged up to $5 per vehicle-km in 2028 and $7 per vehicle-km in 2038. Interpeak values of approximately $1.50 per vehicle-km have also been developed. As a result, we consider our assessment to be conservative.

Forecasts of new commuter peak cycle trips have been obtained directly from the ACM, with additions made to account for school and RTN trips. It is important to recognise that not every new cycle trip on the network would otherwise have taken place by private car. Some cycle trips would instead replace a public transport, walking trip or car passenger trip, while others may be new trips entirely. Recognising this, the number of new cycle trips has been factored down by diversion rates. We have applied the following rates to each type of new cycle trip:

- a 2028 diversion rate of 0.47 has been applied to new cycle trips forecast by the ACM. This reflects future car mode share of trips across Auckland, expected car occupancy, and accounts for some new recreational cycle trips
- a diversion rate of 0.15 have been applied to new cycle trips to RTN stations, reflecting the existing 15% car mode share to existing Auckland RTN stations supplied by Auckland Transport
- a diversion rate of 0.91 for new RTN trips (ie a new train trip from Henderson to Britomart, replacing a car trip). This diversion factor accounts for a car occupancy of 1.1
- a diversion rate of 0.93 for school trips. This accounts for the existing average car mode share for trips to school within Auckland of 62% (from census data), and assumes that 50% of school trips are return trips by a parent or caregiver (ie home-school-home)
- the above diversion rates have been assumed to reduce over time, reflecting a falling car mode share across Auckland in the future.

We note that the MBCM does not provide diversion rates for cycling trips, but provides a rate of 0.725 for public transport trips in Auckland. The weighted average of the rates developed is 0.58, and this is appropriately lower than the MBCM's public transport diversion rate.

We have applied the diversion rate above to the respective commuter peak period cycle trip forecasts, and to the $1.94 benefit per car-km removed from the road network. We have annualised this assuming 245 weekdays per year. The resulting general traffic reduction benefits have been estimated to be $268 million for the $306 million investment scenario, discounted over the 40-year evaluation period. This accounts for approximately 35% of the overall project benefits.

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Congestion and emissions mitigation: A comparison of capacity, demand, and vehicle based strategies

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ABSTRACT

Capacity, demand, and vehicle based emissions reduction strategies are compared for several pollutants employing aggregate US congestion and vehicle fleet condition data. We find that congestion mitigation does not inevitably lead to reduced emissions; the net effect of mitigation depends on the balance of induced travel demand and increased vehicle efficiency that in turn depend on the pollutant, congestion level, and fleet composition. In the long run, capacity-based congestion improvements within certain speed intervals can reasonably be expected to increase emissions of CO_2e, CO, and NO_x through increased vehicle travel volume. Better opportunities for emissions reductions exist for HC and $PM_{2.5}$ emissions, and on more heavily congested arterials. Advanced-efficiency vehicles with emissions rates that are less sensitive to congestion than conventional vehicles generate less emissions co-benefits from congestion mitigation.

1. Introduction

In many cases, emissions reductions are cited as an implicit benefit of congestion mitigation without proper justification or quantification of the benefits. For example, the US Federal Highway Administration's Congestion Mitigation and Air Quality (CMAQ) improvement program suggests a clear co-beneficial relationship. If congestion mitigation is to be tied to air quality goals, we need better understanding of congestion impacts on motor vehicle emissions.

Vehicle emissions from motorized transportation have an established role in decreasing urban air quality and increasing atmospheric greenhouse gases. Concurrently, roadway congestion impacts urban areas throughout the world with varying economic, social, and environmental costs. But the full effects of traffic congestion on motor vehicle emissions are still not well quantified due to the existence of feedback effects and complex interactions. Potential changes in travel behavior or vehicle technology are two factors that complicate the evaluation of congestion mitigation effects on future emissions.

An important consideration to evaluate the impact of congestion mitigation measures on emissions is the effect of induced travel demand volume resulting from travel time savings. A report by Dowling (2005) used travel demand modeling to estimate the air quality effects of traffic flow improvements. The conclusion of the report states that more research is needed "to better understand the conditions under which traffic-flow improvements contribute to an overall net increase or decrease in vehicle emissions." Other, more focused research on a limited spatial scale has shown that induced demand from individual traffic flow improvements can entirely offset emissions rate reductions (Stathopoulos and Noland, 2003; Noland and Quddus, 2006).

Capacity-based strategies (CBSs) for reducing emissions ease congestion by increasing a roadway's vehicle throughput capacity and so increase vehicle operating efficiency. CBS can increase capacity by increasing physical lane-miles or by

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increasing existing roadway utilization through traffic flow improvements. The desired emissions benefit of congestion mitigation through CBS is reduced marginal emissions rates at higher average traffic speeds. However, it has the potential to generate induced vehicle travel demand.

Alternative strategies for reducing emissions can be vehicle based strategies (VBS) or demand based strategies (DBS). VBS directly target emissions through cleaner vehicles and fuels or more efficient driving. DBS, such as road pricing, reduce emissions by reducing vehicle travel volume and can reduce congestion simultaneously.

Here we investigate the broad conditions in which emissions co-benefits can be expected from congestion mitigation and compare capacity, demand, and vehicle based emissions reduction strategies. In particular, we study the effects of travel demand elasticity, the consequences of advanced vehicles in the fleet, and the role of light-duty and heavy-duty vehicles across types of pollutants. The methodological framework allows for a parsimonious estimation of net emissions effects at the aggregated level.

2. Methodological framework

The concept of elasticity is employed to set up the conditions that lead to positive or negative net emissions changes. The elasticity, $\varepsilon_{\bar{e}}^{\bar{v}}$, of average emissions rate, $\bar{e}$, to average travel speed, $\bar{v}$, is expressed

$$\varepsilon_{\bar{e}}^{\bar{v}} = \frac{\bar{v}}{\bar{e}} \cdot \frac{\partial \bar{e}}{\partial \bar{v}}. \tag{1}$$

The average vehicle emissions rate in mass per unit distance of travel is denoted as $\bar{e}$, and emissions from all on-road vehicles in mass per unit length of road, per unit of time is denoted as E. If the vehicle travel demand volume on a roadway is q (in vehicle throughput per unit time), then $E = q \cdot \bar{e}$. The average travel speed on the roadway is denoted as $\bar{v}$, in distance traveled per unit time.

The *long-term* elasticity of travel demand volume q to average speed $\bar{v}$ is expressed

$$\eta_{q}^{\bar{v}} = \frac{\bar{v}}{q} \cdot \frac{\partial q}{\partial \bar{v}}. \tag{2}$$

The value of $\eta_q^{\bar{v}}$ represents the percentage change in vehicle miles traveled (VMT) with a one percent $\bar{v}$ change on a roadway of arbitrary length. The elasticity of E to $\bar{v}$ is then

$$\varepsilon_{E}^{\bar{v}} = \frac{\bar{v}}{E} \cdot \frac{\partial E}{\partial \bar{v}} = \frac{\bar{v}}{q \cdot \bar{e}} \left(\frac{\partial q}{\partial \bar{v}} \cdot \bar{e} + q \cdot \frac{\partial \bar{e}}{\partial \bar{v}} \right) = \eta_q^{\bar{v}} + \varepsilon_{\bar{e}}^{\bar{v}}. \tag{3}$$

This relationship, $\varepsilon_E^{\bar{v}} = \eta_q^{\bar{v}} + \varepsilon_{\bar{e}}^{\bar{v}}$, is the central equation of the methodological framework; it expresses the elasticity of emissions to average travel speed as the combined effects of changes in travel demand volumes and emission rates. The break-even travel demand elasticity to speed, denoted $\gamma_q^{\bar{v}}$, that produces the condition $\varepsilon_E^{\bar{v}} = 0$ is $\gamma_q^{\bar{v}} = -\varepsilon_{\bar{e}}^{\bar{v}}$. It follows that:

$$\varepsilon_E^{\bar{v}} = \eta_q^{\bar{v}} - \gamma_q^{\bar{v}} \tag{4}$$

the difference between true demand elasticity and break-even demand elasticity is the emissions elasticity to speed.

The preceding equations are for an aggregate vehicle fleet; to understand the impacts of vehicle classes, additional notation and formulae are needed. For vehicles of class j (in the mutually exclusive and exhaustive set of vehicle classes J), the average emissions rate is e_j and travel demand volume is q_j. The fraction of on-road vehicles that are of class j (by distance traveled) is f_j, so that $f_j = \frac{q_j}{q}$. Class-total emissions are $E_j = q_j \cdot e_j = q \cdot f_j \cdot e_j$, and the elasticities $\varepsilon_{E_j}^{v_j}$, $\eta_{q_j}^{v_j}$, and $\varepsilon_{e_j}^{v_j}$ are similar to the ones defined previously, but only for vehicles of class j. Total emissions, E, from on-road vehicles of all classes in J, per unit length of road per unit time, are the sum of each class's emissions $E = \sum_{j \in J} E_j = \sum_{j \in J} (q_j \cdot e_j)$. From this,

$$E = q \cdot \sum_{j \in J} (f_j \cdot e_j) = q \cdot \bar{e}. \tag{5}$$

Employing $\varepsilon_{E_j}^{v_j} = \frac{v_j}{E_j} \cdot \frac{\partial E_j}{\partial v_j}$, the elasticity of E to $\bar{v}$ considering distinct vehicle classes is

$$\begin{aligned} \varepsilon_E^{\bar{v}} &= \frac{\bar{v}}{E} \cdot \frac{\partial \sum_{j \in J} E_j}{\partial \bar{v}} = \frac{\bar{v}}{E} \cdot \sum_{j \in J} \left[\frac{\partial E_j}{\partial v_j} \cdot \frac{\partial v_j}{\partial \bar{v}} \right], \\ \varepsilon_E^{\bar{v}} &= \frac{\bar{v}}{q \cdot \bar{e}} \cdot \sum_{j \in J} \left[\frac{E_j}{v_j} \cdot \varepsilon_{E_j}^{v_j} \cdot \frac{\partial v_j}{\partial \bar{v}} \right], \\ \varepsilon_E^{\bar{v}} &= \frac{\bar{v}}{\bar{e}} \cdot \sum_{j \in J} \left[\frac{f_j e_j}{v_j} \cdot \varepsilon_{E_j}^{v_j} \cdot \frac{\partial v_j}{\partial \bar{v}} \right]. \end{aligned} \tag{6}$$

If we assume that speed changes proportionally for all vehicle classes, $\frac{\partial v_j}{\partial \bar{v}} = \frac{v_j}{\bar{v}} \forall j \in J$, then

$$\varepsilon_E^{\bar{v}} = \frac{1}{\bar{e}} \cdot \sum_{j \in J} \left[e_j \cdot f_j \cdot \varepsilon_{E_j}^{v_j} \right] = \sum_{j \in J} \left[\frac{E_j}{E} \cdot \varepsilon_{E_j}^{v_j} \right]. \tag{7}$$

Table 1
MOVES emissions-speed curve fit parameters for $\bar{e}$ and e_j.

	CO_2e	CO	$PM_{2.5}$	NO_x	HC
Full fleet					
a_0	8.191	2.885	−1.223	1.897	0.3352
a_1	−0.1826	−0.1788	−0.1769	−0.1656	−0.2040
a_2	0.006339	0.006629	0.006640	0.005830	0.006643
a_3	−9.690E−05	−1.092E−04	−1.127E−04	−8.928E−05	−1.012E−04
a_4	5.357E−07	6.518E−07	6.724E−07	4.936E−07	5.674E−07
LD vehicles					
$a_{0,l}$	7.987	2.788	−2.856	0.3239	−0.2644
$a_{1,l}$	−0.1856	−0.1760	−0.2000	−0.1152	−0.1878
$a_{2,l}$	0.006352	0.006535	0.007365	0.004155	0.006173
$a_{3,l}$	−9.550E−05	−1.077E−04	−1.157E−04	−6.270E−05	−9.570E−05
$a_{4,l}$	5.210E−07	6.460E−07	6.560E−07	3.440E−07	5.510E−07
HD vehicles					
$a_{0,h}$	9.254	3.541	1.005	4.124	2.059
$a_{1,h}$	−0.1748	−0.1900	−0.1740	−0.1839	−0.2206
$a_{2,h}$	0.006307	0.006843	0.006599	0.006461	0.006967
$a_{3,h}$	−1.007E−04	−1.097E−04	−1.141E−04	−1.003E−04	−1.018E−04
$a_{4,h}$	5.740E−07	6.201E−07	6.870E−07	5.599E−07	5.380E−07

From this equation, emissions break-even conditions can also exist when decreased emissions from one vehicle class offset increased emissions from another, in addition to the general (trivial) case where $\varepsilon_{E_j}^{v_j} = 0 \forall j \in J$.

Following previous emissions research (Sugawara and Niemeier, 2002; Barth and Boriboonsomsin, 2008), the functional form for $\bar{e} = f(\bar{v})$ employed in this paper is

$$\bar{e}(\bar{v}) = \exp\left(\sum_{i=0}^{n}[a_i \cdot \bar{v}^i]\right), \tag{8}$$

where a_i are fitted parameters and $n = 4$. Similarly, class-average emissions rates, e_j, as a function of v_j are

$$e_j(v_j) = \exp\left(\sum_{i=0}^{n}[a_{i,j} \cdot v_j^i]\right). \tag{9}$$

The curves defined by Eqs. (8) and (9) are henceforth referred to as emissions-speed curves (ESC). By differentiating these ESC,

$$\varepsilon_{\bar{e}}^{\bar{v}} = \sum_{i=1}^{4}(ia_i\bar{v}^i) \quad \text{and} \quad \varepsilon_{e_j}^{v_j} = \sum_{i=1}^{4}\left(ia_{i,j}v_j^i\right). \tag{10}$$

Note that $\varepsilon_{\bar{e}}^{\bar{v}}$, and $\gamma_q^{\bar{v}}$, are independent of q as long as $\bar{e} = f(\bar{v})$; the same independence from q holds for the class-specific variables.

ESC parameters a_i and $a_{i,j}$ are estimated using data points generated from the Motor Vehicle Emissions Simulator (MOVES) 2010 model from the US Environmental Protection Agency (EPA) (2009a). The pollutants modeled are CO_2e (greenhouse gases in carbon dioxide equivalent units), CO (carbon monoxide), NO_x (nitrogen oxides), $PM_{2.5}$ (particulate matter smaller than 2.5 μm), and HC (hydrocarbons). Emissions rates are modeled at 16 discrete average speeds (in 5 mph increments), and the parameters a_i and $a_{i,j}$ are estimated by minimizing squared error, with $\bar{e}$ and e_j in grams per vehicle-mile and $\bar{v}$ and v_j in miles per hour (mph). Note that $\bar{v}$ and v_j do not represent constant-speed driving, but are instead facility-specific average speeds representing archetypal driving speed profiles.

The fitted ESC obtain $R^2 > 0.96$ for all five pollutants. Fitted parameters a_i and $a_{i,j}$ are shown in Table 1 for the full vehicle fleet and for light-duty (LD) and heavy-duty (HD) portions of the vehicle fleet on freeways for April 2010. The modeled full fleet is composed of 8.9% HD vehicles. Separate parameters are estimated for arterial emissions rates.

3. Emissions impacts of CBS

The long-term net emissions effects of CBS can be estimated as $\varepsilon_E^{\bar{v}}$ from Eq. (3), with modeled values for a_i and an expected value for travel demand elasticity, $\eta_q^{\bar{v}}$ (which is highly uncertain). To estimate only the sign of net changes in emissions it is only necessary to determine the value of the break-even demand elasticity $\gamma_q^{\bar{v}}$, which is dependent on average travel speed, vehicle fleet composition, and ESC parameters. Three distinct scenarios are possible: (a) if $\eta_q^{\bar{v}} < \gamma_q^{\bar{v}}$ then CBS will likely decrease emissions, (b) if $\eta_q^{\bar{v}} > \gamma_q^{\bar{v}}$ then CBS will likely *increase* emissions, and (c) if $\eta_q^{\bar{v}} = \gamma_q^{\bar{v}}$ then emissions are likely to be unaffected by changes in capacity and congestion in the long term.

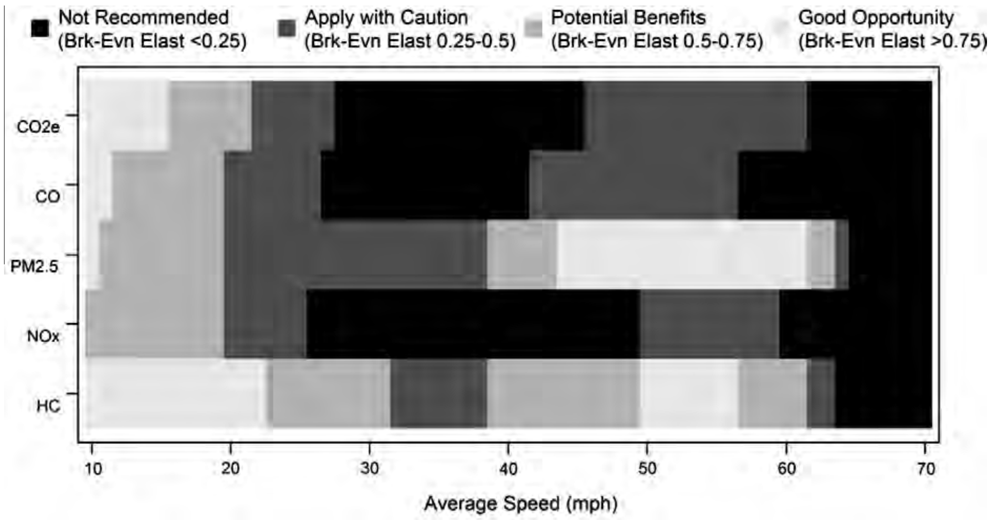

Fig. 1. Characterization of CBS for emissions reductions.

Previous works suggest that likely values of induced demand from capacity increases are in the range: $0.2 < \eta_q^{\bar{v}} < 1.0$. Using this range of likely elasticity values, Fig. 1 shows qualitative characterizations of expected emissions effects of CBS for each pollutant over a range of speeds for the full-modeled fleet on freeways – based on $\gamma_q^{\bar{v}} = -\sum_{i=1}^{4}(ia_i\bar{v}^i)$ and a_i from Table 1. As an emissions-reducing strategy, CBS are "not recommended" for $\gamma_q^{\bar{v}} < 0.25$; CBS are suggested to "apply with caution" for $0.25 \leqslant \gamma_q^{\bar{v}} < 0.5$; CBS have "potential benefits" for $0.5 \leqslant \gamma_q^{\bar{v}} < 0.75$; and CBS provide "good opportunity" for emissions reductions for $0.75 \leqslant \gamma_q^{\bar{v}}$.

Beyond the potential subjectivity of the classification, it is evident from Fig. 1 that CBS will have significantly different net impacts across pollutants. $PM_{2.5}$ and HC have the widest range of speeds for which CBS are likely to reduce emissions. The other pollutants (CO_2e, CO, and NO_x) are only classified as "potential benefits" or better at speeds of about 20 mph and below – suggesting emissions increases from CBS above 20 mph. CBS are "not recommended" for all pollutants at speeds above 65 mph, showing the emissions benefits from limiting free-flow speeds to below 65 mph.

The characterizations in Fig. 1 assume similar responses by vehicle type. Now consider a binary segmentation of the vehicle fleet where $j = l$ is all LD vehicles and $j = h$ is all HD vehicles: $\{j = l, h\}$. If we assume the extreme case of $\eta_{qh}^{vh} = 0$ (inelastic HD vehicle travel demand to travel speed), then from Eq. (7), $\varepsilon_E^{\bar{v}} = 0$ when $\eta_{ql}^{v_l} = -\left(\frac{e_h \cdot f_h}{e_l \cdot f_l} \cdot \varepsilon_{e_h}^{v_h} + \varepsilon_{e_l}^{v_l}\right)$. Based on this net break-even demand elasticity for LD vehicles, Fig. 2 shows a similar characterization of CBS to Fig. 1, but assuming $\eta_{qh}^{vh} = 0$ (with initial $f_h = 0.09$ and $a_{i,j}$ from Table 1).

The demand elasticity of HD vehicles is a major factor to determine net emissions changes. In Fig. 2 there is a wider array of speeds for all pollutants that present opportunities for emissions reductions through CBS than in Fig. 1. For $PM_{2.5}$ and HC good opportunities exist for emissions reductions from CBS all the way up above 60 mph. Although this is perhaps an

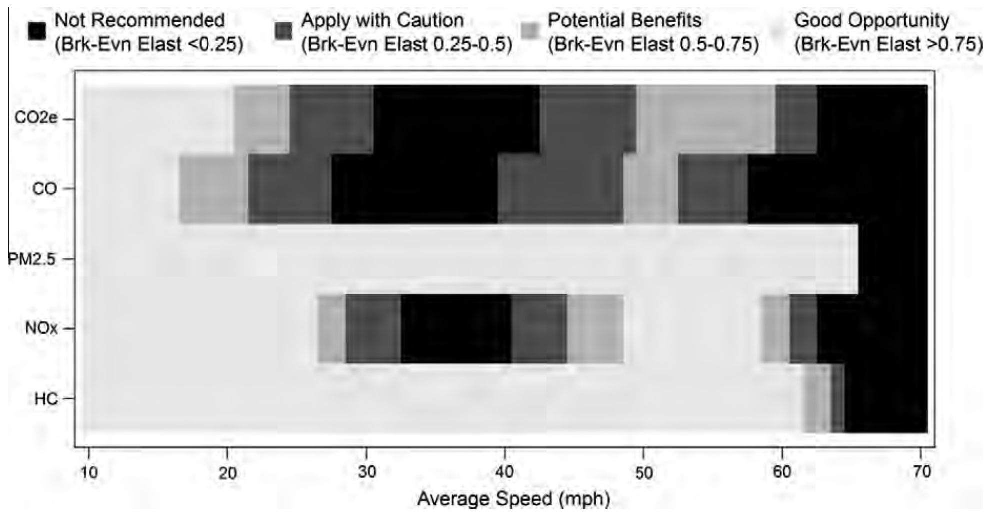

Fig. 2. Characterization of CBS based on break-even demand elasticity for LD vehicles, assuming inelastic HD demand.

extreme value of demand elasticity for HD vehicles, it demonstrates that even at only 9% of the fleet, η_{qh}^{vh} is an important consideration for predicting emissions effects of congestion mitigation.

For this analysis to apply, CBS are not necessarily additional lane-miles. Capacity or throughput can also be increased by various traffic management strategies that target roadway efficiency and utilization such as lane change restrictions on freeways or effective management of variable speed limits. The key to the effects demonstrated here is an increase in average travel speed with baseline or higher traffic volumes.

Some traffic management techniques could have implications for vehicle speed profiles that would affect estimates of $a_{i,j}$ (we assumed $a_{i,j}$ parameters do not change in Figs. 1 and 2). For example, a significant "smoothing" of vehicle speeds could reduce the average emissions rate at a given average travel speed by reducing engine loads (Barth and Boriboonsomsin, 2008). This change in the ESC parameters would have to be considered in concert with any changes in average travel speed or travel demand volume, but the same methodology can be applied to estimate long-term emissions impacts of CBS.

Similarly, emissions rates are expected to trend downward over time. If the *shape* of the ESC (i.e. $\varepsilon_{\bar{e}}^{\bar{v}}$) do not change, then the analysis is unaffected. If, on the other hand, advances in vehicle technology lead to vehicles that are less sensitive to congestion (i.e. flatter ESC), then the prospects of CBS are affected.

4. The impacts of more efficient vehicles (VBS)

The results in Section 3 are for conventional internal combustion engine (ICE) vehicles only – the vast majority of the existing on-road fleet (US Environmental Protection Agency, 2009b). We now examine the effects of introducing advanced vehicles in the fleet, a form of VBS. By reducing $\bar{e}$, VBS decrease emissions as $\frac{\partial E}{\partial \bar{e}} = q$ (from Eq. (5)), and thus $\varepsilon_E^{\bar{e}} = 1$. But VBS can also impact the efficacy of CBS for emissions reductions. Let vehicle class $j = c$ be all conventional ICE vehicles, vehicle class $j = e$ be Electric Vehicles (EV), and vehicle class $j = a$ be other Advanced Efficiency (AE) vehicles. This is the complete set of vehicles, $J = \{c, a, e\}$, with emissions of $E = E_c + E_a + E_e$. The emissions elasticity to speed, from Eq. (7), is then

$$\varepsilon_E^{\bar{v}} = \frac{E_c}{E}\varepsilon_{E_c}^{v_c} + \frac{E_a}{E}\varepsilon_{E_a}^{v_a} + \frac{E_e}{E}\varepsilon_{E_e}^{v_e}. \tag{11}$$

The AE vehicle class contains vehicles (such as many gas-electric hybrids) with regenerative braking and other improvements that render them less sensitive or insensitive to low-speed inefficiencies: i.e. $|\varepsilon_{e_a}^{v_a}| < |\varepsilon_{e_c}^{v_c}|$. Then, because $\varepsilon_{v_c}^{e_c}$ is expected to be negative through most of the range of feasible speeds according to the MOVES-based ESC, $\varepsilon_{e_c}^{v_c} < \varepsilon_{e_a}^{v_a} \leqslant 0$. Considering only emissions from ICE and AE vehicles ($E = E_c + E_a$), Eq. (11) reduces to

$$\varepsilon_E^{\bar{v}} = \frac{E_c}{E}\varepsilon_{E_c}^{v_c} + \frac{E_a}{E}\varepsilon_{E_a}^{v_a} = \varepsilon_{E_c}^{v_c} - \frac{E_a}{E}\left(\varepsilon_{E_c}^{v_c} - \varepsilon_{E_a}^{v_c}\right). \tag{12}$$

If we assume that travel demand elasticity is unaffected by vehicle type, $\eta_{q_j}^{v_j} = \eta_q^{\bar{v}}\forall j$, then using $\varepsilon_{E_j}^{v_j} = \eta_{q_j}^{v_j} + \varepsilon_{e_j}^{v_j}$, Eq. (12) further reduces to

$$\varepsilon_E^{\bar{v}} = \varepsilon_{E_c}^{v_c} - \frac{E_a}{E}\left(\varepsilon_{e_c}^{v_c} - \varepsilon_{e_a}^{v_a}\right). \tag{13}$$

The value of $\varepsilon_{e_c}^{v_c} - \varepsilon_{e_a}^{v_a}$ is expected to be negative because it is assumed that $\varepsilon_{e_c}^{v_c} < \varepsilon_{e_a}^{v_a} \leqslant 0$. Thus, with an increase in E_a (because of higher f_a or e_a), $\varepsilon_E^{\bar{v}}$ increases, too (becomes more positive or less negative). In other words, emissions are more likely to increase with speed when there are more or higher-emitting AE vehicles in the fleet. The change can be explained by lower emissions rate sensitivity to speed for AE vehicles: AE vehicles have less efficiency improvement than ICE vehicles with increasing speed, but still are subject to increased emissions through induced demand.

From Eq. (13), emissions break-even conditions ($\varepsilon_E^{\bar{v}} = 0$) exist when $\varepsilon_{E_c}^{v_c} = \frac{E_a}{E}\left(\varepsilon_{e_c}^{v_c} - \varepsilon_{e_a}^{v_a}\right)$, or substituting and combining terms,

$$\eta_q^{\bar{v}} = \frac{E_c}{E}\gamma_{q_c}^{v_c} + \frac{E_a}{E}\gamma_{q_a}^{v_a}. \tag{14}$$

Because $\varepsilon_{e_c}^{v_c} < \varepsilon_{e_a}^{v_a} \leqslant 0$, we expect that $\gamma_{q_c}^{v_c} > \gamma_{q_a}^{v_a} \geqslant 0$, and thus the break-even demand elasticity with AE vehicles present is smaller than for ICE vehicles alone ($\gamma_{q_c}^{v_c}$). In the extreme case, AE vehicles have emissions rates that are non-zero ($e_a \neq 0$) but that are insensitive to congestion level and average speed, $\varepsilon_{e_a}^{v_a} = \gamma_{q_a}^{v_a} = 0$. Then Eq. (14) reduces to $\eta_q^{\bar{v}} = \frac{E_c}{E}\gamma_{q_c}^{v_c}$ and the break-even demand elasticity is smaller in proportion to the fractional ICE emissions out of emissions. Smaller values of break-even demand elasticity suggest *less* potential for emissions benefits from congestion mitigation. More AE vehicles are expected to decrease emissions as they replace ICE vehicles, as long as $e_a < e_c$; but efficiency gains through speed increases are more likely to be cancelled out by induced demand, and CBS are less likely to be an effective emissions reduction strategy with more AE vehicle emissions.

Regarding electric vehicles, if EV emissions are zero ($e_e = 0$ and by extension $\frac{\partial e_e}{\partial v_e} = \varepsilon_{e_c}^{v_c} = 0$), then Eqs (13) and (14) still apply. Unless a change in f_e affects the fraction of AE vehicle emissions $\frac{E_a}{E}$ through a change in $\frac{f_a}{f_c}$, the emissions elasticity to speed $\varepsilon_E^{\bar{v}}$ is independent of the fraction of EV in the fleet, f_e (even though EV's reduce emissions on a per-vehicle basis). Similarly, if the presence of EV's does not affect $\frac{f_a}{f_c}$, then the EV's will not impact break-even demand elasticity. If we choose to consider the upstream emissions for EV that are generated during the electric power production process (i.e. using a "well-to-wheels"

Table 2
Equivalent emissions reduction strategies for freeway CO_2e $\left(\eta_q^{\bar{v}} = 0.3\right)$.

	19–31 mph	31–53 mph	53–60 mph
Avg. speed change (mph)	11.9 (64%)	22.4 (73%)	6.8 (13%)
Travel demand change (vehicle miles/peak traveler-day)	0.7 (9%)	0.8 (10%)	0.2 (2%)
Net emissions change (g CO_2e/peak traveler-day)	−131 (−3%)	112 (3%)	−31 (−1%)
Alternative demand strategy			
Trip length change (vehicle miles/peak traveler-day)	−0.2 (−3%)	0.2 (3%)	−0.1 (−1%)
Alternative vehicle efficiency strategies			
Vehicle fuel efficiency change (miles/gallon)	0.5 (3%)	−0.5 (−3%)	0.2 (1%)
Fuel carbon intensity change (kg CO_2e/gallon)	−0.3 (−3%)	0.3 (3%)	−0.1 (−1%)
EV penetration by LCA (% of peak period fleet)	8%	−9%	3%
EV penetration by zero-emissions (% of peak period fleet)	4%	−4%	1%

approach or life-cycle assessment (LCA)), then $0 < e_e < e_c$ and we can represent EV as a new type of AE vehicle – and the previous Eqs. (13) and (14) are still applicable.

5. Travel volume reductions and emissions

In terms of the methodological framework, by reducing q, DBS decrease emissions as $\frac{\partial E}{\partial q} = \bar{e}$ (from Eq. (5)), or $\varepsilon_E^q = 1$. But DBS also relate to congestion through the CBS analysis. When $\eta_q^{\bar{v}} > \gamma_q^{\bar{v}}$, average speed-based efficiency alone cannot reduce emissions because of induced travel demand. From the DBS perspective, when $\eta_q^{\bar{v}} > \gamma_q^{\bar{v}}$ a capacity decrease (i.e. "road diet") can reduce emissions if the suppressed travel demand volume offsets higher vehicle emission rates at lower average travel speeds. In other words, with a capacity-based approach, lower emissions are more likely by increasing capacity when $\eta_q^{\bar{v}} > \gamma_q^{\bar{v}}$ and by *decreasing* capacity when $\eta_q^{\bar{v}} > \gamma_q^{\bar{v}}$.[1]

In other forms of DBS vehicle travel demand volume is reduced by motivators such as road pricing or travel restrictions. For the demand volume change alone the emissions effect is indicated by $\varepsilon_E^q = 1$. If the DBS impacts congestion or is jointly implemented with a CBS, the key value for application of this analysis is the *net* travel demand elasticity to travel speed. For example, if a demand-moderating measure such as road pricing is implemented along with a capacity expansion, then that effect can be incorporated as a lower expected range of $\eta_q^{\bar{v}}$. In the best case (for emissions), both increased average travel speeds and reduced vehicle travel demand volume (i.e. $\eta_q^{\bar{v}} < 0$) contribute to a reduction of emissions; e.g. strong pricing programs such as implemented in London (Beevers and Carslaw, 2005).

6. Comparing strategies for emissions reductions

Initially we look at freeways, comparing VBS and DBS to CBS that increase congested speeds as indicated by a level-of-service (LOS) change.[2] The comparison is presented as the amount of a VBS or DBS that would achieve equivalent emissions reductions to the CBS. Results for CO_2e emissions are shown in Table 2 using $\eta_q^{\bar{v}} = 0.3$ (a relatively low demand elasticity value). The three numerical columns in Table 2 (from left to right) show LOS changes from F to E, from E to D, and from D to the A–C range. For each hypothetical LOS improvement the net changes in average speed, travel demand volume, and peak period emissions are shown in the first three rows of the Table. Only emissions from peak-period freeway travel are included, and the LOS changes only apply to the congested portion of freeway travel: 55%.

The final rows in Table 2 show the VBS and DBS changes that would be required to generate the same peak period emissions changes on freeway facilities from each alternative strategy. The VBS and DBS effects apply to all peak-period freeway travel; other impacts are excluded (e.g. EV ownership would also reduce emissions from non-peak period trips and from travel on non-freeway facilities).

As an example, consider the first numerical column of Table 2, which considers CO_2e emissions for a freeway LOS change from F to E. The average speed change on congested freeways from 19 to 31 mph (rounded) is a speed increase of 64%; row 1. Assuming $\eta_q^{\bar{v}} = 0.3$, this speed increase leads to 0.7 additional vehicle-miles of peak period freeway travel (per peak period traveler per day), an increase of 9%; row 2. Considering the increased efficiency and induced demand, CO_2e emissions are reduced fall by 3%; row 3. This 131 g of emissions savings could also have been achieved by reducing daily peak-period freeway travel by 3% vehicle-miles per peak period; row 4. Alternatively, 131 g of CO_2e could be saved if daily peak-period freeway travel were in vehicles with 3% higher average per gallon fuel economy; row 5. A decrease of 0.3 kg CO_2e per gallon in the carbon intensity of fuel burned during peak-period freeway travel could also save 131 g of CO_2e emissions; row 6. Finally,

[1] This assumes that demand elasticities to speed changes in each direction are the same – i.e. the aggregate travel response to a speed increase is equal and opposite of the response to a speed decrease.

[2] LOS is used as a qualitative congestion indicator, with average speeds for freeways from Barth et al. (1999). LOS F is the most congested, while LOS A through C are essentially at free-flow speeds.

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Table 3
Equivalent emissions reduction strategies for arterial CO_2e $\left(\eta_q^{\bar{v}} = 0.3\right)$.

	10–16 mph	16–24 mph	24–35 mph
Avg. speed change (mph)	6.0 (60%)	8.0 (50%)	11.0 (46%)
Travel demand change (vehicle miles/peak traveler-day)	0.7 (9%)	0.6 (8%)	0.6 (7%)
Net Emissions change (g CO_2e/peak traveler-day)	−1002 (−15%)	−374 (−7%)	31 (1%)
Alternative demand strategy			
Trips length change (vehicle miles/peak traveler-day)	−1.3 (−15%)	−0.6 (−7%)	0.1 (1%)
Alternative vehicle efficiency strategies			
Vehicle fuel efficiency change (miles/gallon)	1.9 (17%)	1.1 (8%)	−0.1 (−1%)
Fuel carbon intensity change (kg CO_2e/gallon)	−1.3 (−15%)	−0.6 (−7%)	0.1 (1%)
EV penetration by LCA (% of peak period fleet)	29%	17%	−2%
EV penetration by zero-emissions (% of peak period fleet)	19%	9%	−1%

converting 8% (by LCA) or 4% (by zero-emissions estimation) of the LD vehicle fleet to EV's for peak-period freeway travel could also achieve the same savings of 131 g CO_2e; rows 7 and 8.

As expected from previous results, the LOS change from F to E generates the greatest emissions benefits in Table 2, which require the largest alternative strategies to match. These alternative strategies, subjectively modest but in some cases difficult to implement, have the potential for low or zero capital costs for transportation agencies (but lower fuel tax revenue). On the other hand, capital improvement projects for CBS such as urban freeway widening can be extremely expensive endeavors (but they can increase fuel consumption and associated tax revenues).

At the moderate demand elasticity of $\eta_q^{\bar{v}} = 0.3$ the induced travel for LOS E to LOS D leads to an emissions increase. When an emissions increase is expected, the alternative strategy equivalents have opposite signs from an emissions savings – i.e. longer trips, reduced vehicle efficiency, higher fuel carbon intensity, and fewer EV's in the fleet. Using an assumed elasticity of $\eta_q^{\bar{v}} = 0.5$ the induced travel leads to emission increases for all three LOS improvements in Table 2.

Table 3 shows the results of an equivalent analysis for CO_2e emissions on arterials, again with a demand elasticity of $\eta_q^{\bar{v}} = 0.3$. Table 3 uses travel speed increases of 10–16 mph, 16–24 mph, and 24–35 mph, roughly parallel to the heavily congested – moderately congested – uncongested LOS improvements in Table 2. As expected for a lower-speed facility, arterial congestion mitigation is more effective at reducing emissions rates. Still, even with this moderate demand elasticity the speed improvement above 24 mph produces a net emissions increase because of induced demand.

The values in row 4 of Tables 2 and 3 associated with VMT reductions (DBS) assume a fixed number of peak period travelers and no change in average emissions rates (i.e., shorter or longer trips but the same and $\bar{v}$ and $\bar{e}$). The values in rows 5–8 (VBS) assume no changes in $\bar{v}$. Values in row 7 of Tables 2 and 3 assume an EV carbon intensity of travel of 0.216 kg CO_2e - per mile (Samaras and Meisterling (2008)) based on LCA, although upstream emissions are not included in the on-road emissions estimates for ICE vehicles (a conservative approach). Tables 2 and 3, row 8, assume zero emissions for EV's; the assumption of zero emissions for EV's is also made for local pollutants.

Additional assumptions underlying our calculations include:

- Average daily peak period travel on freeway and arterial facilities of 8.0 and 8.6 miles, respectively, per peak period traveler (the average of 439 US urban areas in 2007 – extractable from the data tables accompanying the Urban Mobility Report (UMR) (Schrank and Lomax, 2009).
- About 55% of peak period freeway and arterial travel (by VMT) is congested (the average of 439 US urban areas in 2007 – again from the UMR data tables).
- Average fuel carbon intensity of 8.90 kg CO_2e per gallon; calculated from US Environmental Protection Agency (2009b).
- MOVES-based ESC parameters as shown in Table 1.
- The portion of peak-period travel on uncongested freeways and arterials is assumed to have average speeds of 60 mph and 35 mph, respectively – emissions from travel on local roads is neglected (a conservative assumption for the VBS).
- Induced demand is calculated using mid-point arc elasticity between two travel speed/travel volume conditions $(\bar{v}_1, VMT_1)$ and $(\bar{v}_2, VMT_2)$ as

$$\eta_q^{\bar{v}} = \frac{(VMT_2 - VMT_1)(\bar{v}_2 + \bar{v}_1)}{(VMT_2 + VMT_1)(\bar{v}_2 - \bar{v}_1)}. \tag{15}$$

The net percent emissions changes from CBS (row 3 of the preceding tables) for each facility-pollutant-LOS combination are shown in Fig. 3, again using $\eta_q^{\bar{v}} = 0.3$ and our assumptions. Positive values indicate emissions increases. Fig. 3 shows that the largest emissions reductions from CBS are for heavily congested arterials. NO_x and CO emissions have almost no benefit from freeway congestion mitigation, while HC, the most speed-sensitive pollutant, has generally the highest potential savings.

From the net emissions benefits of CBS shown in Fig. 3, equivalent VBS and DBS are easily determined by their emissions elasticity. For VMT reductions (row 4, Tables 2 and 3), increased fuel efficiency (row 5, Tables 2 and 3), and decreased fuel carbon intensity (row 6, Tables 2 and 3) the emissions point elasticity is −1. Thus, for these strategies a certain percentage

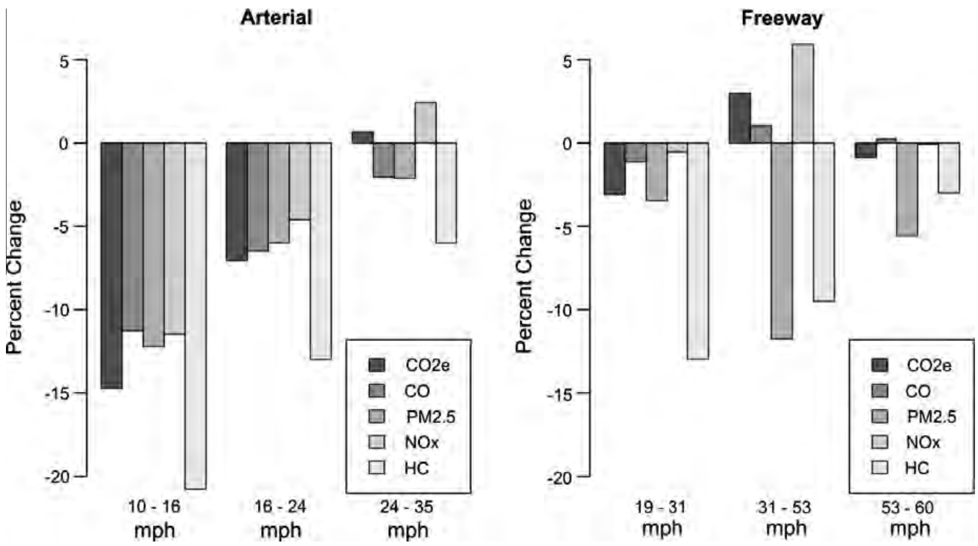

Fig. 3. Percent change in peak period emissions from CBS.

emissions reduction from a CBS can also be accomplished by roughly the same percentage implementation of the VBS or DBS.[3] For example, the 3% reduction in CO_2e for the lowest-speed freeway improvement (Fig. 3) can also be accomplished through a 3% reduction in VMT, a 3% increase in fuel efficiency, or a 3% decrease in fuel carbon intensity.

For EV penetration of the fleet (rows 7 and 8 in Tables 2 and 3) the emissions elasticity is slightly more complicated. Let $J = \{l, h, e\}$ where l and h are entirely ICE classes of LD and HD vehicles and e is a class of LD EV. If all EV are replacing LD ICE vehicles, then $\frac{\partial f_l}{\partial f_e} = -1$ and $\frac{\partial f_h}{\partial f_e} = 0$. The elasticity of E to f_e is then

$$\varepsilon_E^{f_e} = \frac{1}{E}\frac{\partial E}{\partial f_e} = \frac{e_e - e_l}{\bar{e}}. \quad (16)$$

If $e_e = 0$ (zero-emissions EV) and initially $f_e = 0$, then

$$\varepsilon_E^{f_e} = \frac{-1}{1 + f_h\left(\frac{e_h}{e_l} - 1\right)}. \quad (17)$$

The expected range of the ratio $\frac{e_h}{e_l}$ is from around 1 for CO up to 60 for $PM_{2.5}$ at low speeds. Thus, using $f_h = 0.09$, $\varepsilon_E^{f_e}$ can range from -1.0 for CO to -0.16 for $PM_{2.5}$. Considering LCA EV emissions for CO_2e the elasticity is smaller: $\varepsilon_E^{f_e}$ changes by a factor of $\left(1 - \frac{e_e}{e_l}\right)$, or roughly 0.5 employing our assumptions. Since $-1 \leqslant \varepsilon_E^{f_e} < 0$, the emissions elasticity to EV replacement of LD ICE vehicles is equal to or smaller than the emissions elasticity to the other VBS and DBS, and thus greater percent EV penetrations are needed.

Fig. 4 shows the equivalent EV replacement results (i.e. rows 7 and 8 in Tables 2 and 3) for all pollutants on both facilities, again assuming $\eta_q^{\bar{v}} = 0.3$. As expected, the percentages are larger than in Fig. 3 – in addition to having the opposite sign because $-1 \leqslant \varepsilon_E^{f_e} < 0$. From the denominator of Eq. (17), fleets with more HD vehicles (f_h) and pollutants with higher relative emissions rates from HD vehicles $\left(\frac{e_h}{e_l}\right)$ have smaller emissions elasticity to EV penetration, $\varepsilon_E^{f_e}$. Smaller $\varepsilon_E^{f_e}$ means that EV replacement for LD vehicles is less effective at reducing emissions. This effect is reflected in Fig. 4, where $PM_{2.5}$ and NO_x (which have the highest $\frac{e_h}{e_l}$) are proportionally larger than the other pollutants when compared to Fig. 3. The EV replacement of LD vehicles must be particularly large to reduce $PM_{2.5}$ because the $PM_{2.5}$ emissions are primarily from the HD portion of the vehicle fleet. Fig. 4 indicates that VBS that only reduce LD vehicle emissions require large-scale deployment to be competitive with other strategies for reducing certain local pollutants.

7. Vehicle class-specific strategies

The distinct emissions performance of LD and HD vehicles raises the potential for emissions co-benefits from more focused congestion mitigation strategies that address vehicle classes separately. As a comparison of congestion and emissions mitigation approaches and their class-specific effects, Table 4 shows a short list of emissions mitigation strategies with their expected direct impacts on the key variables of this analysis: travel speed v_j, travel volume q_j, emissions rate parameters $a_{i,j}$, and travel demand volume elasticity to speed $\eta_{a_j}^{v_j}$. The cells in the table are filled in with the relationships of an expected increase "+", decrease "–", or no change "o". These relationships are highly generalized, and actual impacts can depend

[3] The percent changes for vehicle efficiency in Tables 2 and 3 are slightly different from the emissions savings because emissions are inversely related to efficiency, so the point elasticity of unity will be different from the arc elasticity which is used in the tables.

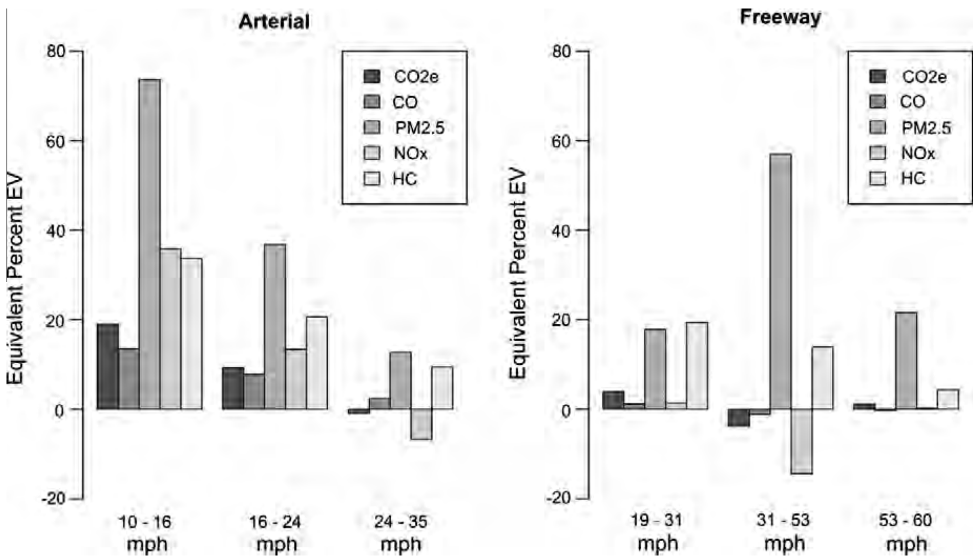

Fig. 4. Zero-emissions LD EV penetration for equivalent VBS.

Table 4
Vehicle class-specific congestion and emissions mitigation strategy impacts.

Mitigation strategy	Light-duty vehicles				Heavy-duty vehicles			
	v_l	q_l	$a_{i,l}$	$\eta_{q_l}^{v_l}$	v_h	q_h	$a_{i,h}$	$\eta_{q_h}^{q_h}$
General capacity increase	+	+	o	o	+	+	o	o
Truck-only lanes (no toll) – new capacity	+	+	o	o	+	+	o	o
Truck-only lanes (no toll) – appropriated capacity	–	–	o	o	+	+	o	o
Truck-only lanes (tolled) – new capacity	+	+	o	o	+	o	o	–
Truck-only lanes (tolled) – appropriated capacity	–	–	o	o	+	o	o	–
Congestion pricing/demand reduction strategies	+	–	o	–	+	–	o	–
Vehicle/fuel efficiency improvements	o	o[a]	–	o	o	o[a]	–	o

[a] Assuming fuel cost savings do not lead to induced travel.

on the details of implementation. Truck-only lanes (TOL) are roadway facilities that provide exclusive right-of-way for HD vehicles (Transportation Research Board, 2010). Just as general capacity expansions can employ road pricing to mitigate induced demand, TOL can utilize lane pricing (tolling) for the same purpose.

Capacity expansions (CBS) increase v_l and q_j, and the emissions effect depends on the relative magnitude of each as demonstrated. The impacts of TOL on LD vehicles depend on whether the TOL are added capacity (in which case v_l and q_l would likely increase with the relocation of HD vehicles), or the TOL are appropriated general purpose capacity (in which case the capacity decrease for LD vehicles would likely lower v_l and q_l, though traffic flow impacts of this type of TOL vary (Transportation Research Board, 2010)). A tolled TOL can have similar efficiency benefits without an increase in q_h by offsetting travel time-savings with toll costs; i.e. reducing the effective value of $\eta_{q_h}^{v_h}$.

Congestion pricing and other forms of DBS reduce effective demand elasticity to travel speed, $\eta_{a_j}^{v_j}$ - but can also increase v_j by decreasing q_j and so reduce e_j. VBS include improvements in vehicle and fuel efficiency that reduce e_j by reducing the ESC parameters $a_{i,j}$, with the only likely impact on q_j or v_j being possible induced demand through a rebound effect due to decreased travel costs. The net effect of any of the strategies in Table 4 on emissions can be determined by the joint evaluation of $\varepsilon_{e_j}^{v_j}$ and $\eta_{a_j}^{v_j}$, representing tradeoffs between vehicle efficiency and volume.

8. Conclusions

We find that congestion mitigation does not inevitably lead to reduced emissions, and that the net effect of congestion mitigation will greatly depend on the type of emissions being analyzed. In the long run, capacity-based congestion reductions within certain speed intervals (e.g. 30–40 mph) can be expected to increase emissions of CO_2e, CO, and NO_x through increased vehicle travel volume. Wider speed ranges will see increased emissions in more specific conditions. Vehicle emissions of HC and $PM_{2.5}$ have greater potential for reductions through traffic congestion mitigation than CO_2e, CO, or NO_x.

Fleet composition and vehicle class relative emissions rates are also key factors that impact congestion and emissions mitigation strategies. Reducing light-duty vehicle emissions alone has only a small impact on $PM_{2.5}$; and a limited impact on other pollutants. Emissions reduction strategies must also seek efficiency improvements for heavy-duty vehicles. Further,

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even as a small fraction of the vehicle fleet, the demand elasticity of heavy-duty vehicles is important for predicting the emissions effects of general congestion mitigation. Advanced-efficiency vehicles with emissions rates that are less sensitive to congestion than conventional vehicles generate less emissions co-benefits from congestion mitigation strategies.

Applying hypothetical level-of-service improvements reveals that large percentage speed increases lead to comparatively small or non-existent net reductions in emissions. The largest potential emissions reductions for all pollutants are on heavily congested arterials; on freeways, large potential reductions are only seen for HC and $PM_{2.5}$ emissions. Comparing these capacity-based mitigation strategies with alternative approaches indicates that the same or more emissions benefits can be achieved by demand or vehicle based emissions reduction strategies.

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