

# TRANSFORMATIVE TRANSPORT PROJECTS (DYNAMIC WEBS AND LAND USE BENEFITS AND COSTS)

A technical paper prepared for the Investment Decision-Making Framework Review

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Waka Kotahi NZ Transport Agency has developed a methodology that can be used to recognise the benefits arising from a transformational transport investment – an investment that is expected to result in significant changes in the places where people live and work. It can be used in business cases involving rapid transit or a new strategic route in an urban area that significantly increases access to an employment centre. This methodology is available now, for immediate use.

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# EXECUTIVE SUMMARY

Waka Kotahi NZ Transport Agency has commissioned EY to undertake a review (this 'Review') of approaches to estimating land use changes, evaluation of dynamic wider economic benefits (WEBs) and land use impacts (benefits) in transport business cases, as well as developing interim guidance for a preferred approach.

Interest in understanding land use change as a result of transport investment has been increasing over the past decade. Importantly, these impacts may give rise to a range of costs and benefits that are additional to those currently captured in conventional appraisal methods. These may include dynamic WEBs (such as dynamic agglomeration and move to more (or less) productive jobs), changes in land value and a number of city-shaping effects. It also presents opportunities for alternative funding (i.e. value capture) where the land use benefits (such as increased land use value) that can be attributed to high quality transport intervention may be captured to help fund the project e.g. developer contributions, sale of above-station air rights etc. For some projects, changing land use may be a primary objective of the project and being able to predict the degree to which they achieve this aim will then be important.

Estimating land use change and associated benefits generally requires a sophisticated approach which is currently limited in its application in New Zealand. The guidance on WEBs in the Waka Kotahi Economic Evaluation Manual (EEM) allows for both static and dynamic WEBs, however, it only provides a step by step approach on determining static WEBs (which assumes constant land use). This is a limitation in the context of large transport investment as it is likely that land use changes will occur as a result and cause additional benefits or costs. The lack of guidance makes it difficult for practitioners to evaluate and assess land use changes and associated dynamic WEBs and land use benefits for projects.

Case studies have shown that for transport projects with significant land use impacts, dynamic WEBs could account for 5-30% of total benefits, and similarly land use benefits can compromise of 5-30% of the total benefits. Being able to predict the extent and magnitude of land use impacts—and therefore any additional costs and benefits—is critical to ensuring both accurate and comprehensive appraisal of infrastructure projects.

A number of options for estimating land use change and associated land use benefits and dynamic WEBs were considered. The following summarises the recommended approach or short-list of options.

## Estimating land use change

Different models and approaches have varying strengths and limitations and there is no single best approach or model for measuring land use impacts. In practice, the adequate selection of the approach to measuring and quantifying land use impacts will depend on a number of factors including the type of infrastructure project, the purpose behind the project, policy scenarios needed to be tested, data requirements and availability, and modelling efforts. A greater level of sophistication is to be expected in larger projects and/or those with economic appraisals that rely heavily on land use impacts. It is also dependent on where the project is in the business case lifecycle i.e. high-level estimations may be appropriate for a Strategic Case or Programme Business Case whilst more detailed analysis would be expected in a Detailed Business Case.

It is not expected that all projects will generate land use changes, and even projects that do may not all be expected to deliver significant dynamic benefits/costs. Therefore, all transport projects should undertake an initial qualitative analysis to estimate the scale of the land use change (and therefore the benefits associated with it) at an early stage of a project to understand whether it warrants a further investigation.

If the project warrants further investigation on its potential for inducing land use change, the following quantitative analysis approaches are recommended:

- **Land capacity analysis:** This supply-side approach estimates land use changes by focusing on the ability of land in a particular location to support densification – taking into account local and district level opportunities and constraints. Geographic Information System (GIS) tools are used to support this analysis.
- **Land Use and Transport Interaction Model (LUTI) or Land Use Attractiveness Model:** It is broadly accepted that these methods are able to establish the most confidence as they are typically based on historical land use relationships. The advantage of these types of statistical models is that challenges around reverse causality may be addressed.
- **Detailed corridor capacity analysis:** this approach combines supply-side and demand-side analysis and uses real-time measures to inform congestion and capacity as well as land use constraints and potential in a corridor, from a bottom-up approach. This approach provides quality results for a smaller area i.e. corridor for a project, compared to the modelling approaches.

## Estimating land use benefits

There are a number of qualitative and quantitative approaches can be undertaken for estimating land use benefits and its various categories including land value changes, public infrastructure cost changes, second round transport externalities, second round user benefits and costs and public health cost changes. Generally, it is recommended these benefits are quantified where there is sufficient information and parameters. Tailored parameters (including elasticities) for New Zealand will be used, where available. A qualitative approach may be undertaken if the proponent faces time or cost constraints or the scale of the project dictates.

## Estimating dynamic WEBS

The recommended quantitative approach for estimating dynamic WEBS, including dynamic agglomeration and move to more productive jobs, is outlined below. If the project faces time or cost constraints or the scale of the project dictates it, a qualitative assessment may be undertaken.

- Dynamic agglomeration: if the relocation of workers or firms results in an increase in net density, existing firms and workers will become more productive. These productivity gains (agglomeration benefits) are net additional to the Cost Benefit Analysis. It is recommended that a full calculation of dynamic agglomeration is performed. Parameters for this benefit calculation already exist in New Zealand and should be utilised.
- Move to more productive jobs (M2MPJ): by improving accessibility for commuters, an infrastructure project may induce workers to change their location of work. If the project induces the worker to take up a more productive job, there is an additional benefit to society. This benefit is the average tax take on the marginal increase in wages that the worker earns. It is recommended that a full calculation of M2MPJ is performed. Where parameters for this benefit already exist in New Zealand they should be utilised. Where these parameters have either yet to be established, or only exist at a different spatial level, proxy parameters may be utilised.

## Further studies required to develop tailored New Zealand parameters

It is recommended that tailored New Zealand parameters (not overseas) are used for the quantitative calculation of benefits outlined above, as this will provide greater certainty in the results. There are some New Zealand parameters that do already exist, and where appropriate these can be adopted. However, where other New Zealand parameters are not available, a separate study will be required to develop them. Tailored parameters will be required for public infrastructure cost change, second round transport externalities, public health cost changes and more (or less) productive jobs.

## Final remarks

The Review has been undertaken in accelerated timeframes to account for the immediate needs of Waka Kotahi, and therefore the focus is on producing interim guidance only, for rapid deployment on the upcoming business cases that need to be developed as part of the new 2018-2021 National Land Transport Programme (NLTP). It is expected that this guidance will be further iterated and improved as it is tested on projects. It is intended that this interim guidance will form part of the EEM.

# 1. INTRODUCTION

## 1.1 Background and need

Waka Kotahi NZ Transport Agency has commissioned EY to undertake a review (this 'Review') on the preferred approach, focusing on short-term/interim needs, for the estimation of land use changes as well as the evaluation of dynamic wider economic benefits (WEBs) and land use impacts (benefits) in transport business cases. This is intended to ultimately form part of the guidance provided for economic appraisals in the Economic Evaluations Manual (EEM).

Interest in understanding land use change as a result of transport investment has been increasing over the past decade. Importantly, these impacts may give rise to a range of costs and benefits that are additional to those currently captured in conventional appraisal methods. These may include dynamic WEBs (such as dynamic agglomeration and move to more (or less) productive jobs), changes in land value and a number of city-shaping effects. Being able to predict the extent and magnitude of land use impacts—and therefore any additional costs and benefits—is critical to ensuring both accurate and comprehensive appraisal of infrastructure projects. From our experience on current and completed projects (discussed later in this report) dynamic WEBs have shown to account for 5-30% of total benefits (and up to 40% in the case of projects with land use change objectives such as Capital Metro Stage 2 in Canberra). Similarly, land use benefits can compromise of 5-30% of the total benefits, especially for transport projects with strong land use objectives.

Furthermore, it presents opportunities for alternative funding (i.e. value capture) where the land use benefits (such as increased land use value) that can be attributed to high quality transport intervention may be captured to help fund the project e.g. developer contributions, sale of above-station air rights etc. For some projects, changing land use may be a primary objective of the project and being able to predict the degree to which they achieve this aim will then be important.

Estimating land use change generally requires a sophisticated approach which is currently limited in its application in New Zealand. There is also a lack of guidance on evaluating the associated dynamic WEBs and land use benefits and costs. The guidance on WEBs in the EEM allows for both static and dynamic WEBs, however, it only provides a step by step approach on determining static WEBs (which assumes constant land use). Guidance for dynamic WEBs (changing land use) as well as land use benefits and costs is very limited. This makes it difficult for practitioners to evaluate and assess land use changes and associated dynamic WEBs and land use benefits.

There are a number of immediate major transport business cases that need to be developed as part of the new 2018-2021 National Land Transport Programme (NLTP). Interim guidance on evaluating dynamic WEBs and land use benefits will ultimately help inform better decision-making between options of these investments, by having a more accurate evaluation of impacts as well as provide a level of assurance and credibility in the benefit calculation. The preferred approach needs to be as simple and as practicable as possible for use in business cases in the near future.

## 1.2 Purpose and scope

The purpose of this document is to provide clear, robust and consistent advice to decision-makers and practitioners on developing and assessing land use impacts as a result of infrastructure projects, and the benefits and costs likely to result, such as dynamic WEBs and land use benefits and costs. The Review has been undertaken in accelerated timeframes to account for the immediate needs of Waka Kotahi, and therefore the focus is on producing **interim** guidance only, for rapid deployment on the upcoming business cases. It is expected that the guidelines will undergo a number of iterations through trial and error of projects and further investigations.

In achieving this outcome, this document explores:

- The circumstances in which infrastructure investment leads to dynamic WEBs and land use benefits or costs.
- Current approaches (options) to estimating the magnitude of the impacts.
- Analysis of options and selection of preferred option/s depending on the scope and scale of projects.
- Implications for business case including the 'case for change' and cost-benefit analysis (CBA), as well as prioritisation of business cases at a portfolio-level.
- Interim guiding principles for evaluating land use change, dynamic WEBs and land use benefits and costs. Given the accelerated timeframes, the focus of the interim guidance will be to provide detailed guidance on evaluating land use changes and dynamic WEBs, with relatively low detail on valuing land use benefits.

- Implementation plan including recommendations and next steps for Waka Kotahi to be in the best place possible to support and undertake evaluations of dynamic WEBs and land use impacts, beyond the interim guiding principles. These also contain a number of issues/concerns raised by the working group that are not already addressed in this Review.

There have been a number of studies already investigating the use of dynamic WEBs and land use benefits and costs in New Zealand’s context (refer to Section **Error! Reference source not found.**), and therefore this Review will only present key findings for context only in considering a range of options suitable for use. The focus of this Review is the interim guidance notes from a practical perspective.

The following is outside the scope of this Review:

- Review of existing accuracy and potential improvements to narrative for static WEBs.
- Development of necessary tools/models and quantitative evidence required to undertake various approaches/options for evaluation of dynamic WEBs and land use impacts. However, this Review will develop an action plan to help best prepare Waka Kotahi to undertake this evaluation for the upcoming business cases.

### 1.3 Report structure

Refer to Table 1 for an overview of the report structure.

**Table 1: Overview of document**

<b>Section 1</b>	Introduction (this section)	Strategic context, need, purpose, approach and scope, as well as other relevant previous studies which inform this Review. Definitions of land use changes, dynamic WEBs and land use benefits and costs are also outlined.
<b>Section 2</b>	Current State	Current guidance and practices at Waka Kotahi with respect to estimating land use change, dynamic WEBs and land use benefits and costs, including its areas for improvement.
<b>Section 3</b>	Options overview and analysis	Determination of long-list of options for consideration, ranging from relatively low investment/low benefit options to high-intensive/large benefit options to suit a variety of projects. Options are evaluated against key success factors to help determine which should be considered for interim guidance notes as well as for further investment.
<b>Section 4</b>	Implementation Plan	Action plan for next steps of development of the interim guidance, including change management, risks and dependencies. This also contains other observations made but not addressed as part of the current Review.
<b>Appendix A</b>	Technical Guidance	Technical narrative on evaluating land use changes, dynamic WEBs and land use impacts including guidance on the underpinning tools/models required.

### 1.4 Working group

A number of workshops were held in this short time to collate together the thoughts and expertise of a number subject matter experts in the space of transport and land use planning, modelling and dynamic WEBs and land use impacts at Waka Kotahi and other central and local government organisations (such as Greater Wellington Regional Council, Auckland Council, Auckland Transport, The Treasury, Ministry of Transport, Wellington City Council and Dunedin City Council) as well as private sector organisations comprising mainly of transport consultancies. This group performed the role of an advisory group to the development of this document.

Issues and ideas from the working group have been addressed where possible within the accelerated timeframes of this Review, however outstanding issues/ideas for further consideration are outlined in Section **Error! Reference source not found.** Implementation Plan.

There was a high level of consensus on the need to address land use change as it relates to infrastructure projects in a CBA. This includes the identification and measurement of land use change, dynamic WEBs and land use benefits and costs. Critically, it was acknowledged that by ignoring land use CBA's will not give the complete picture or produce the right answer.

In particular it was recognised that previous projects have demonstrated significant dynamic land use impacts, although these have proven challenging to analyse. There is therefore a need to look at challenges and issues with land use change, dynamic WEBs, and land use benefits and costs and how to implement changes in the EEM to reflect these. It was also recognised that there is no one perfect solution to capturing these in the EEM. The interim guidance should look to build people's confidence when considering these impacts as part of a CBA, and be something that is built upon and extended over time. The purpose of this interim guidance exercise is therefore very much to understand current context and bounds to help us to move forward and provide continuous improvement.

There is a desire for the interim guidance to include direction as to which projects require quantification of impacts in a CBA context and which may only require a more strategic approach. Therefore, the working group identified options analysis or decision tree analysis that would go into a toolkit.

Members of the working group also provided substantial guidance on what they would like to see in each of these areas. This is contained in the relevant sections below.

## 1.5 Previous studies

Previous studies for Waka Kotahi have recommended the need for dynamic WEBs in New Zealand in the long-term and provide guidance on the estimating of WEBs and land use impacts. Key studies include the Wider Economic benefits and Value Capture Mechanisms (2017), and Wider Economic Impacts of Transport Investments in New Zealand (2011). Other key overseas studies are outlined in Section **Error! Reference source not found.** International review.

### **Wider Economic benefits and Value Capture Mechanisms: A Report by Volterra Partners, 2017**

Volterra undertook a review of the application of Wider Economic Benefits (WEBs) and Value Capture (VC) mechanisms in New Zealand. The report primarily focussed on:

- A review of the evidence on dynamic WEBs and how the EEM might change to account for this.
- A review of VC mechanisms used overseas and a recommendation of VC mechanisms appropriate to New Zealand.
- The application of the findings on dynamic WEBs and VC mechanisms to three case studies that are yet to be implemented.

The report produced four recommendations on a Waka Kotahi approach to estimating WEBs in the EEM including:

- Update the guidance on static WEBs so that the effective density calculations include a distance decay parameter.
- Include estimation of dynamic WEBs when the project supports land use changes and growth in a major industrial or urban centre of New Zealand.
- Estimate dynamic WEBs using a LUTI model. Where a LUTI model does not exist, an alternative approach involving accessibility-density analysis and benchmarking can be used.
- Estimate and present a range of values to achieve flexibility rather than a one size fits all approach.

### **Wider Economic Impacts of Transport Investments in New Zealand September 2011**

The project developed a methodology for Waka Kotahi to assess WEBs of proposed transport investments, none of which were included at the time. This study therefore informed the WEBs component of the EEM, as it is today. The project involved three phases:

- Stage 1 was composed of a literature review looking at the theory behind estimating WEBs for transport investments and an analysis of research evidence regarding WEBs in the New Zealand context.
- Stage 2 built on the findings and recommendations from the first stage in order to develop the evidence and methods required to enable the assessment of WEBs for transport projects in New Zealand.

- Stage 3 demonstrated the application of the method developed in stage 2 to a case study.

The project examined the latest research and evidence to derive values for the key parameters of the wider economic impacts calculation methodology for impacts relating to:

- Imperfect competition benefits.
- Labour supply benefits.
- Job relocation benefits, or a “Move to More Productive jobs (M2MPJ)”.

The study carried out an assessment of how likely each WEB would be to have an impact in the New Zealand context. Parameter values were then calculated for the use of estimating WEBs. Imperfect competition and labour supply benefits were found to be significant, but the job relocation benefits were deemed to be small and costly to estimate. Therefore, the report recommended estimating job relocation benefits for sufficiently large transport projects only.

## 1.6 Definitions

### 1.6.1 Land use changes

Land use impacts are defined as a change in, or a change in the intensification of, the types of activities that occur in a location. Changes in activity may be from a change in use of the existing built form or a change in the built form itself. What is pertinent is the net change in activity. For example, a land use change can include both more people working on existing commercial floor space as well as the construction of new floor space, despite the latter only involving a change in the built form.

Such land use impacts are derived from the inherent relationship between the land use system and infrastructure. Land use, in a broad sense, refers to a range of human activities, generally associated with the state of the built environment, but also to some aspects of the natural environment. In a practical sense, however, and for the purposes of this paper, land use can be taken to refer to the spatial distribution and intensity of population, households, and economic activity.

The use of the land for instance, while influenced by infrastructure, is subject to a range of forces that affect where, what and how land is used. These include:

- The location decisions of households and firms.
- Government policies and interventions.
- The investment decisions of government and the private sector.
- Legal, regulatory and tax systems.
- Market forces and dynamics.
- Geographical and climatic factors.

Disentangling the various forces at play within the land use system is a difficult task that requires great care and consideration. Nonetheless, it is generally accepted that infrastructure impacts land use in a number of ways. This interaction is as a complex and dynamic process, as infrastructure is both a response to and determinant of land use change.

Whilst the relationship between land use and infrastructure is complex and multi-faceted, there are two main mechanisms through which we can explain how infrastructure can affect land use. The first are demand-side mechanisms whereby infrastructure, particularly transport infrastructure, can make a location more or less attractive—encouraging intensification of built form/and or development of new stock. The second are supply-side mechanisms whereby infrastructure can either lower the costs of private development or ‘unlock’ indirect supply constraints on land by allowing a relaxation of regulatory controls.

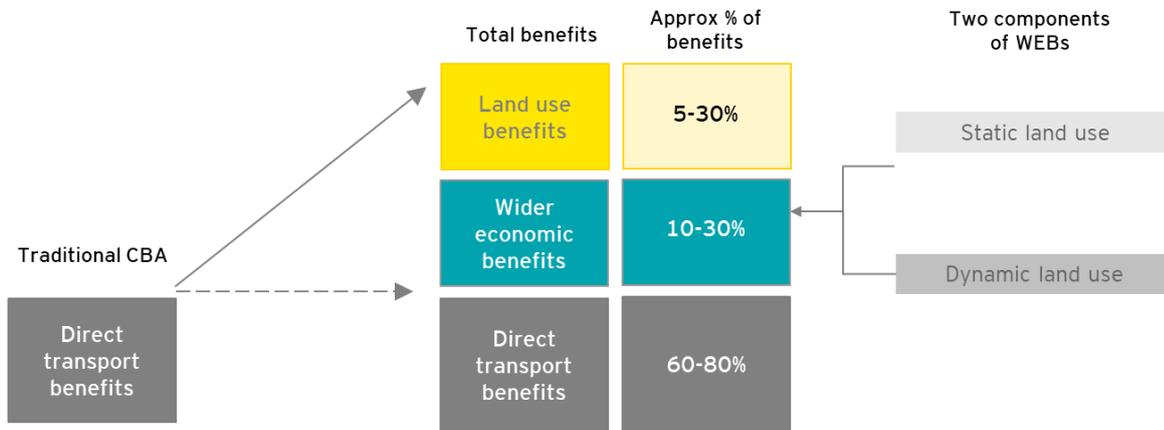
There is a distinction between developing land use **projections**, which attempt to predict the likely future growth in, and distribution of, population, dwellings and jobs in the absence of further investment – and the assessment of land use **changes**, which attempts to predict how the distribution of future population, dwellings and jobs may change in response to an investment (or other intervention). The focus of the proposed interim guidance is the latter – tools and techniques that can help understand the impacts of a transport intervention on future land use in one or more given future years.

This report also distinguishes between the estimation of **land use impacts** (due to transport intervention and other causes) and the estimation of **land use benefits and costs** (outlined in section below) that result from land use impacts and can be incorporated into business cases.

## 1.6.2 Transport benefits

Benefits created by transport interventions can be categorised as follows and is illustrated in the figure below.

- Traditional transport benefits.
- Wider economic benefits.
- Land use benefits ('city shaping' benefits).
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**Figure 1 | Key categories of benefits induced by transport projects, with indicative order of magnitude**

Historically, transport projects have considered the 'traditional' direct transport benefits and 'static' wider economic benefits. However, there is less evidence and experience in considering 'dynamic' wider economic benefits and land use benefits. Although the range can of benefits (or disbenefits) can vary significantly based on our experience (discussed in Section 2.23: International review), wider economic benefits can typically account for 10-30% of total benefits, with dynamic WEB's comprising of 5-30% (and up to 40% in the case of projects with land use change objectives such as Capital Metro Stage 2 in Canberra), of total benefits. Similarly, land-use benefits can comprise of 5-30% of the total benefits, the latter especially for transport projects with strong land use objectives.

The focus of this Review is on the wider economic benefits (and specifically dynamic WEBs), land use benefits and the approach in evaluating land use changes that inform these benefits.

### 1.6.2.1 Direct transport benefits

Direct transport benefits are those that accrue to the user, as a result of a transport option. There is a well-established practice at Waka Kotahi of identifying these benefits in business cases to inform options analysis and preferred option selection. Benefits include but are not limited to travel time savings, vehicle cost savings, crash cost savings and environmental cost savings. These benefits often comprise of the large majority of the benefits for a transport intervention. From a business case perspective, these benefits are considered in economic and financial appraisals in business cases. Transport modelling is usually undertaken to help estimate these benefits.

### 1.6.2.2 Direct transport benefits

Further to direct transport benefits, there are also wider economic benefits that accrue to the economy as a whole from alleviating market failures outside of the transport market. They are productivity benefits that arise through a change in effective density and improved accessibility.

By improving the accessibility of land, it effectively creates a denser landscape (agglomeration). Density in a city breeds productivity and in turn causes external benefits outside the user of the transport. Improving the access to producers and consumers will lead to more efficient markets and an increase in economic output. The benefits flow in the form of additional consumer and/or producer surplus. Lastly, by reducing the commuting costs for potential workers, the effective wage induces more workers to enter the workforce, leading to a further benefit.

WEBs can be both static and dynamic. Static WEBs are more the commonly assessed. They are influenced by changes in factors such as travel times and travel costs (due to the transport investment option) based on static (unchanged) land use. Currently EEM includes guidelines for assessing these.

Dynamic WEBs estimates additional productivity benefits from a change in location or level of jobs/workers as a result of changing land use (dynamic). Given the reliance on understanding land use changes caused by a project, they are less commonly estimated, even if a framework for their quantification was provided in the original UK guidelines on WEBs. Since static WEBs leave productivity changes associated with land use change unaccounted for, also capturing dynamic WEBs would enable a more complete estimate of wider economic benefits. For transport projects with a sizeable land use component or objectives, this may be material and impact upon the viability of the project.

### Static wider economic benefits

Static WEBs include the following types of benefits:

- **Static Agglomeration:** Improved accessibility can help make places effectively denser, resulting in improved productivity. This is measured by an increase in gross value added (GVA) per worker.
- **Imperfect competition:** reducing firms' transport costs reduces the barriers to entry for suppliers in a market, inducing additional output, which represents a benefit in the form of additional consumer and producer surplus. This is measured by a proportion of business travel time savings (as a proxy).
- **Increased labour supply:** reductions in commuting costs mean the effective wage rises, incentivising more people to enter the workforce. The additional tax take on the marginal increase in labour represents the benefit.

### Dynamic wider economic benefits

Dynamic WEBs furthermore include the following types of benefits:

- **Dynamic agglomeration:** if the relocation of workers or firms results in an increase in net density, existing firms and workers will become more productive. These productivity gains (agglomeration benefits) are net additional to the CBA.
- **Move to more productive jobs (M2MPJ):** by improving accessibility for commuters, an infrastructure project may induce workers to change their location of work. This is because the worker's 'effective wage' is now higher in one location vs another. If the project induces the worker to take up a more productive job (as the effective wage afforded by the increased accessibility is now higher to this job) there is an additional benefit to society. This benefit is the average tax take on the marginal increase in wages that the worker earns.

Academic literature and international practice would suggest that dynamic WEBs accrue to the extent that the transport investment causes land use changes. In some cases, it may not be appropriate to assume that transport investment would cause land use change. Therefore, it is appropriate to outline the cause of dynamic land use which makes a dynamic assumption realistic when assessing project appraisal.

Provided that specific guidelines are followed, there would not be a risk of any double counting of benefits or costs between static and dynamic WEBs, nor between either and conventional user benefits. Further explanation can be found in EEM, Waka Kotahi research reports and UK guidelines.

#### 1.6.2.3 Land use impacts (benefits)

Land use benefits (costs) include the following:

- **Land value changes:** In circumstances where a transport investment is unlocking development constraints, either by relieving congestion or crowding, or by reducing development risk, there may be benefits from higher value land use that are additional to benefits measured elsewhere. It is important to distinguish this effect from that of property values increasing around corridors when transport is improved, which in itself is simply a capitalisation of travel time savings and other benefits into property values. If, on the other hand, additional transport capacity enables denser development, the more intensive land use can deliver benefits – equal to the value of the expected new land use, less value of existing use less any costs. It is important to consider that land value is also influenced by supply-side factors independent of the infrastructure project. Therefore, the change in land value may only be captured to the extent that it is attributable to the infrastructure project. This may include the project being a catalyst for a relaxation of zoning constraints or being a necessary enabler of land use development. Also, to avoid double counting, unit values must not change – i.e. the benefits pertain to the value of the additional floorspace that can be allowed on a given parcel of land, but not to a change in the value per m<sup>2</sup> of floorspace (which is a capitalisation of other benefits and therefore cause double counting).
- **Public infrastructure cost changes:** the public infrastructure (e.g. water, sewerage, community facilities, etc.) cost required to facilitate growth is typically lower per dwelling in infill locations than on the urban

fringe. Therefore, if an infrastructure project induces more infill development vs fringe development, there may be a public infrastructure cost saving. This at least requires estimates of per-dwelling costs for infill/fringe locations. But applications should also consider project specific conditions that affect infrastructure cost – such as whether attracting additional development triggers the need for new, lumpy infrastructure investment or, alternatively, sufficient spare capacity is already in place to allow densification without additional investment.

- **Second round transport externalities:** land use change can alter transport patterns and, therefore, external costs (crowding, congestion, pollution, crash costs etc.) associated with travel. For example, clustered households around trip destinations make more use of public and active transport. Quantifying this benefit may require undertaking 'second round' transport modelling, or the use of externality unit rates.
- **Second round benefits and costs:** additional costs and benefits to those that relocate and live in a new location. Quantifying this benefit requires undertaking 'second round' transport modelling.
- **Public health cost changes:** denser pattern of urban development can lead to health cost savings associated with more people using active transport. This requires evidence on active travel patterns by location, and health cost savings per km of active travel. Note that only incremental impact on active travel caused by a land use change, over and above that caused by the transport investment, should be captured here.

## 2. CURRENT STATE

This section provides a discussion on current practices and guidance notes for estimating land use changes as well as evaluating dynamic WEBs benefits and land use benefits and costs at Waka Kotahi. A brief overview of international practice and guidance is also provided for context, particularly where it provides guidance to inform the options.

### 2.1 Current guidelines

The EEM is Waka Kotahi guidance for practitioners on undertaking transport economic appraisals to assess transport investments. It considers both traditional transport benefits (including travel time and cost savings) as well as indirect benefits or static WEBs; including agglomeration, imperfect competition and increased labour supply. Appendix 10 of the EEM provides guidance on the evaluation of WEBs including first-principles for evaluating the static WEBs. Land use change is currently not considered as part of the EEM. This means that there is no explicit guidance for the inclusion of dynamic WEBs or land use costs or benefits in a CBA.

#### 2.1.1 Observations – land use changes

The EEM currently notes that only fixed land use and employment projections are available as part of economic evaluation and are therefore acceptable. The EEM therefore contains a clear limitation with respect to the treatment of land use change. This consideration of land use change and its treatment is consistent with the time that the EEM was established when there was little access to sophisticated land use modelling tools and techniques.

Holding land use constant is likely to result in a number of concerns around economic project evaluation. These include:

- Lack of accuracy in transport outputs due to unrealistic land use assumptions. This results in inaccuracy in transport benefit or cost estimation.
- Missing of productivity benefits associated with land use change.
- Missing of other land use benefits.

#### 2.1.2 Observations – dynamic WEBs

A number of key observations are made where there are limitations in the current EEM with respect to dynamic WEBs.

##### Lack of explicit technical guidance

The EEM has identified WEBs that accrue to the economy assuming that land use remains the constant as a result of transport investment (static WEBs). This is a limitation in the context of large transport investment as it is likely that land use changes will occur as a result and cause additional benefits or costs. There is no guidance on how to evaluate dynamic WEBs, including the necessary tools/models, assumptions and constraints in the approach. Therefore, the level of detail is insufficient for practitioners to have a reference point when evaluating dynamic WEBs in business cases. This poses a risk of not understanding the full benefits associated with a transport project and why it should (or should not) be committed in the first place.

In terms of dynamic agglomeration, it does implicitly allow for this in the following equation found in step D on page 5-384 of the EEM:

$$ED_i^S = \sum \frac{E_j^S}{AGC_{ij}^S}$$

##### Where:

- $E$  is employment with  $s$  land use in the  $j$  destination.
- $AGC$  is the average generalised cost in  $j$  destination from the  $i$  origin.
- $ED$  is the effective destiny with  $s$  land use from the  $i$  origin.

As the superscript  $S$  allows for a change in land use, such as from residential or green land to commercial, this methodology could be used to quantify the dynamic agglomeration benefits between base and project case scenarios.

There is no guidance for the evaluation of the benefits (or disbenefits) of workers moving for more productive jobs (M2MPJ).

### Lack of narrative on when to consider dynamic WEBs

There is a lack of guidance on when to evaluate dynamic WEBs and how to use them to justify the case for change i.e. land use objectives may be strong components of some transport projects and therefore should form part of the story of why a project should proceed. Providing clear guidance on when dynamic WEBs may be material would provide greater encouragement to proponents to quantify it and apply consistency across transport business cases.

### 2.1.3 Observations – land use impacts

The EEM currently does not provide any technical guidance or narrative on when to consider land use impacts.

## 2.2 Current practices

### 2.2.1 Observations – land use changes

There is little to no evidence of estimating dynamic land use changes in New Zealand. A land use model for the Auckland isthmus was used to develop the Auckland Unitary Plan, which outlines district and regional plans for Auckland in meeting its economic and housing needs. However, it is considered too high-level for use in evaluation of the land use changes of transport projects.

### 2.2.2 Observations – dynamic WEBs

Feedback from the working group suggested that dynamic WEBs are rarely considered in business cases in New Zealand. It is perceived to be too complex to undertake, with insufficient tools and guidance. While it is evident that large projects would accrue additional benefits as a result of land use changes, the guidance lacks an applicable methodology that takes these benefits into account.

### 2.2.3 Observations – land use impacts

There is little to no evidence of estimating land use benefits for transport projects in New Zealand.

## 2.3 International review

Globally there is increasingly growing focus on appropriate guidance and practices for evaluating land use changes and associated benefits, including dynamic WEBs. Outlined below is an overview of the latest practices in these countries, including high-level benchmark or lessons that can be applied to Waka Kotahi and New Zealand’s context.

### 2.3.1 Guidance

Table 2 | Guidance in other countries

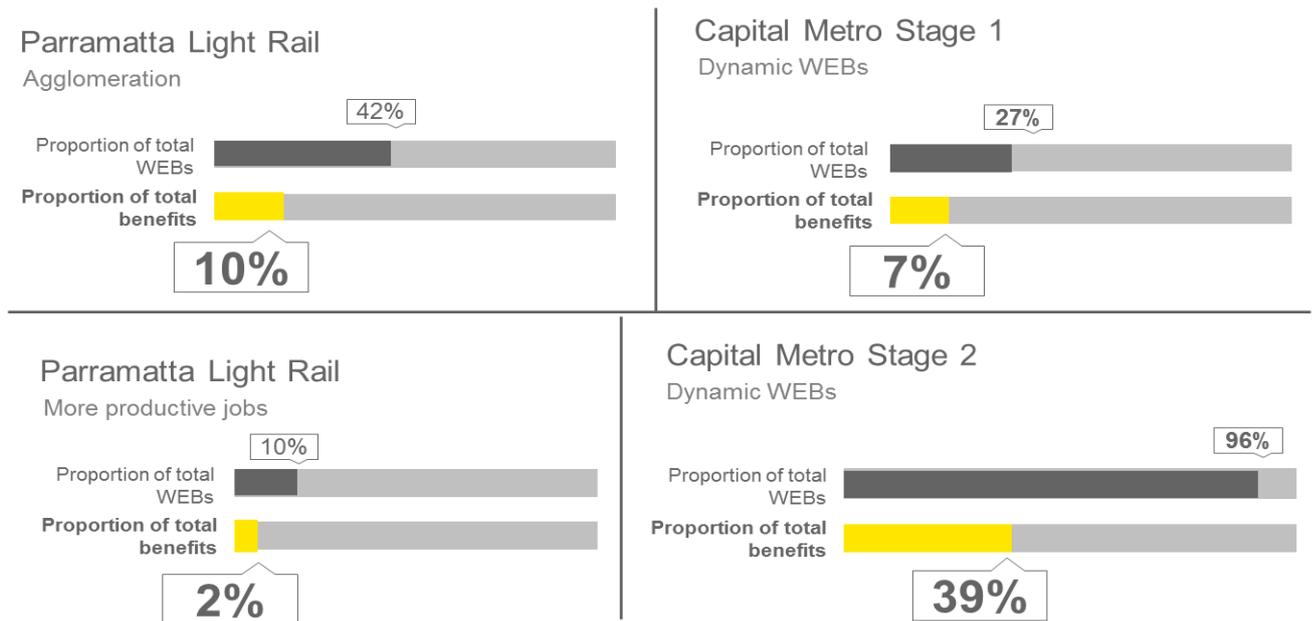
United Kingdom	
Overview	<ul style="list-style-type: none"> <li>▶ UK WebTAG contains technical guidance on estimating dynamic WEBs.</li> <li>▶ The guidance also provides steps on how to disentangle the effects of accessibility and land use change that drive agglomeration. Understanding the two effects is important for analytical transparency and to add to the economic narrative of the specific project.</li> <li>▶ Guidance on modelling land use change and other land use benefits is not included.</li> </ul>
Key learnings relevant to this Review	<ul style="list-style-type: none"> <li>▶ The step-by-step nature of the guidance provides a clear description and approach for estimating dynamic WEBs.</li> <li>▶ The reference to the relevant formulae further assists practitioners, as does an agglomeration impacts checklist.</li> </ul>
Australia	
Overview	<ul style="list-style-type: none"> <li>▶ The Infrastructure Australia economic evaluation methodologies includes guidance on how to undertake land use modelling as part of a CBA. This includes:               <ul style="list-style-type: none"> <li>▶ Various land use and transport interaction modelling tools and methods – includes best practice techniques for accurate land use modelling and integration in to transport modelling.</li> <li>▶ Guidance for estimating land use benefits in a CBA, including dynamic WEBs.</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>▶ A review on the measurement of WEBs in Australian cities is also currently being undertaken in Australia. This review is for the purpose of providing guidance for productivity benefits (including dynamic agglomeration and move to more productive jobs) for inclusion in the Australian Transport Assessment and Planning (ATAP) guidelines.</li> </ul>
Key learnings relevant to this Review	<ul style="list-style-type: none"> <li>▶ Given that land use change is the critical input into dynamic WEBs and land use benefits, it is important to include thorough guidance on how to model land use change. This includes the correct modelling tools, and the common pitfalls and nuances when undertaking the modelling.</li> </ul>

### 2.3.2 Case studies

#### Dynamic WEBs

Outlined below are a number of case studies where dynamic WEBs have been quantified, including Sydney (Parramatta Light Rail) and Canberra (Capital Metro Stage 1 and Stage 2).



**Figure 2 | Case studies for evaluation of dynamic WEBs**

Key learnings relevant to this Review include:

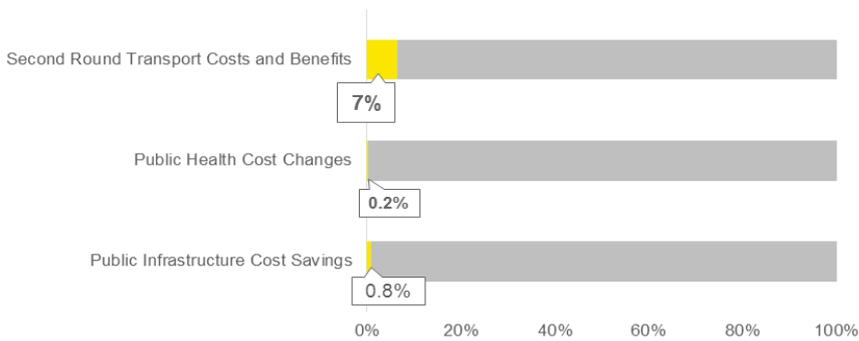
- Almost 40% of total benefits for Capital Metro Stage 2 are comprised of dynamic WEBs; this is significant due to the land use focus and objectives of the project. The land use modelling estimated a relocation of jobs and workers such that they would be far more agglomerated.
- The proportion of dynamic WEBs for Parramatta Light Rail and Capital Metro Stage 1 were lower (5-10% of total benefits) but still material in absolute terms.
- Parramatta Light Rail also quantified a move to more productive jobs – this benefit was 10% of WEBs and 2% of total benefits. The challenge associated with land use modelling for this project was identifying the proportion of land use change that could be attributed to the actual project itself (project vs land use policy). This can often be a limitation of the land use modelling approach, as it produces estimates of full land use change by considering demand and supply-side factors together.

#### Land use benefits

Outlined below are a number of case studies where land use benefits have been quantified internationally, including Sydney Metro and South West and Capital Metro.

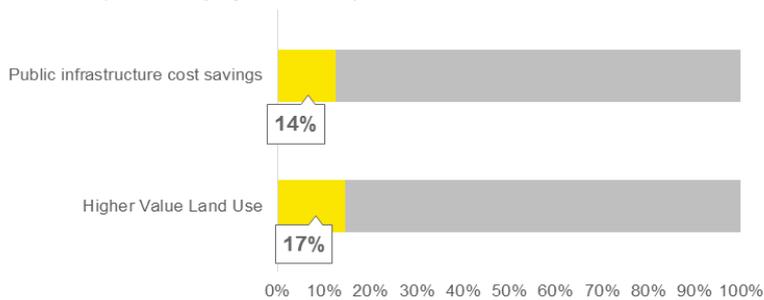
## Sydney Metro and South West

Land Use Benefits (% of total project benefits)



## Capital Metro

Land Use Benefits (% of total project benefits)



Key learnings relevant to this Review include:

- Land use benefits made up over 30% of total economic benefits for Capital Metro. This shows there may be significant benefits for a project with land use change objectives that is able to induce land use change.
- Second round transport benefits made up 7% of total benefits for Sydney Metro and South West. This is not an insignificant proportion of total benefits and highlights the importance of integrating land use change modelling into transport modelling for greater accuracy of transport benefits.
- Public infrastructure cost savings as a proportion of total benefits varies between projects. This demonstrates the localised nature and impact of public infrastructure cost savings, including dependency on land use change and unit costs of provision.

## 3. OPTIONS OVERVIEW AND ANALYSIS

### 3.1 Approach

A long list of options for estimating land use changes and associated benefits (including dynamic WEBs and land use benefits) are presented in this section. These are based on current practices seen globally and tailored to the needs of Waka Kotahi and the New Zealand context.

The approach has been to be as comprehensive as possible before refining to a selected short-list of options. The options have considered a range of sophistication and quality of analysis with trade-offs for the amount of investment required. These are broadly categorised as follows:

- **Bronze or do minimum options:** relatively low effort to undertake and implement, providing some improvement over the current situation ('do nothing'). These options focus on providing qualitative guidance on evaluating benefits and are best suited to estimating the scale of benefits and whether it warrants further investigation.
- **Silver or medium effort options:** 'rule of thumb' estimates with more evidence and quantification, beyond only the qualitative guidance. However, it generally lacks the quality of data and analysis (and therefore the level of confidence) compared to more intensive (e.g. modelling) options. These options are suited to providing indicative estimate of benefits from a quantitative perspective.
- **Gold or maximum effort options:** ideal situation (from a results or outcome perspective) where the best available data and tools/models/methodologies are adopted to obtain maximum reward and confidence in results. These are more suited to larger-scale projects or where more detail is required in a business case.

### 3.2 Options description

#### 3.2.1 Working group – land use change

The working group raised a number of important considerations when thinking about the options for interim guidance for land use estimation. These considerations are discussed below.

It is important to indicate at what decision point in time land use change should be evaluated. It may be that at a strategic phase that land use change is only thought about qualitatively, with deeper analysis coming at a later decision point. It is also important to establish for what purpose the land use change analysis is being undertaken. The analysis may be used to differentiate between options for a particular project, or may be used to evaluate between different projects themselves.

Flexibility and scalability is also important when recommending options for land use change. Approaches which can be adapted relatively easily for projects of different sizes are seen to be advantageous relative to those that may only be suitable for projects of a particular size. Any other additional flexibility should be built in such that it enables the application to a greater range of project sizes and types.

For smaller projects, a qualitative assessment may be more appropriate as compared to a more sophisticated quantitative measurement. It may also be that a qualitative assessment is the 'minimum' requirement for land use change evaluation, with larger more complex projects requiring additional analysis. More generally, different tools may be required for different levels of assessment – there may not be one size fits all. Procedures should be pragmatic and rapid where appropriate. Complex projects should do more.

The working group also stressed that confidence can be gained by testing interim guidance on a number of local case studies. In this way the interim guidance should be iterative with updates on an ongoing basis.

It was accepted that proponents should be rewarded for more robust analysis of the land use change component of the project which increases certainty in results. Without this, proponents may be put off from applying a more robust analysis. Therefore, the interim guidance should provide the right incentive mechanisms, such that there is a viable trade-off between effort and reward for proponents.

It was broadly accepted that a land use attractiveness or land use and transport interaction model (LUTI) is able to establish the most confidence, given that these models are typically based on historical land use relationships. The advantage of these types of statistical models is that challenges around reverse causality may be addressed. This is typically done using instrumental variables or similar. It was also noted, however, that these models can be seen as a black box to some decision makers.

All options for interim guidance should include careful consideration of supply-side factors. There may be constraints such as zoning which may prevent land use change being realised despite a change in demand

triggered by a transport project, for example. Therefore, an evaluation of necessary and sufficient conditions in terms of what needs to happen from a supply-side perspective needs to be performed.

### 3.2.2 Working group – benefits estimation

The working group raised a number of important considerations when thinking about the options for interim guidance for land use benefits and costs estimation. These considerations are discussed below.

The working group agrees that it is important that there is clarity on what a benefit is and what a cost in relation to land use change is. There may be a number of benefits associated with additional densification, for example, but also some costs (e.g. congestion). Both benefits and costs should be captured where possible.

Particular attention should be paid to avoiding double counting of land use benefits. For example, it should be considered which portion of land value uplift reflects the capitalised value of transport user benefits, and which portion reflects the added (re)development potential created by the project.

The aim of the interim guidance should be to increase confidence and robustness in land use benefit and cost estimation, rather than accuracy of results. There is a clear marginal cost versus marginal benefit in increasing confidence, however for some projects (e.g. small size) it may be that the effort level in undertaking this estimation is prohibitive. In addition, proponents will require a level of certainty that decision makers value the additional effort put into measuring land use benefits and costs, as well as will be accepting of a robust evaluation of these.

For a number of land use benefits and costs (such as public infrastructure cost savings), location and other spatial considerations matter. For example, the unit cost of infrastructure is different in different areas.

The working group also stressed the role of developer contributions when it comes to public infrastructure provision. The interim guidance should clarify that we are valuing the change in the subsidy for infrastructure, after subtracting development contributions, user charges and on-site servicing.

Land use benefits may be used to inform value-capture in the funding of infrastructure projects. It is important to note that there may be a number of challenges in estimating these benefits for this purpose, and also applying these benefits to actual value-capture mechanisms. Despite this, it is important to be able to link these benefits to potential funding opportunities given that some existing projects are not being funded due to a lack of traditional transport-based funding. These benefits may help to bridge this gap.

### 3.2.3 Land use estimation

The various options for estimating land use changes, as a result of transport intervention and other factors, are provided below. Options consider both supply-side and demand-side centric models.

- **Supply-side approach** estimates how infrastructure can unlock additional development through reducing cost of private development or allowing relaxation of planning controls. Consideration is also given to whether the envisaged land use can be achieved given the demand.
- **Demand-side approach** estimates how infrastructure can impact demand for land use through making a location more attractive. Consideration is also given to whether forecast land use change can be achieved given the current regulatory controls.

Different models and approaches have varying strengths and limitations and there is no single best approach or model for measuring land use impacts. In practice, the adequate selection of the approach to measuring and quantifying land use impacts will depend on a number of factors including the type of infrastructure project, the purpose behind the project, policy scenarios needed to be tested, data requirements and availability, and modelling efforts. There is also a strong interplay between demand and supply-side approaches and, in practice, this often requires an iterative approach between the two.

Key challenges with modelling options include:

- **Substantial upfront and ongoing investment required.** This includes collecting large quantities of spatially disaggregated data, GIS expertise and econometric model estimation and calibration and statistical testing.
- **Managing the interface** between various types of transport models and land use models, including technical interface as well as multi-disciplinary skillsets of project teams undertaking the different analysis.
- **Natural land use change over time vs accessibility induced land use change;** it is difficult to identify and separate the change in land use that is attributable to transport intervention, as opposed to natural land use change over time. Natural land use change is not dependent on infrastructure investment and should not be considered in economic appraisals of the project.

- **Dual causality between transport infrastructure and land use** - where investment may lead to land use change, but land use change also attracts investment in infrastructure - an assessment must be able to demonstrate the dependency of the land use change on the infrastructure investment in question.
- **Incorporating both demand and supply-side influences when measuring land use change** – land use modelling typically focuses on demand response to a change in accessibility. In order to test whether the demand can be achieved, supply-side analysis also needs to be integrated. Often supply-side assessments are undertaken separate to the land use demand modelling, making it tricky to incorporate into the assessment.
- **Accounting for all positive and negative land use changes** – in most cases the impacts of a project on population and jobs is primarily about distribution. Growth is attracted to locations that experience improved transport access and amenities, at the expense of other locations. It is true that a project can attract additional people or workers into a sub-region, region or a country – or even increase the number of jobs available for a given population. But even if this could reliably be evidenced, considerations would also need to be given to the benefits and cost of hosting additional people and jobs, including the cost of public infrastructure and services. For practical reasons it is therefore usually desirable to control total population and employment within an appropriate spatial area – for instance the extent of the transport model being used.

#### **Option 1: Do Nothing (Status Quo)**

This option continues the current practice (i.e. a lack of guidance on estimating land use changes) and no change will be made to the EEM. This serves as the relative benchmark for all other options to be considered against. This option is not considered feasible due to the established need for estimating dynamic WEBS and land use benefits.

#### **Option 2 (Bronze): Provide qualitative guidance**

This option provides an outline of qualitative guidance only to the EEM, including when to consider land changes, how it may occur and what type of projects (and when) it might apply to. This is useful for estimating the scale of the land use change (and therefore the benefits associated with it) at an early stage of a project to understand whether it warrants a further investigation as a key factor in the objectives and options of that project.

#### **Option 3 (Silver): Rapid supply-side analysis**

This option consists of a 'rule of thumb' approach of supply-side/corridor capacity analysis (bottom-up approach) to calculate increase in land-values and then apportion the benefits to the transport intervention. For example, X year's acceleration of growth, or Y% uplift around a station/stops. Consideration is also given to whether the envisaged land use can be achieved given the demand by considering the likelihood that there is enough demand to match the envisaged land use uplift.

#### **Option 4 (Silver): Rapid demand-side analysis**

This option consists of a 'rule of thumb' approach of applying overseas elasticities to estimate demand based on attractiveness to corridors. This is used as a proxy for what may occur in New Zealand. For example, applying land use elasticities from Australia to changes in effective densities as a result of the project. Consideration is also given to whether forecast land use change can be achieved given the current regulatory controls by analysing any policy or planning constraints.

#### **Option 5 (Gold): Land use modelling**

This consists of Options 3 and 4 plus the establishment of a land use model in New Zealand to integrate with existing transport models. Land use interaction modelling is one of the most sophisticated approaches in estimating land use changes in the future as a result of transport interventions. It can predict where jobs and residents will choose to locate based on accessibility changes, and feed this information back into transport models to capture "second round" impacts. Land use models can be calibrated to specific local attributes and planning constraints. Models can span across cities and regions to help understand how people and employment moves from one place to another.

The iterative relationship between changes in a land use and transport capacity is outlined in the figure below.

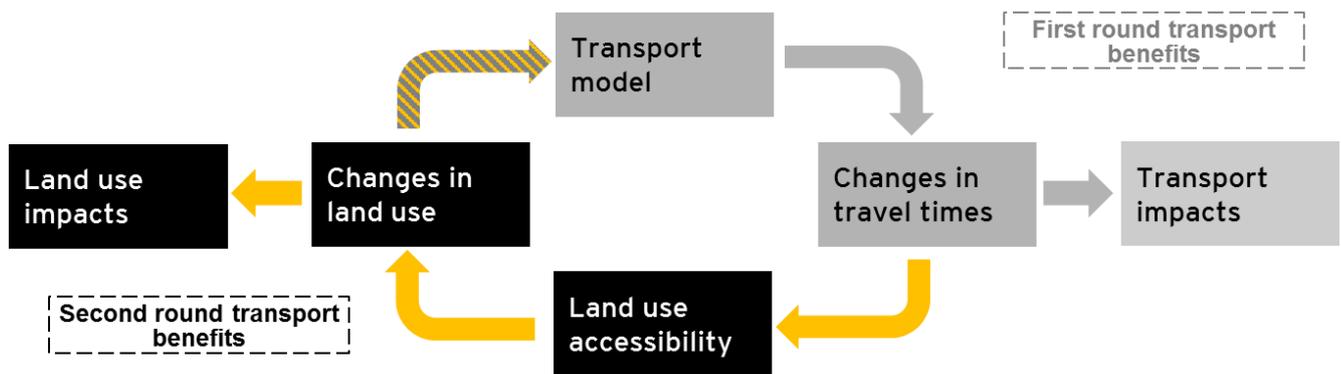


Figure 3 | Iterative approach of land use and transport modelling

### Option 6 (Gold): Land Use Transport Integration (LUTI) modelling

This option consists of Options 3 and 4 plus establishing an integrated land use and transport model; where both land use and transport elements are estimated in one model. This is the same as Option 5 except the land use and transport modelling is undertaken in a singular, integrated model. This allows for quicker manipulation of information with no technical interfaces required. It also requires the skillset of professionals who understand land use and transport planning and can run the models accordingly.

### Option 7 (Gold): Detailed corridor capacity analysis

This option consists of Options 3 and 4 plus real-time measures to inform congestion and capacity as well as land use constraints and potential in a corridor, from a bottom-up approach. This approach provides quality results for a smaller area, i.e. corridor for a project, compared to the modelling approaches in Options 5 and 6.

### Other options not considered at this stage

Another approach for modelling land use change involves utilising computational general equilibrium (CGE) modelling. CGE models are best suited to modelling macroeconomic impacts of a policy or a project on aggregated spatial areas. These models are not as well suited to modelling land use change at the spatially disaggregated level required for land use modelling. They also require a high level of technical expertise and effort to build and operate. For these reasons, further development and additional care is needed in the consideration and use of CGE models for land use change estimation.

### 3.2.4 Benefits estimation

These include the estimating of both dynamic WEBs and land use benefits (costs), associated with changes in land use as a result of transport intervention. The options are as follows:

#### Option 1: Do Nothing (Status Quo)

This option continues the current practice (lack of guidance on estimating dynamic WEBs and land use change) and no change will be made to the EEM. This serves as the relative benchmark for all other options to be considered against. This option is not considered feasible due to the need for estimating dynamic WEBs and land use benefits.

#### Option 2 (Bronze): Provide qualitative guidance

This option provides guidance that helps identify types and relative scale of benefits from a **qualitative perspective only**. This includes which types of benefits to consider, when to consider it, what type of projects it applies to, and appropriate calculations for dynamic WEBs and land use impacts. This is useful for estimating the scale of benefits at an early stage of a project to understand whether it warrants a further investigation as a key factor in the objectives and options of that project.

#### Option 3 (Gold): Overseas parameters as a proxy

This option includes the provision of parameters from overseas (such as Australia) to use in the quantitative calculation of benefits. This will require a relatively low effort for implementation given that overseas parameters can be chosen from regions that have similar characteristics to Auckland, Wellington and other regions in New Zealand. Parameters that would be sourced include agglomeration and labour supply elasticities, unit costs of infrastructure, congestion unit costs and active transport with respect to density elasticities. The parameters will serve as a proxy to estimate the dynamic WEBs and land use benefits.

#### Option 4 (Gold): Tailored NZ parameters

This option includes the development and provision of bespoke parameters to New Zealand. There are some parameters that do already exist, and where appropriate these can be adopted. Where other parameters are not available, a separate study will be required to develop them. This option provides greater certainty in the results, however will take marginally more effort to develop and maintain.

### 3.3 Options evaluation

#### 3.3.1 Key success factors

A number of key success factors have been developed to help inform the options assessment. These are outlined below and reflect the current context and immediate needs of Waka Kotahi, which is effectively to provide interim guidance for immediate use of evaluating land use change and forecasting dynamic WEBs and land use benefits for transport projects.

- **Low up-front investment:** low effort (time and cost) to implement necessary models/guidelines for use, including data sets and adaptability with existing systems/processes.
- **Low maintenance requirement** (from the perspective of Waka Kotahi) in managing and updating the method in the long-term, including tools/models, data sets etc.
- **Ease of use:** low effort (time and cost) for practitioners to implement the method. This considers the relative complexity of evaluation.
- **Confidence of results:** how much confidence the approach provides to practitioners and decision makers on estimating land use changes, dynamic WEBs benefits and land use benefits. This is informed by the quality of data, methodology and robustness of the analysis.

Regarding the last criteria, it is worth noting that as a number of options are relatively new and introduced only in the last 10 years, there is not necessarily a strong basis on how much confidence can be instilled in these approaches. The confidence of the results can be increased by testing these methods on a number of local case studies or having access to a wider pool of post-implementation reviews from overseas.

Each option is evaluated, from a qualitative perspective only, against the key success factors. Each key success factor has been weighted the same for simplicity of analysis. This is not intended to be a detailed quantifiable multi-criteria assessment but rather a high-level indication of which options are feasible under which project environments.

The following ratings have been applied to help evaluate the options against each key success factor, relative to one another.

**Table 3 | Rating of options against each key success factor**

Rating against key success factors				
Very Poor	Poor	Average	Good	Very Good

The interim guidance (Appendix A) provides detailed guidance on the short-list/preferred option(s) only.

#### 3.3.2 Evaluation of land use estimation options

Comparison of options for evaluating land changes are outlined in the table below.

In summary, there is justification that some of the options be included as part of the guidance in the interim guidance note (Appendix A). The interim guidance will outline when and how to undertake these methods, depending on the project scale and nature.

It is recommended that the qualitative approach (option 2) should be a do minimum option for all projects, regardless of size and complexity.

It is recommended that projects:

- Require a qualitative assessment for all projects to ensure consistency (Option 2). A consistent framework to indicate the order of magnitude for benefits will help understand whether further investigation is warranted from an appraisal point of view, but also to help justify a project in the first place (a 'case for change'), particularly if the project has strong land use or 'city-shaping' objectives.
- Allow evaluators to implement one of the quantitative options (options 5-7). Model-based approaches are likely to be able to ultimately deliver a higher level of confidence in the robustness of results than more qualitative/back of envelope methods. This would be similar to the level of confidence delivered by current transport models.

**Table 4 | Evaluation of land use estimation options**

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
1	<b>Do Nothing (Status Quo)</b>	n/a	n/a	n/a		-
2	<b>Qualitative approach only (Bronze)</b>					Yes
3	<b>Rapid Supply-side analysis (Silver)</b>					Yes
4	<b>Rapid Demand-side analysis (Silver)</b>					Yes
5	<b>Land use attractiveness model (Gold)</b>					Yes
6	<b>Integrated land use and transport model (LUTI) (Gold)</b>					Yes – It will recommend estimation of a full LUTI model where possible, however detailed guidance is provided for a simplified LUTI approach appropriate for the interim
7	<b>Detailed corridor capacity analysis (Gold)</b>					No

**3.3.3 Evaluation of land use benefits options**

Comparison of options for evaluating land use benefits are outlined in the tables below, by type of land use benefit.

**Land value changes**

Option 4 consists of a moderate amount of effort but produces a much higher confidence in results. This option is therefore recommended for inclusion in the interim guidance. Given this option requires real estate data and potentially professional real estate advice, there is additional time and expense required. There may also be the requirement for additional personnel to provide this expertise as part of the team performing the economic assessment.

A qualitative approach may be undertaken if the proponent faces time or cost constraints, the scale of the project dictates or if there are any data constraints.

**Table 5 | Evaluation of options for estimating land value changes**

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
1	<b>Do Nothing (Status Quo)</b>	n/a	n/a	n/a		No
2	<b>Qualitative approach only (Bronze)</b>					Yes – however only if Option 4 cannot be undertaken due to time or cost constraints
3	<b>Overseas parameters for calculations (Silver)</b>					No
4	<b>Tailored NZ parameters for calculations (Gold)</b>					Yes

## Public infrastructure cost changes

Option 4 is the only option which offers a very good level of confidence in results. To achieve this confidence, however, a higher level of effort is required. Option 4 requires a higher level of investment due to having to estimate public infrastructure costs for different density levels. These need to be estimated for New Zealand because infrastructure costs are largely location-specific and increasing confidence relies upon location-specific parameters. It is therefore not reasonable to approximate these using overseas parameters.

Despite the additional effort associated with Option 4, it will be included as the recommended option in the interim guidance.

A qualitative approach may be undertaken if the proponent faces time or cost constraints or the scale of the project dictates.

**Table 6 | Evaluation of options for estimating public infrastructure cost changes**

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
1	<b>Do Nothing (Status Quo)</b>	n/a	n/a	n/a		-No
2	<b>Qualitative approach only (Bronze)</b>					Yes – however only if Option 4 cannot be undertaken due to time or cost constraints
3	<b>Overseas parameters for calculations (Silver)</b>					No
4	<b>Tailored NZ parameters for calculations (Gold)</b>					Yes – however additional work will need to be undertaken to estimate localised parameters

## Second round transport externalities

Second round transport externalities are implicitly captured when undertaking second round transport modelling (see next benefit/cost). Therefore, second round transport externalities only need to be considered when second round user benefits and costs is not considered.

It should be noted that as the interim guidance is to include second round transport modelling to capture second round benefits and costs, it does not provide detailed guidance on how to capture second round transport externalities.

In the absence of second round transport modelling, second round transport externalities may be estimated using externality unit rate parameters. If this is the case, it is recommended that Option 4 is undertaken.

**Table 7 | Evaluation of options for estimating second round transport externalities**

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
1	<b>Do Nothing (Status Quo)</b>	n/a	n/a	n/a		-No
2	<b>Qualitative approach only (Bronze)</b>					No
3	<b>Overseas parameters for calculations (Silver)</b>					No
4	<b>Tailored NZ parameters for calculations (Gold)</b>					Yes – however this will need a separate study

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
						to complete the guidance

### Second round user benefits and costs

All options aside from Option 4 are relatively low effort, however only Option 4 provides an appropriate level of confidence in the results. This is because a local strategic transport model is the only effective and accepted way to model the effect of land use change on the transport network, and therefore capture second-round transport benefits. It is not recommended that any other Option is included in the interim guidance for capturing this benefit.

**Table 8 | Evaluation of options for estimating second round user benefits and costs**

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
1	Do Nothing (Status Quo)					No
2	Qualitative approach only (Bronze)					No
3	Overseas parameters for calculations (Silver)					No
4	Tailored NZ parameters for calculations (Gold)					Yes

### Public health cost changes

Option 4 is the only Option which offers a very good level of confidence in results. To achieve this confidence, however, a high level of effort is required. Option 4 requires a high level of investment due to having to estimate active transport elasticities with respect to density, and the savings to the public healthcare system as a result of higher levels of active transport. Both of these sets of data may present a challenge in estimating or building an evidence base for.

Option 3 is able to achieve a good level of confidence in results for a low level of required investment. Given this, it is recommended that the interim guidance include Option 3. Option 3 is relatively low effort due to this data has been estimated in UK and Australian contexts, which is sufficient in the short term for use as a proxy for New Zealand.

In the future, it is encouraged that a separate study is undertaken, or evidence collected, for specific New Zealand-based public health unit parameters required to undertake the calculation of the benefit.

A qualitative approach may be undertaken if the proponent faces time or cost constraints or the scale of the project dictates.

**Table 9 | Evaluation of options for estimating public health cost changes**

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
1	Do Nothing (Status Quo)					-No
2	Qualitative approach only (Bronze)					Yes – however only if Option 3 cannot be undertaken due to time or cost constraints
3	Overseas parameters for calculations (Silver)					Yes

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
4	Tailored NZ parameters for calculations (Gold)	Red	Yellow	Green	Green	No – however this should be included once further work has been undertaken to estimate the required parameters

### 3.3.4 Evaluation of dynamic WEBs options

Comparison of options for evaluating dynamic WEBs are outlined in the tables below, by type of dynamic WEB.

#### Dynamic agglomeration

Option 4 provides the most confidence in results, for a relatively low amount of effort. It is therefore recommended that Option 4 is adopted in the interim guidelines. It is relatively low effort to perform this calculation as New Zealand agglomeration elasticities already exist that can be leveraged.

It is suggested that the interim guidance only recommend a qualitative approach if the proponent faces time or cost constraints or the scale of the project dictates. This is because there can only be a moderate level of confidence in results under this approach.

Table 10 | Evaluation of options for estimating dynamic agglomeration

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance?
1	Do Nothing (Status Quo)	Green	Green	Green	Red	-No
2	Qualitative approach only (Bronze)	Light Green	Green	Green	Yellow	Yes – however only if Option 4 cannot be undertaken due to time or cost constraints
3	Overseas parameters for calculations (Silver)	Light Green	Green	Light Green	Light Green	No
4	Tailored NZ parameters for calculations (Gold)	Light Green	Light Green	Light Green	Green	Yes

#### More (or less) productive jobs

Only Option 4 provides a reasonable level of confidence in results. The guidance will therefore recommend that Option 4 is implemented, despite the relatively higher amount of effort required for proponents to undertake this Option. This Option will require a separate study to complement any existing parameters with new tailored parameters for New Zealand.

To evaluate this, there is a need to provide evidence on productivity differentials by location, making this a more time consuming and costly exercise. Census data can be used to estimate existing wage/income differentials between locations, controlling for industry or occupation. This requires a custom data request but it would be relatively straight forward to make a rough estimate of wage premium at a census area unit level. Alternatively, the guidance will make a recommendation of how to utilise data used in the land use modelling. The EEM already provides an estimate of the tax wedge on additional labour income and therefore this can be leveraged.

It is suggested that the interim guidance only recommend a qualitative approach if the proponent faces time or cost constraints or the scale of the project dictates. This is because there can only be a poor level of confidence in results under this approach.

**Table 11 | Evaluation of options for estimating more (or less) productive jobs.**

#	Option	Low investment	Low maintenance	Ease of use	Confidence in results	Include in interim guidance
1	<b>Do Nothing (Status Quo)</b>					-No
2	<b>Qualitative approach only (Bronze)</b>					Yes – however only if Option 4 cannot be undertaken due to time or cost constraints
3	<b>Overseas parameters for calculations (Silver)</b>					No
4	<b>Tailored NZ parameters for calculations (Gold)</b>					Yes – however additional work will need to be undertaken to estimate localised parameters

### 3.3.5 Presentation of WEBs and Land Use Benefits as part of CBA

In keeping with convention for WEBs, proponents should present the results of the CBA with and without Dynamic WEBs and Land Use benefits. This will ensure clarity of the magnitude of the costs and benefits that are driven by these more recent additions to the CBA toolbox, and enable readers to place weight on the different components based on how well they have been evidenced in the appraisal. A suggested presentation is shown below.

<b>Benefits</b>	
Standard benefits	
A	\$x
B	\$x
...	\$x
Wider economic benefits	
WEB A	\$x
WEB B	\$x
...	\$x
Land use benefits	
LU A	\$x
LU B	\$x
...	\$x
<b>Costs</b>	
Capex	\$x
Opex	\$x
<b>Appraisal Summary</b>	
Standard only	
BCR	x.x
NPV	\$x
Standard + WEBs	
BCR	x.x
NPV	\$x
Standard + WEB + Land Use	
BCR	x.x
NPV	\$x

## 4. IMPLEMENTATION PLAN

### 4.1 Actions

Table 12 - Actions

#	Observation	Recommendation
1	<p>The use of tailored New Zealand parameters in the quantitative calculation of benefits is recommended as this will provide greater certainty in the results. There are some New Zealand parameters that do already exist, and where appropriate these can be adopted. However, where other New Zealand parameters are not available, a separate study will be required to develop them.</p>	<p>Develop tailored New Zealand parameters in the following areas:</p> <ul style="list-style-type: none"><li>- Public infrastructure cost changes</li><li>- Second round transport externalities</li><li>- Public health cost changes</li><li>- More (or less) productive jobs</li></ul>

### 4.2 Other considerations

A number of other considerations raised by the working group, which are not already addressed in Appendix A (Interim Technical Guidance), are outlined below. These warrant further investigation as part of further revisions of the interim guidance or as part of separate initiatives.

- There is a need to provide guidance on when and how to adequately capture all land use costs and having a consistency in evaluating this between options/projects; some evaluations have ignored land use costs especially if there is no acquisition. There are inconsistencies across projects.
- From a Local Government perspective, there is a need for clarity around infrastructure costs to include in calculations is needed (which will be out with direct transport options) to ensure all infrastructure costs elements are captured, or alternatively how land use benefits can be attributed to transport investment as opposed to natural growth or investment in other infrastructure (e.g. 3 waters).
- That is a need for guidance to be created on how to help encourage proactive development behaviours from prospective developers or create developer interest/unsolicited bids (and that could actually get across the line), what focus on the end developer could be included. This can form part of the commercial case of a business case.

# APPENDIX A: INTERIM TECHNICAL GUIDANCE

## The connection between transport and land use

Land use impacts are defined as a change in, or a change in the intensification of, the types of activities that occur in places. This land use change may or may not affect built form. For example there may be a net change in land use activity with a greater (or lesser) utilisation of existing floor space, without any change to the actual built form itself. Likewise there may be a net change in land use activity as a result of a new development which sees a change in the amount of floor space, affecting built form.

Land use is affected by a number of things, including geography, economics, policy and infrastructure. These include:

- The location decisions of households and firms.
- Government policies and interventions.
- The investment decisions of government and the private sector.
- Legal, regulatory and tax systems.
- Market forces and dynamics.
- Geographical and climatic factors.
- Infrastructure.

Infrastructure may impact upon land use through both demand and supply side factors.

- **Demand-side** - Transport infrastructure is able to influence accessibility on a network, thereby impacting on the attractiveness of an area. For example, people are more likely to be attracted to an area to live if it has better accessibility to employment opportunities and amenities. Firms are more likely to be attracted to setup in a particular location if they have better accessibility to workers and other firms. Therefore, a transport infrastructure project which improves accessibility on one part of the network may result in an intensification of land use in that area as people and firms become more attracted to it relative to other areas.
- **Supply-side** - Infrastructure may either lower the costs of private development or 'unlock' indirect supply constraints on land by allowing a relaxation of regulatory controls.

It is important to realise that the interaction between transport infrastructure and land use is a complex and dynamic process, as infrastructure is both a response to and determinant of land use change. For example, infrastructure provision in a greenfield area may make that area more attractive, resulting in an intensification of land use in response. Infrastructure provision may also itself be a response to the needs of an area that has seen an intensification of land use, independent of any initial infrastructure investment. Identifying the correct causal relationship between infrastructure and land use is therefore often a challenging exercise.

There is a distinction between developing land use **projections**, which attempt to predict the likely future growth in, and distribution of, population, dwellings and jobs in the absence of further investment – and the assessment of land use **changes**, which attempts to predict how the distribution of future population, dwellings and jobs may change in response to an investment (or other intervention). The focus of these interim guidance is the latter – tools and techniques that can help understand the impacts of a transport intervention on future land use in one or more given future years.

This interim guidance also distinguishes between the estimation of **land use impacts** (due to transport intervention and other causes) and the estimation of **land use benefits and costs** (outlined in section below) that result from land use impacts and can be incorporated into business cases.

## Measuring land use impacts

### Principles and Methodological Challenges

There are a number of principles that should be adhered to when undertaking the measurement of land use change. These are discussed below.

#### *Interaction between supply and demand*

Both demand and supply-side factors must be considered when undertaking measurement of land use change. These may be considered together under a single modelling approach, or considered separately but iteratively. Questions that need to be considered when modelling land use change are:

1. Can the estimated land use demand be facilitated given any natural constraints or policy or planning regulations?
  2. Can the envisaged land use (dwellings, floor space) be fulfilled given the level of demand for the area?
- Approaches which ignore either side or their interplay reduce confidence in the estimated land use change.

### ***Dual causality***

Infrastructure and land use tend to exhibit dual causality. That is, infrastructure may be:

1. A driver of land use, as people and firms respond to changes in accessibility; or
2. The result of land use, as infrastructure provision tends to respond to the need for infrastructure given a particular land use.

Therefore, when measuring land use change and attributing the extent of the change to infrastructure provision, the direction of causation must be established and any 'reverse causation' corrected for.

### ***Attribution***

When measuring land use change it is important to isolate the change that is attributable to the transport project. Land use change may result from a number of factors (as listed above), including policy or planning constraints (such as zoning). A change in zoning by itself may be enough to trigger a change in land use, independent of any transport investment that takes place. This land use change therefore should not be attributed to the transport project. In instances where the transport project is a necessary condition for the policy change (e.g. the zoning change is only permitted if the transport investment happens) or infrastructure triggers a land use change by lowering the cost of development, part of the land use change may be attributed to the infrastructure project. The amount of attribution should be carefully considered on a project-by-project basis.

### ***Compatibility***

When modelling land use change, the correct level of spatial disaggregation must be sought such that it is able to integrate with a transport model. Often the default level of spatial disaggregation in a transport model is a travel zone. Therefore, in order to be compatible with the transport model, the land use modelling must either be at a travel zone level or a level in which there is a correspondence with the travel zone level.

### ***Conditionality***

There are often a number of supporting conditions and expenditure that must take place in conjunction with transport infrastructure in order for land use change to be realised. This may be zoning changes or investment in supporting infrastructure (such as utilities). In order to claim the land use change as part of an economic appraisal, the costs of these should also be included.

### **Accounting for all positive and negative land use changes**

In most cases the impacts of a project on population and jobs is primarily about distribution. Growth is attracted to locations that experience improved transport access and amenities, at the expense of other locations. It is true that a project can attract additional people or workers into a sub-region, region or a country – or even increase the number of jobs available for a given population. But even if this could reliably be evidenced, considerations would also need to be given to the benefits and cost of hosting additional people and jobs, including the cost of public infrastructure and services. For practical reasons it is therefore usually desirable to control total population and employment within an appropriate spatial area – for instance the extent of the transport model being used.

## **Tools and Techniques**

### ***Land Use attractiveness model***

Land use models estimate demand for land use by considering a number of factors which impact on where people choose to live and work, firms choose to locate, dwelling density and other economic activity. For example:

**Population** – individuals and households base their decision on where to live on accessibility to employment opportunities and other amenities. The better the accessibility to employment opportunities and amenities, the more desirable is the location. Land use attractiveness models estimate the relationship between population density and each of the individual attractiveness factors.

**Employment** – firms base their decision on where to live on accessibility to workers, other firms and a range of critical economic infrastructure such as ports, airports and freight routes. Land use attractiveness models estimate the relationship between employment density (by industry) and each of the individual attractiveness factors.

Land use attractiveness models typically use econometric techniques to estimate the relationship between land use demand and the range of attractiveness factors. These techniques are statistically robust and founded on historical relationships between land use intensification and attractiveness factors. They therefore are able to produce a relatively high degree of confidence in their estimates on the demand-side. Specifically, these models are able to:

1. Measure whether there is a significant relationship between land use and each attractiveness factor (such as accessibility, amenity) by isolating each individual effect.
2. Measure the size of the relationship. For example, the x% increase in population density as a result of a 1% increase in accessibility to jobs.
3. Treat any potential reverse causality using advanced statistical techniques.

The advantage of using these models is that land use change is able to be estimated quantitatively which adds robustness to the economic assessment relative to a qualitative assessment.

The major shortcoming of a land use attractiveness model is that supply-side influencers on land use are not considered. This leaves out a critical consideration in the land use market, meaning results from the land use attractiveness modelling should only be interpreted from a demand perspective, and not necessarily from the perspective of land use market equilibrium. Separate supply-side assessments should be performed in conjunction with the land use attractiveness modelling in order to arrive at final land use change estimates.

### ***Land Use and Transport Interaction Model (LUTI)***

LUTI models are land use attractiveness models integrated with transport models. Integrating with transport models means land use forecasts can inform the transport modelling as part of the assessment of a transport project, producing more realistic estimates of the impacts on the transport network, and therefore the economic benefits of the project.

LUTI models are able to:

1. Predict land use change based on estimated accessibility changes as measured by a transport network model.
2. Use the predicted land use change as an input into the transport network model for the purpose of modelling 2nd round transport impacts.

LUTI models therefore have the dual effect of being able to assist in the measurement of land use benefits or costs and second round transport benefits or costs.

The land use modelling component of the LUTI model may be:

1. Integrated directly into the transport model. In this case, the 1st round transport, land use, and 2nd round transport modelling components are all performed in the same model and as part of the same process.
2. Performed separate to the transport model, but used in an iterative fashion with the transport model. Typically, the outputs of the 1st round of transport modelling informs the land use modelling, with the outputs of that in turn acting as inputs for the 2nd round of the transport modelling. This approach is less fluid than if fully integrated and generally requires multiple parties to perform the modelling (i.e. a specialist land use modeller and a specialist transport modeller).

LUTI models are often quite complex, owing to their modelling of complex land use and transport systems and statistical foundations. Because of this, LUTI models generally require a high level of expertise to develop and operate. Due to their level of spatial disaggregation and large number of variables, these models require large quantities of input data. They may also require significant processing power to operate. Utilising already-developed LUTI models may also pose a challenge as many are proprietary-based or have licensing requirements. These factors all mean that LUTI models often have a relatively high cost of operation when utilising them as part of an economic assessment of a transport investment.

### ***Land Capacity Analyses***

Often considered a set of approaches with a clear supply-side focus, these consider how infrastructure projects enable amendments to land use planning frameworks to unlock additional development potential. The increasing use of GIS software has enabled significant advances in the sophistication of such analyses over the last years.

Supply-side analyses focus on the ability of land in a particular location to support densification – taking into account local and district level opportunities and constraints. The detail of the analysis can be tailored to individual

circumstances – with high level assessments at a precinct-level appropriate for earlier stages of a business case and/or for projects that have geographical dispersed effects, down to a lot-level analysis for later stages and/or where impacts are much more localised.

GIS based models use digitised maps containing current planning frameworks to display constraints (such as FSR's, height limits, heritage, strata, environmental, flood plains, etc) and opportunities (such as Government-owned land and under-utilised sites). A renewal assessment then considers potential changes to planning controls for individual sites or areas in response to the proposed transport improvement. This typically follows consultation with key government agencies. A demand-side overlay is usually provided, where market evidence is used to inform likely take-up rates of commercial and residential floor space capacity over time.

## **When to Consider Measuring Land Use**

It is not expected that all projects will generate land use changes. And even projects that do may not be expected to deliver significant dynamic benefits/costs. Proponents should consider carefully the nature of an investment and whether the local conditions are conducive of land use impacts and benefits before undertaking an assessment and, if appropriate, consult with Waka Kotahi in advance.

Where such impacts are likely, qualitative analyses should be undertaken. The proposed interim guidelines suggest qualitative analyses that will help inform the decision about whether or not a quantitative assessment is warranted.

## **Recommended interim approach**

The recommended approach for measuring land use change is in two parts. Part A provides guidance for a qualitative assessment of measuring land use change. Part B provides guidance for a quantitative assessment. The outcome of Part A should be used to inform the assessment in Part B.

Figure 4 below contains the approach overview including guidance on key decisions to be made. The detail of the approach is contained in the following sections.

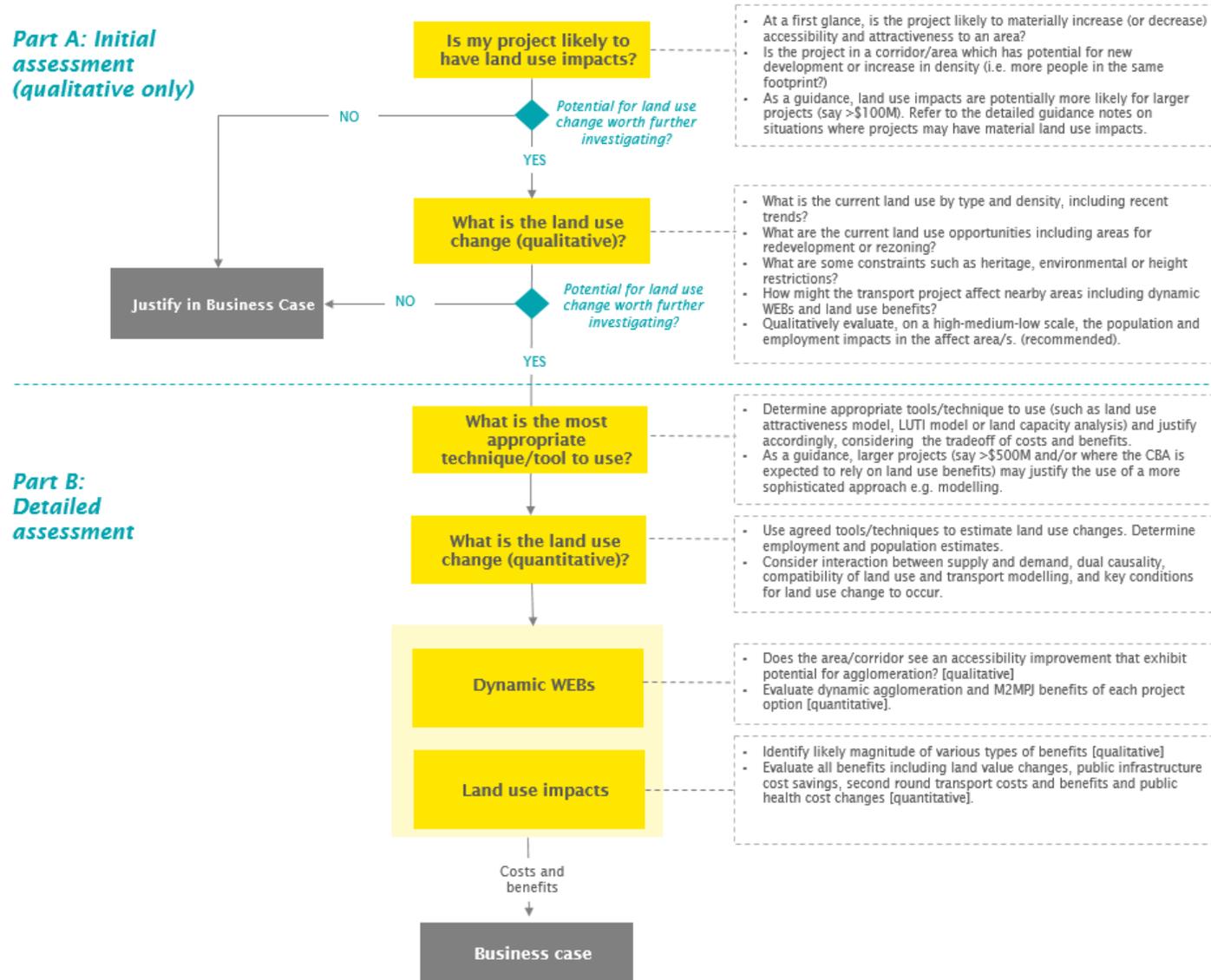


Figure 4 | Overview of approach to assessing land use changes and benefits in transport projects

## **Part A**

### **Initial assessment of whether the project is likely to have land use impacts**

An initial discussion should be had on whether the project is likely to have any material land use impacts that are worth further consideration (i.e. continue Part A and if required, Part B). This should be undertaken for all transport projects.

Although it is difficult to provide clear guidance on what may constitute significant land use impacts as it depends on many complex factors and is unique to each project, a few key considerations are outlined below:

- A key question to ask is 'Is there an opportunity for the transport project to act as a catalyst for residential and industrial growth in areas, and re-sculpt the form and structure of regions?'
- It is likely to occur for greenfield or brownfield areas in or near city centres (for the latter especially if there is a poor existing urban form and a transport project could act as a catalyst for a transformation of the area). Conversely, there is a lower possibility of material land use impacts in rural locations.
- As a high-level guidance, land use impacts are more likely to be for larger projects, i.e. greater than \$100M.

Should there be merit in further investigating the land use impact, the following steps can be undertaken to greater qualify the impact.

### **Describing current land use, opportunities and constraints**

This should enable an understanding of current and future potential land use in the project area.

- **Current land use** – a description of current use by type and density, including recent trends.
- **Opportunities** – highlight areas that are marked for redevelopment or rezoning, or where there are key opportunities for doing so.
- **Constraints** – identify constraints that could prevent redevelopment or rezoning, such as heritage, environmental, height restrictions, etc.

### **Describing how the project will affect nearby areas**

This should aim to articulate how the proposed improvement will impact the surrounding area.

- **Spatial extent** – Different types of infrastructure will have different impacts depending on the characteristics of the infrastructure. For instance, a new rail station will typically have significant impacts on the immediate surroundings, but much less so beyond a 1-2km radius. A new highway, in contrast, will have impacts that are much more dispersed. A new light rail line might have substantial effects on a corridor extending 400-800m on either side of the line.
- **The characteristics of the affected area** – Improving transport will affect areas differently depending on location and local characteristics. For instance, the impact of a new rail station in an industrial area at the urban fringe is likely to be very different from a high density residential area close to the CBD.
- **Nature of the improved transport services** – Different transport technologies cater to different types of users, from the local corridor movements of a light rail system, to the mass transit capacity of suburban rail and trunk movements of intercity motorway networks.

### **Documenting consultation with key stakeholders**

- The land use assessment should be developed in consultation with key stakeholders, such as councils, significant land owners, transport and planning agencies and other bodies with significant interest or jurisdiction over land use.

### **Summarising the relationship of the project with land use change**

- In light of the identified current use, opportunities and constraints, and the role of the proposed project, describe what type and magnitude of land use change is likely to occur and over what timeframes.
- If appropriate, classify different parts of the project area into sub-areas according to type and likely impacts (e.g. precincts, corridors or catchment areas).
- For each project sub-area, indicate likely order of magnitude of land use change – using the below classifications as a guide.

**Table 13 Example of classification of sub-areas by likely scale of land use impacts**

Project sub-area	Population Impact - Scale	Population Impact – Description ( <i>example</i> )	Employment Impact - Scale	Employment Impact – Description ( <i>example</i> )
A	High Positive	Underutilised land unlocked and rezoned to high density residential	Small Negative	Current industrial park to be rezoned to residential
B	Medium Positive	Increased accessibility likely to attract additional demand, with infill and/ or rezoning driving densification	Small Positive	Additional retail offering as part of mixed use development
C	Insignificant	No impact	Small Positive	Some densification in use of current stock.
D	Small negative	Some residential removed due to rezoning to commercial	Large Positive	Rezoning from residential to commercial to take advantage of new infrastructure node
E	Medium Negative	Planned mixed used development to give way for new interchange with lower yield	Medium Negative	Planned mixed used development to give way for new interchange with lower yield
F	Large Negative	Future planned residential rezoned to Enterprise Zone	Medium Positive	Ambition for new Enterprise Zone that is unlikely to be viable without the new infrastructure

### **Part B – Quantitative Assessment**

Proponents of a project that seek to claim dynamic WEBs or land use benefits must also undertake a quantitative assessment of likely land use change. Where possible this assessment should make use of detailed modelling techniques (such as those described in the Tools and Techniques section). However, where this is not possible or practical, the following sets out a high-level approach to arrive at an order of magnitude level of impacts.

It is difficult to have clear guidance on which level of sophistication the analysis should be. However, a greater level of sophistication is to be expected in larger projects and/or those with CBA's that rely heavily on land use impacts.

This simplified assessment is based on assessing a project's impact on local attractiveness through change in residents' access to jobs and firms' access to workers. For simplicity, the approach uses the same indicator of access as used in the existing agglomeration method in the EEM (i.e. the calculation of Effective Density in A10.1 of the EEM).

It then uses the scale of impact classifications by area under Part A together with approximate low, medium and high elasticities of land use to effective density from Australian evidence to estimate potential demand-driven land use uplifts.

Two further adjustments are then required to the results:

- **Supply-side controls** - An assessment of the modelled results against the opportunities and constraints identified in Part A. In some locations this would cap modelled results to what is considered sensible uplifts from a land capacity perspective. In areas where the qualitative assessment has identified key opportunities for rezoning, or where the project unlocks a bottleneck to densification, it may be appropriate to replace modelled results with a 'bottom-up' assessment of expected future land use.
- **Total employment and population controls** – The analysis requires the total employment and population of the modelled area (e.g. in the transport model) to be held constant. Population and employment outside the project area may therefore need to be adjusted to ensure totals are controlled. Although small reductions in further densities can be spread over large areas (e.g. through reductions in occupancies or infill development), it is likely that the majority of such displacement will happen where developer returns are marginal.

### **Inputs**

Inputs needed for the quantitative assessment of land use change are documented in the following table.

**Table 14 | Guidance on inputs to quantitative assessment of land use change**

Input required	Spatial area	Description	Source
Future base case/do minimum land use forecasts	Travel zone for modelled area	Employment and population forecasts	Inputs to transport model
Transport model outputs	Travel zones for modelled area	Origin-Destination matrices (trips and generalised costs by mode and purpose)	Transport model outputs
Land use elasticities	Model wide	Elasticity of land use with respect to accessible jobs/workers (low/medium/high)	Population/ Employment:  Low: 0.23/1.81  Medium: 0.61/2.89  High: 0.99/3.97

**Approach**

A recommended approach for measuring land use change is presented below. It should be noted that these steps may be performed iteratively, or as part of the same modelling framework, depending on the exact nature of the land use model adopted.

**Step A** – Calculate average generalised cost in the ‘do-minimum’ and option cases. The transport model outputs required for this calculation are discussed in Section B4 of Appendix 10 of the EEM. The average generalised cost (AGC) is calculated as:

$$AGC_{ij}^S = \frac{\sum_{m,p,AM} GC_{ij}^{S,m,p,AM} * D_{ij}^{*,m,p,AM}}{\sum_{m,p,t} D_{ij}^{*,m,p,AM}}$$

$GC_{ij}^{S,m,p,t}$  is the generalised journey time (in hour) from origin  $i$  to destination  $j$  in scenario  $S$  (do-minimum or option case), by mode  $m$ , for purpose  $p =$  travel to work, in the AM peak time period.

$D_{ij}^{S,m,p,t}$  is the number of trips from origin  $i$  to destination  $j$  in scenario  $S$ , by mode  $m$ , for purpose  $p =$  travel to work, in the AM peak time period.

The use of travel to work in the AM peak is consistent with the approach used in the derivation of the above elasticities.

**Step B** - Measure land use change as a result of the transport investment by calculating effective densities in the ‘do-minimum’ and option cases. Two components need to be calculated, the Effective Job Accessibility (EJA), which drives population density, and Effective Worker Accessibility (EWA), which drives job density. Both are informed by the average generalised cost calculation in Step A. Note the reversal of the origin and destinations ( $ji$ , vs  $ij$ ) in the EWA formula:

$$EJA_i^S = \sum_j \frac{E_j^S}{AGC_{ij}^S}$$

$$EWA_i^S = \sum_j \frac{P_j^S}{AGC_{ji}^S}$$

$E_j^S$  is employment in zone  $j$  in scenario  $S$

$P_j^S$  is population in zone  $j$  in scenario  $S$

$S = DM$ . This is ‘do-minimum’ case

$S = OPT$ . This is the option case

Both cases use **constant land use** (natural forecast employment growth in the do minimum).

**Step C** - Measure land use change as a result of the transport investment. The relative change in effective density between the 'do-minimum' and option cases from Step B forms an input into the land use modelling. These models measure the change in population or employment at a travel zone level in response to a change in effective density (accessibility to employment or workers). This land use change calculation is presented below:

$$E_i^{OPT} = E_i^{DM} * \left( \left( \frac{EWA_i^{OPT}}{EWA_i^{DM}} \right)^{\partial^{e,z}} - 1 \right)$$

$$P_i^{OPT} = P_i^{DM} * \left( \left( \frac{EJA_i^{OPT}}{EJA_i^{DM}} \right)^{\partial^{p,z}} - 1 \right)$$

Where

$\partial^{T,z}$  is the land use elasticity of type T (population and employment) for a location with scale of impact z.

**Land Use Outputs** - The output of the land use modelling is a set of employment and population estimates by travel zone. These are used as inputs in the recommended interim approach to calculating dynamic WEBs and second-round transport benefits or costs (presented below).

**Step D** – Control total population and employment to the chosen spatial extent (e.g. the extent of the transport model). In its simplest form this could involve scaling back land use by a fixed proportion across all zones in the modelled area to ensure totals are held fixed. More sophisticated approaches could use indicators of supply-side constraints/flexibility to force more of the 'corrections' to take place in locations where supply is likely to be more responsive to changes in demand. Indicators could include rents, projected growth and/ or accessibility measures.

## Dynamic WEBs

WEBs can be both static and dynamic. Static WEBs are more commonly assessed. They are influenced by changes in factors such as travel times and travel costs (due to the transport investment option) based on static (unchanged) land use. Currently EEM includes guidelines for assessing these.

Dynamic WEBs estimates additional productivity benefits from a change in location or level of jobs/workers as a result of changing land use (dynamic). Given the reliance on understanding land use changes caused by a project, they are less commonly estimated, even if a framework for their quantification was provided in the original UK guidelines on WEBs. Since static WEBs leave productivity changes associated with land use change unaccounted for, also capturing dynamic WEBs would enable a more complete estimate of wider economic benefits. For transport projects with a sizeable land use component or objectives, this may be material and impact upon the viability of the project.

Dynamic WEBs include the following benefits:

- **Dynamic agglomeration:** if the relocation of workers or firms results in an increase in net density, existing firms and workers will become more productive. These productivity gains (agglomeration benefits) are net additional to the Cost Benefit Analysis.
- **Move to more productive jobs (M2MPJ):** by improving accessibility for commuters, an infrastructure project may induce workers to change their location of work. This is because the worker's 'effective wage' is now higher in one location vs another. If the project induces the worker to take up a more productive job (as the effective wage afforded by the increased accessibility is now higher to this job) there is an additional benefit to society. This benefit is the average tax take on the marginal increase in wages that the worker earns.

Provided that specific guidelines are followed, there would not be a risk of any double counting of benefits or costs between static and dynamic WEBs, nor between either and conventional user benefits. Further explanation can be found in EEM, Waka Kotahi research reports and UK guidelines.

## When to Consider Dynamic WEBs

As dynamic WEBs are driven by increased or decreased concentration of jobs and workers in or near employment clusters, they are only likely to be significant for projects that deliver substantial changes in land use near important employment centres. For instance, unlocking additional development at the urban fringe is only likely to generate dynamic WEBs if this will cause a reduction in population and/ or employment near existing centres.

## Recommended interim approach

### Dynamic agglomeration

It is recommended that a full calculation of dynamic agglomeration is performed. Parameters for this benefit calculation already exist in New Zealand and should be utilised. If the proponent faces time or cost constraints or the scale of the project dictates it, a qualitative assessment may be undertaken.

### Qualitative Approach

The proponent should consider a number of factors in a qualitative assessment of dynamic agglomeration. These are described below:

- **Project area/corridor** - Does the area or corridor that sees an accessibility improvement exhibit the potential for agglomeration? Transport improvements that better link a more educated labour force with existing higher-productive jobs are going to produce a higher agglomeration benefit relative to say a connection between two regional centres.

An indicative rating may be applied to relevant categories to better get a sense of the overall indicative level of the benefit.

**Table 15 | Example qualitative comparison**

Category/consideration	Impact on benefit/cost - Scale	Description of impact
A	Low/Medium/High	
B	Low/Medium/High	
C	Low/Medium/High	

### Quantitative Approach

#### Inputs

Inputs needed for the calculation of dynamic agglomeration are presented below. Included here are land use outputs from the recommended interim approach for land use modelling.

**Table 16 | Inputs for calculating dynamic agglomeration**

Input required	Variable	Disaggregation	Source
Agglomeration elasticities	$\epsilon$	ANZSIC	Table A10.1 of the Waka Kotahi EEM
GDP	$GDP$	Zone/ANZSIC	Statistics NZ
Generalised Cost	$AGC$	Origin-destination pair, do-minimum, option mode, purpose, year	Transport Model
Employment – Future year Base Case	$Emp^{DM}$	Zone (option)	Transport model/other
Employment – Future year Option Case	$Emp^{OPT+LU}$	Zone (option)	LUTI model or land use attractiveness model
Population – Future year Base Case	$Pop^{DM}$	Zone (option)	Transport model/other
Population – Future year Option Case	$Pop^{OPT+LU}$	Zone (option)	LUTI model or land use attractiveness model

**Step A** – Re-calculate average generalised cost in a transport model scenario which incorporates updated future employment and population estimates from the land use modelling as inputs. The transport model outputs required for this calculation are discussed in Section B4 of Appendix 10 of the EEM.

**Step B** – Calculate effective density of the option case with updated land use. The effective density of the option case with updated land use includes the updated employment as estimated in the land use modelling, and the average generalised cost estimated in Step A:

$$ED_i^S = \sum_j \frac{Emp_j^S}{AGC_{ij}^S}$$

$$ED_j^S = \sum_i \frac{Pop_i^S}{AGC_{ij}^S}$$

$S = OPT + LU$ . This is the option with **updated land use** as estimated in the land use modelling.

It should be noted that population (worker) effective density and employment effective density can be heavily correlated. This, combined with the fact that existing agglomeration elasticities have been estimated for employment rather than for population, has meant that typically only agglomeration associated with employment effective density is captured. It is recommended that work is undertaken to estimate agglomeration elasticities for population. This would enable proponents in the future to capture the agglomeration benefit associated with population (workers) as well as employment.

**Step C** – Compare the effective density in Step B with the ‘do-minimum’ effective density and calculate dynamic agglomeration. The productivity gains from agglomeration are calculated for each zone by applying the agglomeration elasticities to the change in density in each zone. This is then multiplied by average value-add per worker to obtain the change in output per zone, before being summed over all zones for a total dynamic agglomeration benefit.

$$dynamic\ agglomeration = \sum_i \left( \left( \frac{ED_i^{OPT+LU}}{ED_i^{DM}} \right)^{\varepsilon_i} - 1 \right) * GDP_i$$

$\varepsilon$  is agglomeration elasticity

$GDP$  is the average gross value added per worker for marginal labour supply by zone  $i$

### Move to more productive jobs (M2MPJ)

It is recommended that a full calculation of M2MPJ is performed. Where parameters for this benefit already exist in New Zealand they should be utilised. Where these parameters have either yet to be established, or only exist at a different spatial level, proxy parameters may be utilised.

#### Qualitative Approach

The proponent should consider a number of factors in a qualitative assessment of M2MPJ. These are described below:

- **Location of higher-productive jobs** – Is there a disconnection between location of higher-productive jobs and qualified labour force? The proponent may consider if there are any shortages of labour for these types of jobs due to accessibility constraints between where labour resides and where jobs are situated.
- **Project Corridor** - Does the transport project alleviate accessibility constraints between higher-skilled labour and higher-productive jobs
- **Labour Market Constraints** - Are there any other labour market constraints that may prevent labour from being matched to its most productive role? If this is the case, accessibility improvements may not be enough to result in the move to more productive jobs.

An indicative rating may be applied to relevant categories to better get a sense of the overall indicative level of the benefit.

**Table 17 | Example qualitative comparison**

Category/consideration	Impact on benefit/cost - Scale	Description of impact
A	Low/Medium/High	
B	Low/Medium/High	
C	Low/Medium/High	

#### Quantitative Approach

##### Inputs

Inputs needed for the calculation of M2MPJ are presented below. Included here are land use outputs from the recommended interim approach for land use modelling.

**Table 18 | Inputs for calculating M2MPJ**

Input required	Variable	Disaggregation	Source
GDP	$GDP$	Zone/ANZSIC	Statistics NZ
Generalised Cost	$AGC$	Origin-destination pair, do-minimum, option mode, purpose, year	Transport Model
Employment – Future year Base Case	$Emp^{DM}$	Zone (option)	Transport model/other
Employment – Future year Option Case	$Emp^{OPT+LU}$	Zone (option)	LUTI model or land use attractiveness model
Productivity differential	$P_i$	Zone/ANZSIC	Statistics NZ, NZ income survey, NZIER (2004), Kalb (2003a)
Average tax rate	$\tau$	National	NZTA – Wider economic impacts of transport investments in New Zealand – September 2011

**Step A** – Obtain productivity differentials by zone. It is challenging to determine productivity differentials by spatial area as there are a number of variables that must be corrected for (such as skills, education and other socioeconomic factors). Currently, no reliable estimates of relative productivity by spatial area are known for New Zealand. It is recommended that further study is undertaken in the future to establish robust estimates.

One approach in the meantime is to use Census data to estimate existing wage/income differentials between locations, controlling for industry or occupation. This requires a custom data request, but it would be relatively straight forward to make a rough estimate of wage premium at a census area unit level.

In the absence of this, or other quantitative evidence, a recommended approach for productivity differentials by zone is to use the relative effective densities between zone  $i$  and the average of the study area. The effective density for zone  $i$  is expressed in the effective density equation (in the quantitative approach to calculating dynamic agglomeration above).

**Step B** – Calculate the M2MPJ benefit. This calculation, given below, firstly applies the relative productivity differential between a zone  $i$  and the study area average to the change in employment in that area between the option (including land use change) case and ‘do-minimum’ case. It then applies the average tax rate on wages before summing up over each zone and multiplying by value-add per worker.

$$M2MPJ = GDP * \sum_i (Emp_i^{OPT+LU} - Emp_i^{DM}) * P_i * \tau$$

$GDP$  is the average gross value added per worker for marginal labour supply in the study area

$Emp_i^{DM}$  is employment in zone  $i$  in the ‘do-minimum’ case

$Emp_i^{OPT+LU}$  is employment in zone  $i$  in the option with updated land use case

$P_i$  is the productivity differential between zone  $i$  and the study area average

$\tau$  is the average tax rate on wages

## Land Use Benefits or Costs

A series of land use benefits or costs may arise as a result of land use change that can be attributed to the transport project. With the appropriate evidence base and parameters, it may be appropriate to capture these as part of the CBA. A recommended interim approach for accounting for each of these benefits or costs is presented further below.

In circumstances where a transport investment is unlocking development constraints, either by relieving congestion or crowding, or by reducing development risk, there may be benefits from higher value land use that are additional to benefits measured elsewhere. It is important to distinguish this effect from that of property values increasing around corridors when transport is improved, which, in itself, is simply a capitalisation of travel time savings and other benefits into property values. If, on the other hand, additional transport capacity enables denser development, the more intensive land use can deliver benefits – equal to the value of the expected new land use, less value of existing use less any costs. It is important to consider that land value is also influenced by supply-side factors independent of the infrastructure project. Therefore, the change in land value may only be captured to the extent that it is attributable to the infrastructure project. This may include the project being a catalyst for a relaxation of zoning constraints or being a necessary enabler of land use development. Also, to avoid double counting, unit values must not change – i.e. the benefits pertain to the value of the additional floorspace that can be allowed on a given parcel of land, but not to a change in the value per m<sup>2</sup> of floorspace (which is a capitalisation of other benefits and therefore cause double counting).

### When to Consider Land Use Benefits or Costs

Land use benefits are relevant for projects that have been identified as having appreciable impacts on the location of population and employment. Whilst each of the benefit categories will involve different level of effort in terms of developing evidence and analysis, it is important that all components are quantified. For instance, densification can lead to higher value land use and agglomeration benefits, but also cause additional costs in terms of transport externalities and public infrastructure costs. Proponents who wish to quantify land use benefits therefore need to ensure all cost and benefit items are assessed. A careful consideration of the likely magnitude of benefits and costs is recommended before undertaking analysis.

### Recommended interim approach

#### Higher Value Land Use

Where an infrastructure project enables densification, the change in land use will generate a net economic benefit if the value of the new use is higher than the value of current use. This benefit can be estimated using estimated increase in floor space together with evidence on land values per square metre of floor space.

It is important, however, to distinguish between the increase in value of land caused directly by the new infrastructure and the value generated by densification. The former is merely a capitalisation of the gains to users of the infrastructure that are already captured elsewhere in the CBA. The latter, if fully attributed to the project, generates net additional value that should be captured as a land use benefit.

#### Qualitative Approach

The proponent should consider a number of factors in a qualitative assessment of land value changes. These, and other areas to focus on in the qualitative assessment are described below:

- **Market Demand** - consider the appetite for market uptake of additional floor space in the corridor or precinct. Is there demand for additional residential, commercial and retail floor space?
- **Supply** - Is there propensity for developers to come into the market and provide floor space? Analysing price movements and supply over time may assist in this analysis.
- **Current land use** – include a description of current use by type and density, including recent trends. Does current use impact on opportunities for higher value land use?
- **Opportunities** – highlight areas that are marked for redevelopment or rezoning, or where there are key opportunities for doing so.
- **Constraints** – identify constraints that could prevent redevelopment or rezoning, such as heritage, environmental, height restrictions, etc.

An indicative rating may be applied to relevant categories to better get a sense of the overall indicative level of the benefit.

**Table 19 | Example qualitative comparison**

Category/consideration	Impact on benefit/cost - Scale	Description of impact
A	Low/Medium/High	
B	Low/Medium/High	
C	Low/Medium/High	

## Quantitative Approach

### Inputs

Inputs needed for the calculation of land values are presented below. Included here are land use outputs from the recommended interim approach for land use modelling.

**Table 20 | Inputs for calculating land values**

Input required	Variable	Disaggregation	Source
Gross Floor space Area per m2	$GFA^t$	Sub-area, a	Statistics NZ and real estate data
Average residual land value per m2	$RLV^t$	Sub-area, a	Market evidence

**Step A** – Analyse market evidence to establish average Residual Land Values (RLV) per m2 of Gross Floor space Area (GFA) for different product (residential, commercial, retail) in each of the identified project sub-areas (same areas as defined in the earlier ‘Example of classification of sub-areas by likely scale of land use impacts’ Table).

**Step B** – Convert estimated land use uplifts into m2 of GFA using assumptions about average intensity of use (e.g. average occupancy per dwelling and average dwelling size, average m2 per worker for different commercial uses). These assumptions should reflect the type of product that is expected in each project sub-area.

**Step C** – Estimate land value uplift as the product of RLV per m2 by product by the amount of additional m2 GFA by product and sub-area.

$$HVLU = \sum_i \Delta GFA_a^t * RLV_a^t$$

$\Delta GFA_a^t$  is incremental m2 of GFA of type t in project sub-area a.

$RLV_a^t$  is average RLV per m2 of type t in project sub-area a

### Public Infrastructure Cost Savings

The public infrastructure (e.g. water, sewerage, community facilities, etc.) cost required to facilitate growth is typically lower per dwelling in infill locations than on the urban fringe. Therefore, if an infrastructure project induces more infill development vs fringe development, there may be a public infrastructure cost saving. This requires estimates of per dwelling costs for infill/fringe.

Applications should also consider project specific conditions that affect infrastructure cost – such as whether attracting additional development triggers the need for new, lumpy infrastructure investment or, alternatively, sufficient spare capacity is already in place to allow densification without additional investment.

It is recommended that a calculation of public infrastructure cost savings is only performed if sufficient evidence on appropriate parameters can be obtained. Below sets out an approach for measuring this benefit if the proponent has a reasonable level of comfort in these parameters.

### Qualitative Approach

The proponent should consider a number of factors in a qualitative assessment of public infrastructure cost savings. These, and other areas to focus on in the qualitative assessment are described below:

- **Future growth patterns** - Is the project likely to lead to a change in the distribution of future growth from less dense areas to more dense areas? If this is the case, there are likely to be some form of public infrastructure cost changes.

- **Public infrastructure cost per dwelling** - Is the public infrastructure cost per dwelling (net of developer contributions) likely to be higher or lower in the corridor? Consideration should be given to unique localised conditions. This includes considering any unique constraints that a development may face in an area.
- **Consult with service providers** - Where possible proponents should take into account variability in the type of housing and consult with service providers as to the likely public infrastructure costs in the corridor or local precinct

An indicative rating may be applied to relevant categories to better get a sense of the overall indicative level of the benefit.

**Table 21 | Example qualitative comparison**

Category/consideration	Impact on benefit/cost - Scale	Description of impact
A	Low/Medium/High	
B	Low/Medium/High	
C	Low/Medium/High	

## Quantitative Approach

### Inputs

Inputs needed for the calculation of public infrastructure cost savings are presented below. Included here are land use outputs from the recommended interim approach for land use modelling.

**Table 22 | Inputs for calculating public infrastructure cost savings**

Input required	Variable	Disaggregation	Source
Public infrastructure cost per dwelling of $\rho$ (low, medium, high) density	$GIP_{\rho}$	Dwelling density type	
Proportion of dwellings that is of $\rho$ (low, medium, high) density at location $i$	$Den_{i,\rho}$	Zone (option)	Statistics NZ
Dwellings – Future year Base Case	$Dwlg_i^{DM}$	Zone (option)	Transport model/other and Statistics NZ
Dwellings – Future year Project Case	$Dwlg_i^{OPT+LU}$	Zone (option)	LUTI model or land use attractiveness model and Statistics NZ
Population – Future year Base Case	$Pop^{DM}$	Zone (option)	Transport model/other
Population – Future year Option Case	$Pop^{OPT+LU}$	Zone (option)	LUTI model or land use attractiveness model

**Step A** – Convert population into dwellings. This may be done by applying projected occupancy rates to the ‘do-minimum’ and option with land use change population estimates in the land use modelling. Projected occupancy rates may be developed by looking at historical trends in occupancy rates by zone. Dwelling mix may be represented by type of dwelling density, for example ‘low’, ‘medium’ and ‘high’ density in a particular zone. It may be that an area is classified as low dwelling density if it has more detached dwellings, and high dwelling density if it has more apartment dwellings.

**Step B** – Calculate public infrastructure cost savings. Savings in government provision can be calculated as the change in dwelling mix multiplied by the cost of government infrastructure provision per dwelling mix. The formula for public infrastructure cost savings is given as:

$$\text{Public infrastructure cost savings} = \sum_{i,\rho} (Dwlg_i^{OPT+LU} - Dwlg_i^{DM}) * Den_{i,\rho} * GIP_{\rho}$$

$Den_{i,\rho}$  is the proportion of dwellings that is of  $\rho$  (low, medium, high) density at location  $i$

$Dwlg_i^S$  is the number of dwellings at location  $i$  in scenario  $S$  ( $DM$  = 'do-minimum' and  $OPT + LU$  = option with updated land use)

$GIP_\rho$  is the cost of government infrastructure provision per dwelling of  $\rho$  density

## Second round benefits and costs

Second round transport benefits and costs represent the additional benefits and costs to those that relocate and live in a new location.

It is recommended that a full calculation of second round transport benefits and costs is performed where possible. The recommended interim approach for land use modelling should be undertaken to generate land use change outputs to feed into the second-round transport modelling.

Land use change can alter transport patterns and therefore external costs (crowding, congestion, pollution, crash costs, etc.) associated with travel. For example, clustered households around trip destinations make more use of public and active transport. Quantifying this benefit may require undertaking 'second-round' transport modelling, or the use of externality unit rates.

Undertaking a calculation of second round transport benefits also implicitly captures any second-round transport externalities. This approach is therefore comprehensive in capturing all second-round transport impacts on the network.

## Quantitative Approach

### Approach

**Step A** – Feed the outputs of the land use modelling into the transport model as updated land use inputs. The transport model then produces a future scenario with the option and estimated land use change. The outputs required for this calculation are discussed in Section B4 of Appendix 10 of the EEM. The outputs represent the full effect of the option after considering the impact of land use change.

**Step B** – Call up the outputs of the initial option transport modelling scenario which holds land use constant. This scenario represents the transport impact of the option, holding land use constant. They are known as 'first-round' transport impacts.

**Step C** – Take the difference between the outputs in **Step A** and **Step B**. These represent the 'second-round' transport impacts.

First and second-round transport impacts are independent of one another and additive.

## Public health cost changes

Denser pattern of urban development can lead to health cost savings associated with more people using active transport. This requires evidence on active travel patterns by location, and health cost savings per km of active travel. Note that only incremental impact on active travel caused by a land use change, over and above that caused by the transport investment, should be captured here.

It is recommended that a calculation of public health cost changes is only performed if sufficient evidence on appropriate parameters can be obtained. Below sets out an approach for measuring this benefit if the proponent has a reasonable level of comfort in these parameters.

If undertaking the calculation, the recommended interim approach for land use modelling should be undertaken to generate population land use change outputs to feed into the calculation.

## Qualitative Approach

The proponent should consider a number of factors in a qualitative assessment of public health cost changes. These, and other areas to focus on in the qualitative assessment are described below:

- **Supporting active transport infrastructure** - does supporting infrastructure for active transport exist in the corridor? This may include fit-for-purpose footpaths and bike lanes.
- **Existing active transport patterns** – proponents should think about what the propensity is for active travel amongst the affected population. Is there currently clear and noticeable patterns of active transport amongst the population?

An indicative rating may be applied to relevant categories to better get a sense of the overall indicative level of the benefit.

**Table 23 | Example qualitative comparison**

Category/consideration	Impact on benefit/cost - Scale	Description of impact
A	Low/Medium/High	
B	Low/Medium/High	
C	Low/Medium/High	

## Quantitative Approach

### Inputs

Inputs needed for the calculation of public health cost changes are presented below. Included here are land use population outputs from the recommended interim approach for land use modelling.

Additional work should be undertaken to calculate the active transport health benefit per km for New Zealand. In the absence of New Zealand-specific data for this parameter, proxy data may be taken from international evidence.

Active transport kilometres travelled should be sourced from a transport model where appropriate. Where this is not available in a transport model, New Zealand Travel to work data should be utilised.

**Table 24 | Inputs required for calculating public health cost changes**

Input required	Variable	Disaggregation	Source
Active transport health benefit per km	$AT$	Network level	
kilometres travelled to work via active transport – Future year Base Case	$KT^{DM}$	Zone (option)	Transport model
kilometres travelled to work via active transport – Future year Option Case	$KT^{OPT+LU}$	Zone (option)	Transport model
Population – Future year Base Case	$Pop^{DM}$	Zone (option)	Transport model/other
Population – Future year Option Case	$Pop^{OPT+LU}$	Zone (option)	LUTI model or land use attractiveness model

**Step A** – Obtain average kilometres travelled to work via active transport on the network. Also gather ‘do-minimum’ and option with updated land use population as estimated in the land use modelling.

**Step B** – Calculate the public health benefit. This is done by applying the active kilometres travelled to work for each zone to the change in estimated population for each zone and multiplying by the health benefit per active kilometre travelled. The benefit is the sum of all zones on the network.

$$public\ health\ benefits = \sum_{i,a} (Pop_i^{DM} - Pop_i^{OPT+LU}) * \overline{KT}_i^a * AT^a$$

$KT^{S,a}$  is the kilometres travelled to work via active transport  $a$  (i.e. cycling, walking) in scenario  $S$  ( $DM$  = ‘do-minimum’ and  $OPT + LU$  = option with updated land use)

$Pop_i^S$  is the number of residents who live at location  $i$  in scenario  $S$  ( $DM$  = ‘do-minimum’ and  $OPT + LU$  = option with updated land use)

$AT^a$  is the value of active transport health benefits per kilometre travelled that result from shifting the mode from car to active transport  $a$

## Presentation of WEBs and Land Use Benefits as part of CBA

In keeping with convention for WEBs, proponents should present the results of the CBA with and without dynamic WEBs and Land Use benefits. This will ensure clarity of the magnitude of the costs and benefits that are driven by these more recent additions to the CBA toolbox, and enable readers to place weight on the different components based on how well they have been evidenced in the appraisal. A suggested presentation is shown below.

<b>Benefits</b>	
Standard benefits	
A	\$x
B	\$x
...	\$x
Wider economic benefits	
WEB A	\$x
WEB B	\$x
...	\$x
Land use benefits	
LU A	\$x
LU B	\$x
...	\$x
<b>Costs</b>	
Capex	\$x
Opex	\$x
<b>Appraisal Summary</b>	
Standard only	
BCR	x.x
NPV	\$x
Standard + WEBs	
BCR	x.x
NPV	\$x
Standard + WEB + Land Use	
BCR	x.x
NPV	\$x

## When to consider land use impacts in the business case lifecycle

Figure 5 provides guidance on the level of assessment to be expected across the project business case lifecycle, from the Strategic Case to the single-stage or detailed business case phases. This is based on the current Waka Kotahi process for business case.

It is worth noting that this is guidance only; the application is dependent on what is required for each project. However, the business case should be transparent on what has been undertaken (and why) and what is planned to be done in the next stage of the project (i.e. following business cases). Specifically:

- **For the problem statement/objectives:** articulate how land use changes (if at all) forms part of the project need ('case for change') and project objectives. This is typically from a qualitative perspective only.
- **For the economic appraisal:** evaluate land use impacts using appropriate tools and techniques before evaluating dynamic WEBs and land use benefits/dis-benefits for project options/preferred option. Incorporate costs and benefits into the CBA as appropriate.

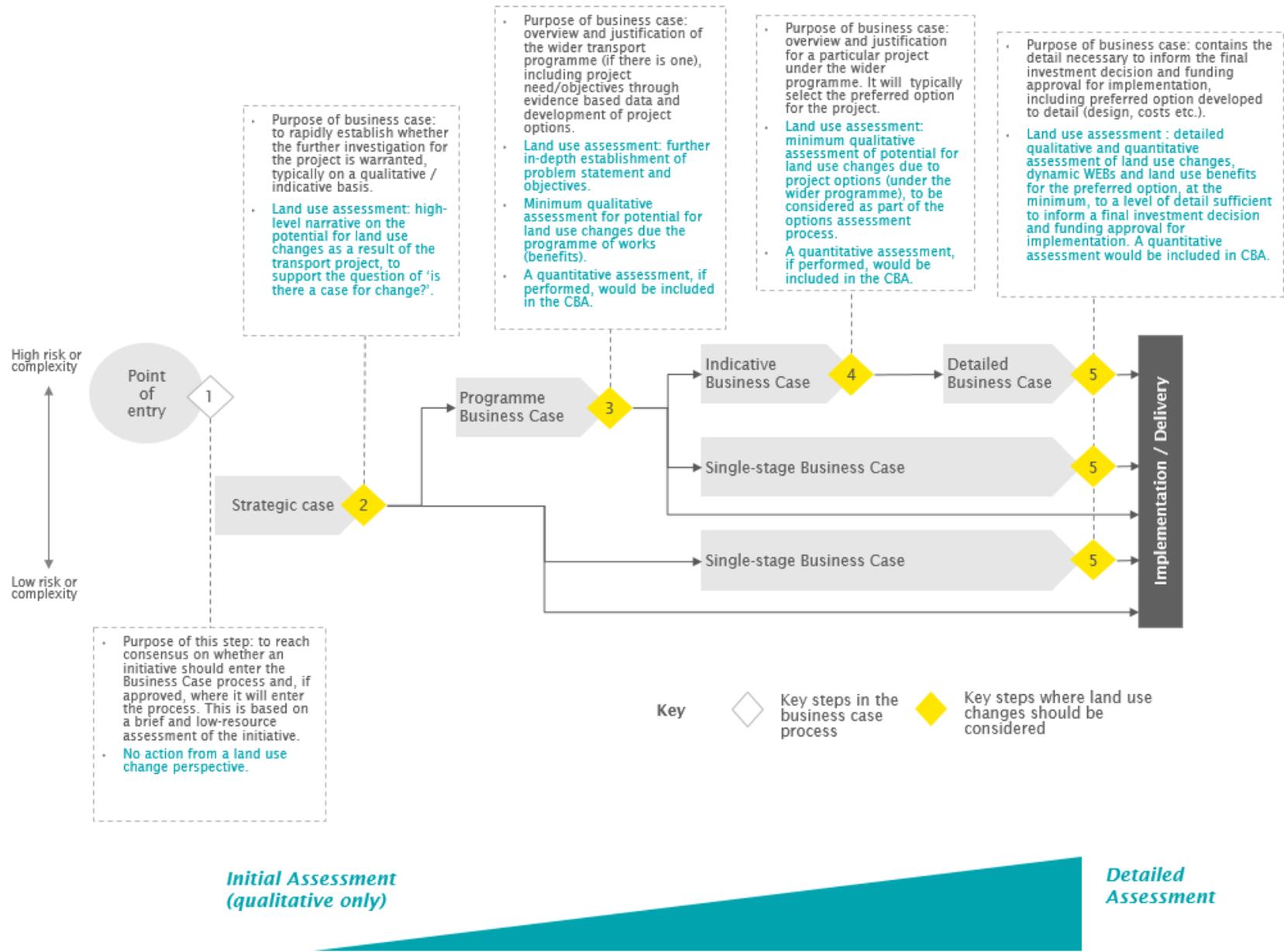


Figure 5 | Guidance for considering dynamic WEBs and land use impacts across the Waka Kotahi business case lifecycle

## Guidance for evaluators

A number of key indicators are outlined below to assist decision-makers in considering whether the proposed project has adequately considered and, if relevant, meets desired land use outcomes or identified needs. This can assist existing business case review (including quality assurance) processes undertaken by Waka Kotahi.

Where land use outcomes are relevant to the project, key strategic indicators to consider include:

Land use outcomes are clearly identified in the service needs and/or project objectives and how important (or not important) they are for the project.	<input type="checkbox"/>
Opportunities, assumptions/limitations, risks and issues are clearly outlined. Specifically, it is clearly explained that the local conditions support a land use change and that this change is dependent on the investment. Any external activities, decisions and expenditure required to unlock the land use potential is outlined and included in the project costs if applicable.	<input type="checkbox"/>
All relevant and feasible land use and dynamic WEBs benefits have been considered and is transparent as to why they have or not been included.	<input type="checkbox"/>
Where applicable, benefits (and costs) have been considered in the economic appraisal.	<input type="checkbox"/>
Land use assessment has been developed in consultation with key stakeholders such as councils, significant land owners and transport and planning agencies, appropriate to the level of detail required in the current stage of the project lifecycle.	<input type="checkbox"/>

More detailed, technical indicators include:

A process of land use change estimation and benefits has been followed and is transparent.	<input type="checkbox"/>
Both supply and demand-side factors have been adequately considered in the measurement of land use change.	<input type="checkbox"/>
The timing of impacts has been explicitly considered. Land use changes can take a very long time to materialise, but could also lead infrastructure decisions.	<input type="checkbox"/>
The extent of change to land use due to infrastructure provision, as opposed to other factors such as regulation, policy or market forces, is clearly identified.	<input type="checkbox"/>
The direction of causality is established and any 'reverse causation' is accounted for.	<input type="checkbox"/>
Any land use modelling is compatible with the transport model, specifically, the level of spatial disaggregation is the same across the models.	<input type="checkbox"/>
The tool/technique for estimating land use change is appropriate to the complexity of the project and the current stage of the project lifecycle (i.e. strategy vs detailed design).	<input type="checkbox"/>