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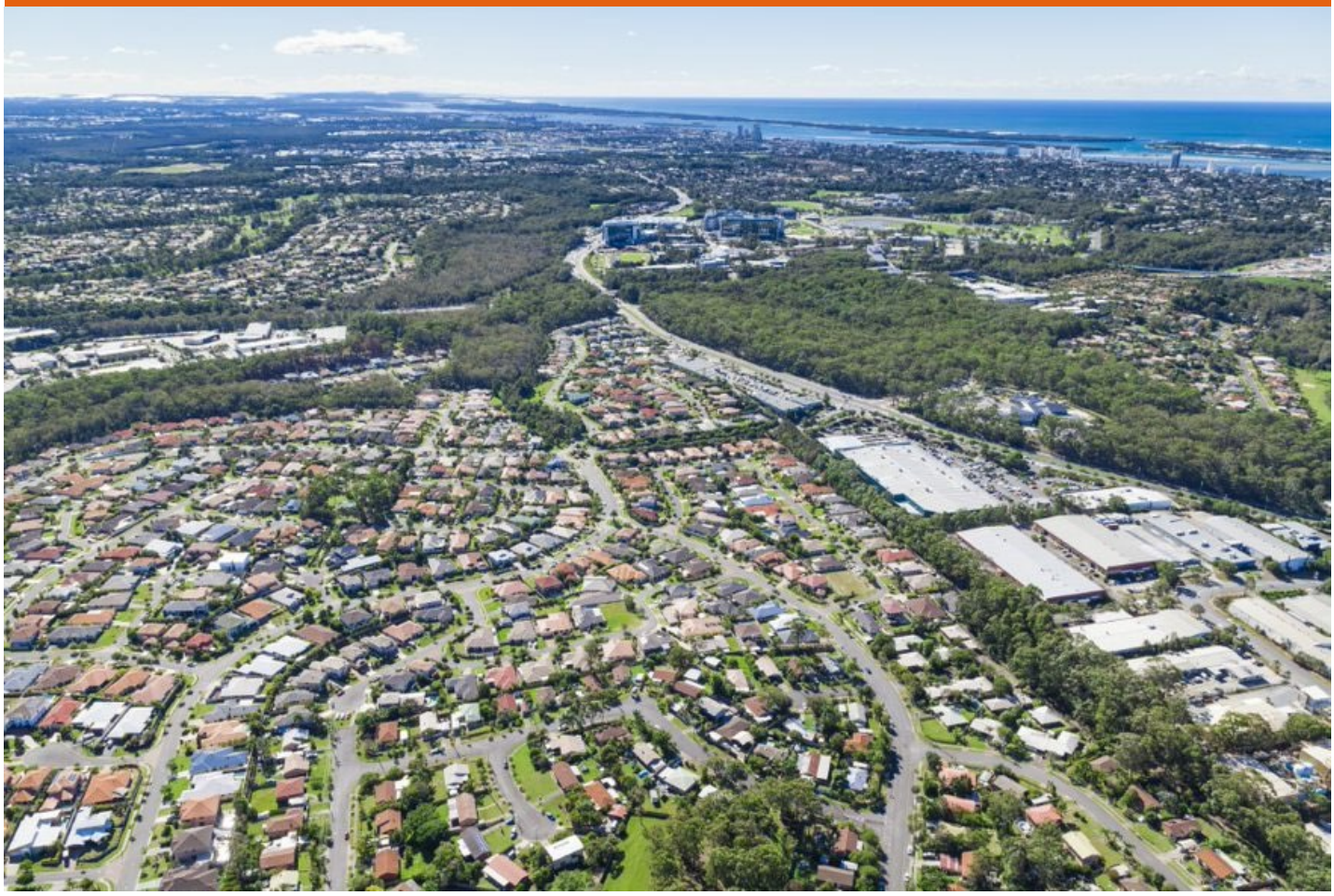
M1 PACIFIC MOTORWAY VARSITY LAKES TO TUGUN BUSINESS CASE REVIEW

08 MARCH 2019



CONTACT

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M1 PACIFIC MOTORWAY (VARSITY LAKES TO TUGUN)
BUSINESS CASE REVIEW

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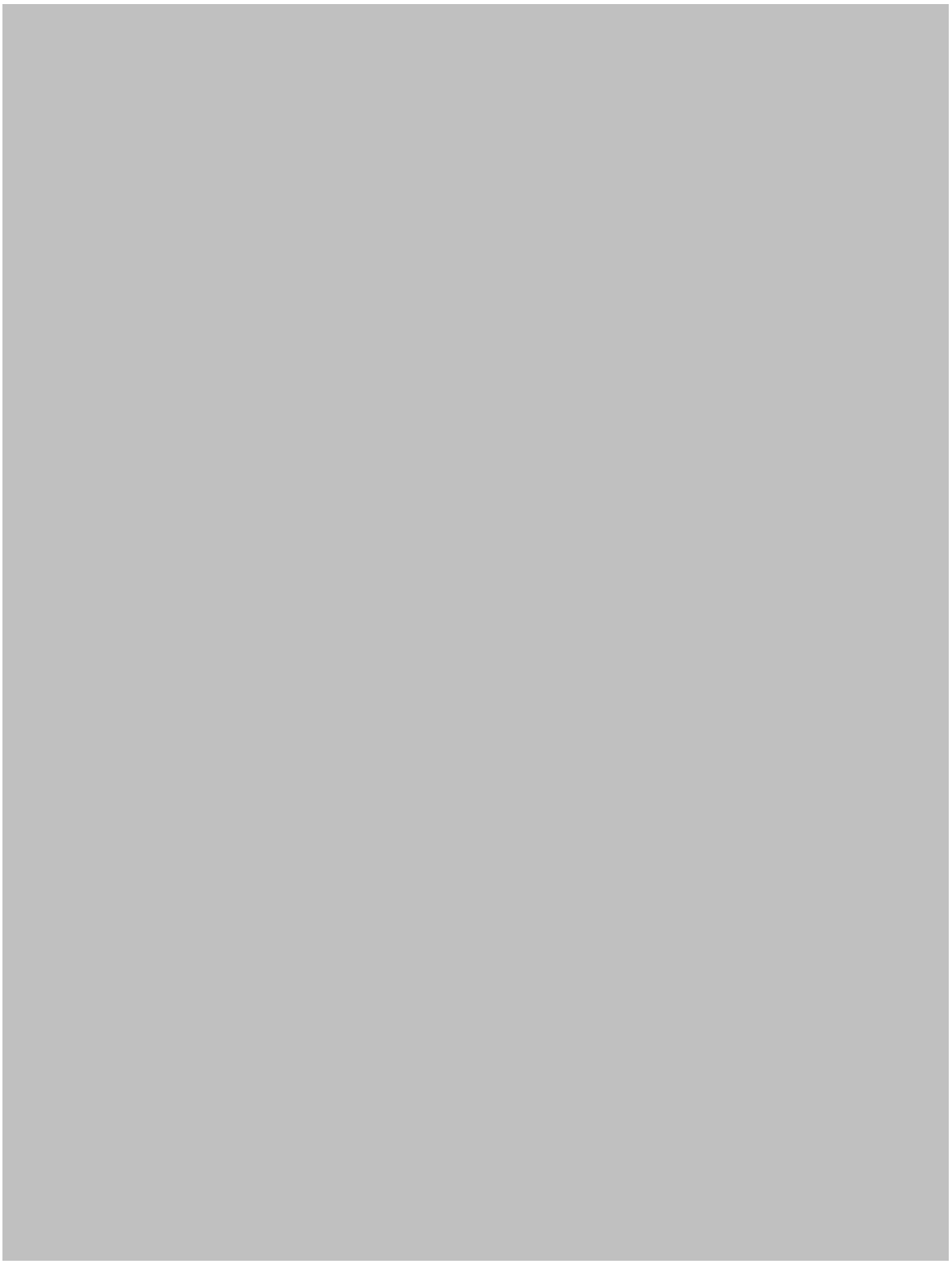


CONTENTS

EXECUTIVE SUMMARY

Overview

Arcadis Australia Pacific Pty Ltd (Arcadis) was appointed by the Department of Infrastructure, Regional Development and Cities (DIRDC) in February 2019 to undertake an independent, high-level review of the Detailed Business Case (DBC) for the M1 Varsity Lakes to Tugun (VL2T) Project in Queensland.

The M1 Pacific Motorway is an important multi-modal transport corridor providing a connection between New South Wales and South East Queensland. Apart from being an important carrier of commuters and tourists, it is a key road link in the transport of freight between Queensland and the domestic and international markets. The M1 Pacific Motorway is an important connector to the Gold Coast Airport, which is crucial aviation hub for the continued growth of South East Queensland's Visitor Economy.

The section of M1 Pacific Motorway between Varsity Lakes Interchange (Exit 85) and Tugun Interchange (Exit 95) . It is currently severely congested, especially during the peak periods as well as during holiday periods. Projected population and employment growth are expected to underpin major increases traffic levels.

Planning for the VL2T upgrade has been advanced through a Strategic Assessment of Service Request (SASR) and Preliminary Evaluation. The VL2T Project will contribute to a substantial increase in the capacity of the M1 Pacific Motorway and will facilitate the transition of the Gold Coast Highway to a boulevard that prioritises active and public transport modes.

Project Options

Two project options in addition to the Base Case were assessed as part of the DBC for the VL2T Project. These are described below in Table ES1.

Table ES1 – Project Scenarios Descriptions

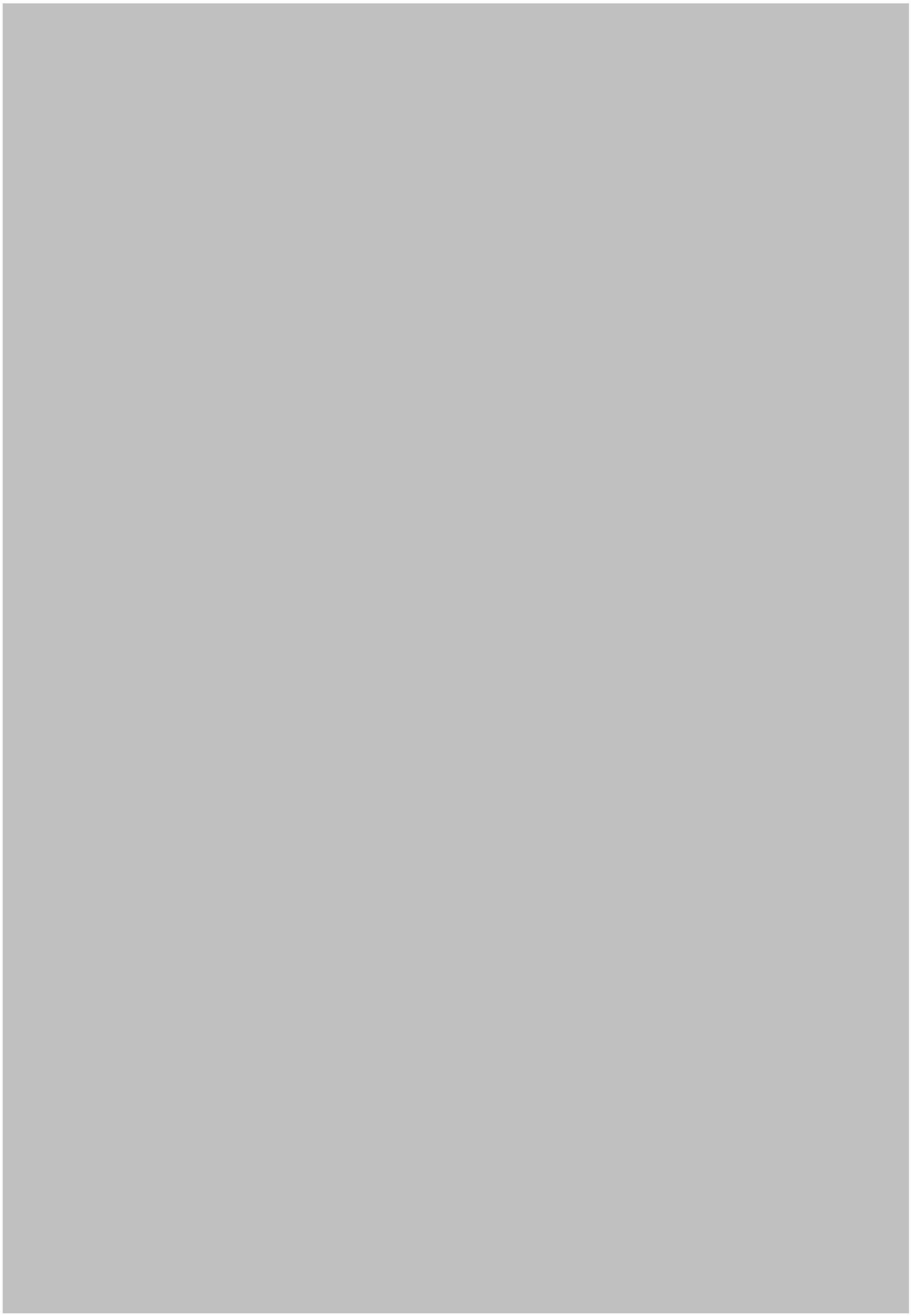
Scenario	Description
Base Case	
Project Case 1	• Replacement of existing pavement • Managed motorway implemented on on-ramps
Project Case 2 (Reference Case)	• Widening of motorway to six lanes • Provision of auxiliary lanes for improved exit movements Full implementation of managed motorway measures

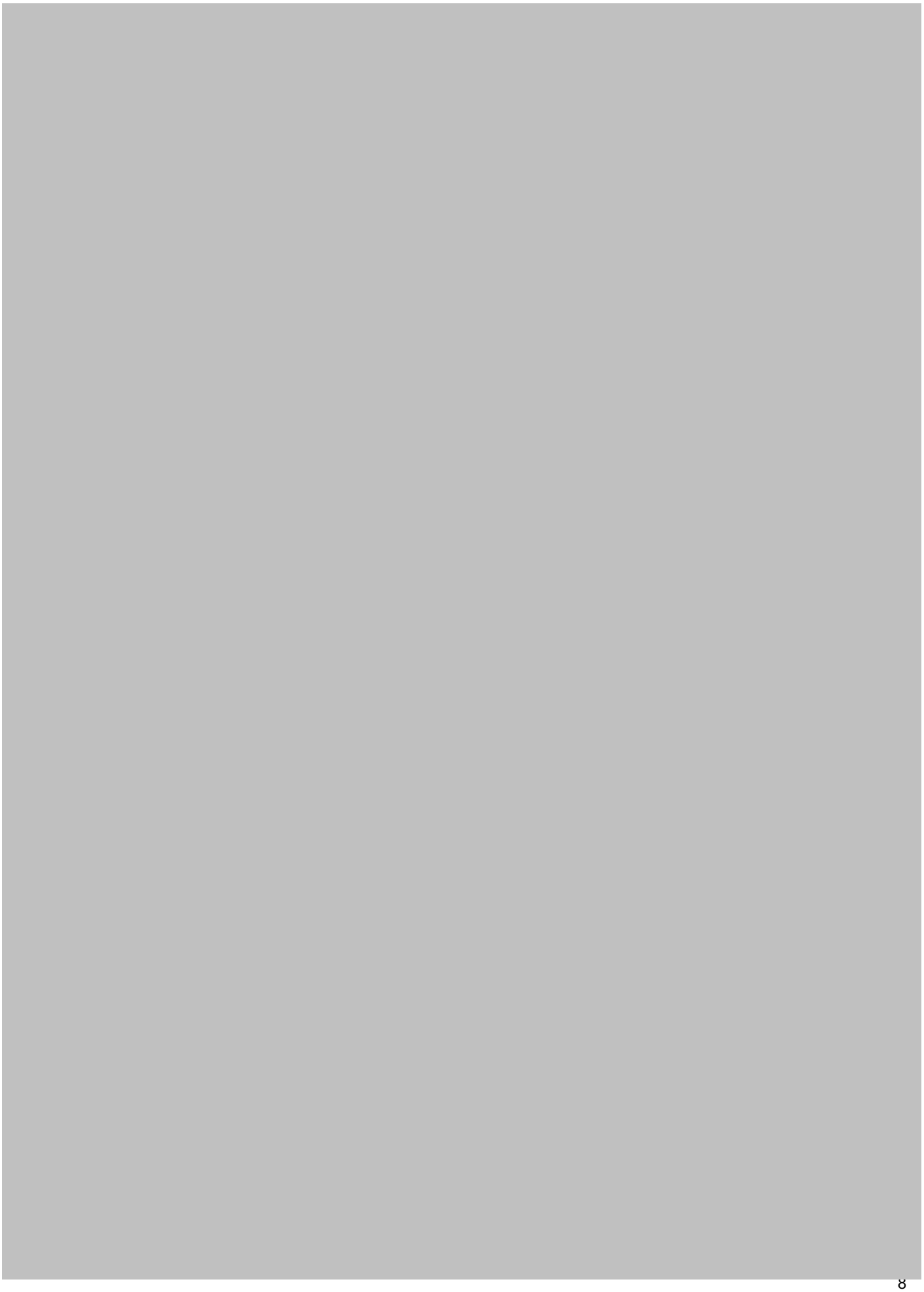
Methodology

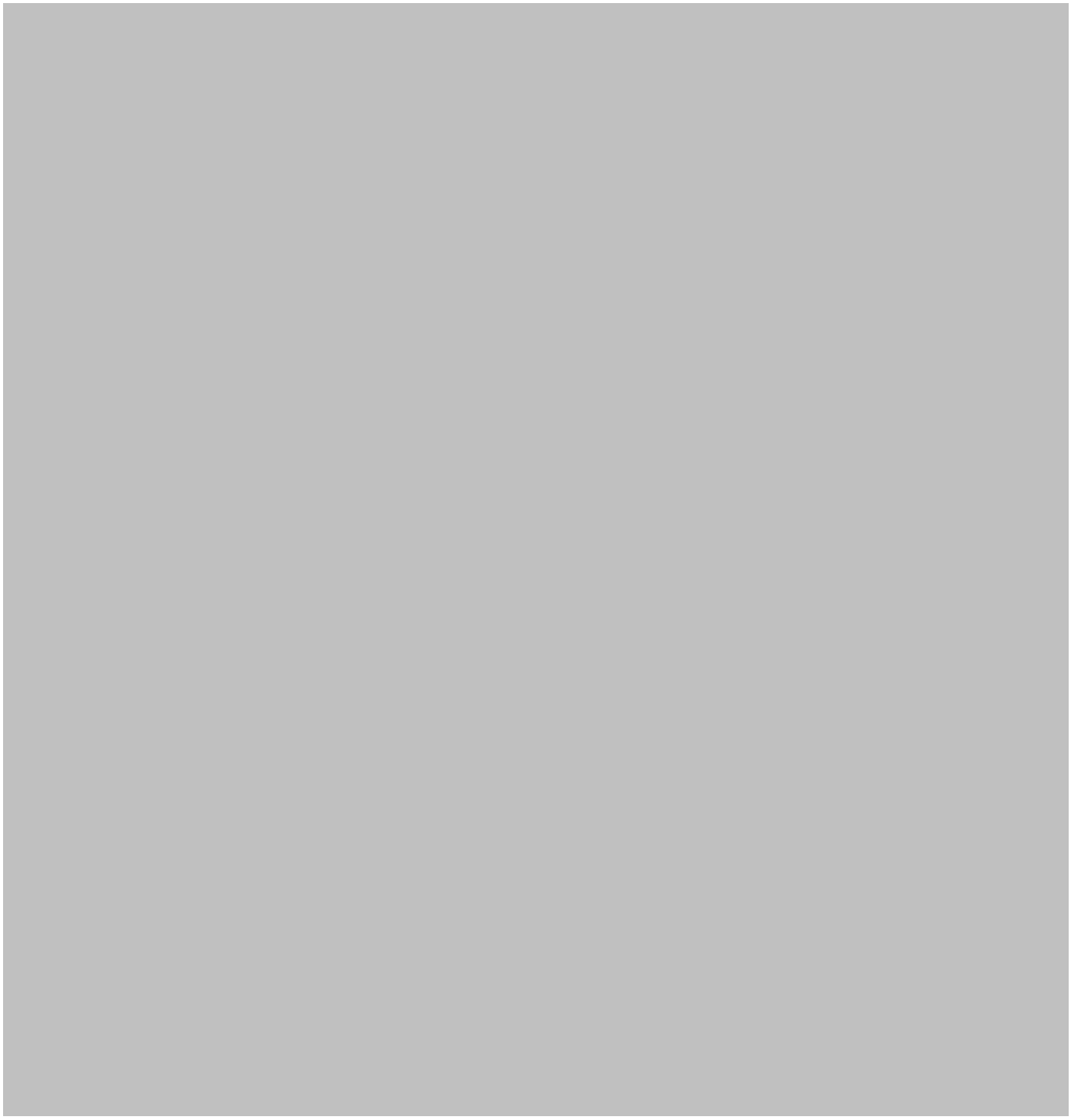
For this commission, Arcadis has reviewed the DBC and relevant appendices for the VL2T Project. The documentation was provided by DIRDC. To complete the independent review in the required timeframe, the chapters of the DBC were prioritised in order of likely impact on the validity and outcomes sought by the overall business case document.

Key Review Findings

The main findings of the independent review of the DBC for the VL2T Project can be summarised as follows:







Recommendation

Based on Arcadis' review of the V2LT DBC, the recommendation is to accept the DBC with the understanding that some of the benefits are likely to have been overstated, but not to the extent that the BCR would fall below 1.

1 INTRODUCTION

Arcadis Australia Pacific Pty Ltd (Arcadis) was appointed by the Department of Infrastructure, Regional Development and Cities (DIRDC) in February 2019 to undertake a high-level, independent review of the Detailed Business Case (DBC) for the M1 Varsity Lakes to Tugun (VL2T) Project (the Project) in Queensland. This report details the findings and recommendations of the Arcadis review.

1.1 Overview

The M1 Pacific Motorway is an important transport corridor providing a connection between New South Wales and South East Queensland (SEQ). Apart from being an important carrier of commuters and tourists, it is a key road link in the transport of freight between Queensland and the domestic and international markets. The M1 Pacific Motorway is an important connector to the Gold Coast Airport, which is crucial aviation hub for the continued growth of South East Queensland's Visitor Economy.

It is currently severely congested, especially during the peak periods, but also during holiday periods. High population and employment growth are expected to drive increasing traffic volumes into the future.

Planning for the VL2T upgrade has been advanced through a Strategic Assessment of Service Request (SASR) and Preliminary Evaluation. The project will contribute to a substantial increase in the capacity of the M1 Pacific Motorway and will facilitate the transition of the Gold Coast Highway to a boulevard that prioritises active and public transport modes.

Infrastructure Australia (IA) have listed the VL2T upgrade as a priority project and funding for the project has been committed.

1.2 Strategic context

The M1 Pacific Motorway has been progressively upgraded over the past twenty years and the upgrade program from the New South Wales border to the Gateway Motorway is nearing completion. The section of road from Nerang to Tugun is gradually being upgraded from four lanes to six lanes. Construction is complete from Nerang to Mudgeeraba, and works are underway on the length of road from Mudgeeraba to Varsity Lakes. Upgrade of the VL2T Project section will complete the upgrade program between the New South Wales border and Nerang.

The M1 Pacific Motorway is an important connector to the Gold Coast Airport, which is crucial aviation hub for the continued growth of South East Queensland's Tourism Industry.

There are several other projects either in construction or planning phases in the SEQ region. These projects include Cross River Rail, Brisbane Metro and Gold Coast Rail Stage 3 and upgrades of the M1 Pacific Motorway between the Logan Motorway and Gateway Motorway interchanges.

1.3 Options considered

Two project options in addition to the Base Case were assessed as part of the DBC. These are described in Table 1 overleaf.

Table 1 - Project options

Scenario	Description
Base Case	
Project Case 1	• Replacement of existing pavement • Managed motorway implemented on on-ramps
Project Case 2 (Reference Case)	• Widening of motorway to six lanes • Provision of auxiliary lanes for improved exit movements. • Full implementation of managed motorway measures •

1.4 Purpose and structure of this report

The purpose of this report is to document a high-level, independent review of the forecasts that underpin the VL2T DBC. It details the findings associated with:

- Assumptions made in the DBC, including inputs like demography and employment, changes in economic conditions and community expectations
- The transport modelling that informs economic assessment and planning of the upgrades
- The procedures associated with the overall economic evaluation of the VL2T Project.

The sections of this report are arranged as follows:

Table 2 - Report Structure

Chapter	Contents
2	Summarises our approach to undertaking this independent review
3	Provides a review of the overall alignment of the business case to policies, plans and guidelines
4	Addresses specific aspects of the business case and issues identified during the inception meeting
5	Contains a detailed review of the transport modelling and forecasts used during the project
6	Reports on the review of the economic assessment in the business case.
7	Summarises the findings of this review.

2 OUR APPROACH

Our approach to conducting an independent review of the DBC of the proposed M1 Pacific Motorway upgrades between Varsity Lakes and Tugun is based on the following considerations:

- The need to address the itemised scope of works specified in the request for tender issued by DIRDC
- Completion, as far as possible, of the nominated tasks outlined in the Arcadis proposal

Our overall approach for the review of the VL2T DBC has been to review the documentation provided by DIRDC and establish at a high level:

- The internal consistency of the document, ensuring the there are no contradictions of ambiguities through the report
- The consistency of the business case assumptions, forecasts, results and conclusions with existing policies and evidence
- That there are no omissions or misleading statements in the documents.

The following section details the methodology employed for Arcadis' independent review of the DBC for the VL2T Project.

2.1 Methodology

For this commission, Arcadis has reviewed the DBC and relevant appendices provided to Arcadis by DIRDC. To complete the independent review in the required timeframe, the chapters of the DBC were prioritised in order of likely impact on the validity and outcomes sought by the overall business case document. Appendix A identifies the review for each chapter of the business case.

The business case review for the VL2T Project contained a number of discrete tasks, including:

- Familiarisation, during which the documents were reviewed
- Analysis of internal consistency, with a focus on identifying omissions, inconsistencies and misleading statements and understanding the business case in more detail
- Assessment of the assumptions associated with business case forecasts
- Analysis and evaluation of the transport modelling and forecasts
- Evaluation of the economic assessment
- Assessment of the level of compliance with Infrastructure Australia (IA) and Australian Transport Assessment and Planning (ATAP) requirements
- Evaluation of the projects to current policies and plans
- Examination of the specific issues identified by DIRDC.

To complete each of these tasks, additional information, statistics and documents were sourced and evaluated. These additional documents and information included:

- Demography forecasts from the Queensland Government Statistician's Office, 2015 version
- Demography forecasts from the Queensland Government Statistician's Office, 2018 version
- Australian Census data from 2011 and 2016
- Various strategy documents of the Federal and State Governments
- Local plans from Brisbane, Logan, and Gold Coast local government areas
- Technical notes regarding the modelling, from Veitch Lister Consulting's website.

Wherever an issue was identified, its impact on the outcome of the business case has been evaluated, either quantitatively where possible or qualitatively.

2.2 Assumptions and limitations

The independent review by Arcadis was undertaken on the basis of the following assumptions and limitations:

- The findings of this review are limited by the documentation contained in the business case document
- Areas and topics in the DBC that contain incomplete information have been identified but not completed
- Any project cost review or advice is based on a high-level indicative assessment and is intended for discussion only
- Arcadis was not provided with any of the models from the DBC (i.e. Cost Benefit Analysis spreadsheets or traffic models) and therefore any calculations undertaken in this review are indicative and intended for discussion only.

3 POLICY CONTEXT AND STRATEGIC FIT

3.1 Commonwealth policies and plans

3.2 State policies and plans

3.3 Local Government strategies and plans

3.4 How Local Governments influence land use planning

State and Territory governments generally set the overarching legislative and regulatory framework for land use planning and development in Australia. They provide the machinery that gives effect to State planning strategies and policies. Strategically, State and Territory governments have responsibility for the development of State and Territory as well as regional level strategies and policies. From a statutory perspective, State and Territory Governments, via sub-ordinate legislation, set the structure for land use planning through local environmental plans, planning schemes and development plans. These key planning instruments provide for the implementation of State, regional and local policies affecting land use and development.

Local governments set the overall direction for the use, development and conservation on land within their municipal area. They provide a clear and consistent framework within which local decisions about the use and development of land can be made. Local government further influences land use planning by expressing local and community expectations for discrete areas and land uses. Planning at the local government level seeks to anticipate and respond to the needs of existing and future communities through provision of zoned and serviced land for housing, employment, recreation and open space, commercial and community facilities and infrastructure. Changes to zoning has the potential to increase the residential population density and/or employment density. Future zoning changes can have implications on traffic demand in the study area.

In certain regions, groupings of Councils pool together to exert a greater influence on key land use planning issues. Planning issues rarely stop at municipal boundaries and acting as a group of Councils provides both economies of scale and additional funding opportunities. The Council of South East Mayors in Queensland is an example of a group of Councils collaborating and acting as a regional local government advocacy organisation.

In certain instances, regional groupings of Councils pool together human and financial resources to exert a greater level of influence on key land use planning issues. Land use planning issues rarely stop at municipal boundaries and the ability to act as a group of Councils helps deliver both economies of scale and additional funding opportunities. The SEQ Council of Mayors is a leading example of a group of Councils collaborating and acting as a regional local government advocacy organisation.

3.5 IA guidelines

The DBC draws on a series of state and national guidelines which are noted to have been applied in the order of the listing provided in the document. The IA Assessment Framework (2018) has been listed as the first source of reference.

The IA Assessment Framework provides a structured and objective approach to infrastructure decision-making. It sets out the criteria used to assess and prioritise submissions as initiatives and projects for inclusion on the Infrastructure Priority List. This comprises strategic fit, economic, social and environmental value and deliverability.

A recent addition to the IA Assessment Framework is the inclusion of climate change risks. There is growing evidence that early action on these risks can result in rapid payback times. For example, the Queensland Reconstruction Authority highlights that improving infrastructure resilience can pay for itself within two to four years (IA 2018).

The IA Assessment Framework suggests that a sensitivity analysis within the CBA should be used to help identify and design response options to ensure the preferred options are robust to a

diversity of future uncertain scenarios. It also sets out key steps on how to incorporate and consider climate change risks in economic appraisals and provides examples of climate risk impacts on infrastructure projects.

A more detailed assessment of the economic appraisal compared to the IA Assessment Framework is provided in Section 6.

3.6 Australian Transport Assessment and Planning guidelines

The ATAP Guidelines (the Guidelines) provide a comprehensive framework for planning, assessing and developing transport systems and related initiatives. The Guidelines provide a transport planning and decision-support framework and set out best-practice for planning and assessing transport systems and initiatives in a consistent and harmonised way across jurisdictions.

They are endorsed by all Australian jurisdictions and are published by the Transport and Infrastructure Council. They are closely aligned with the IA Assessment Framework (IA 2017).

The ATAP Guidelines are structured around a Transport System Management Framework (the ATAP Framework or the Framework) shown in Figure 1.

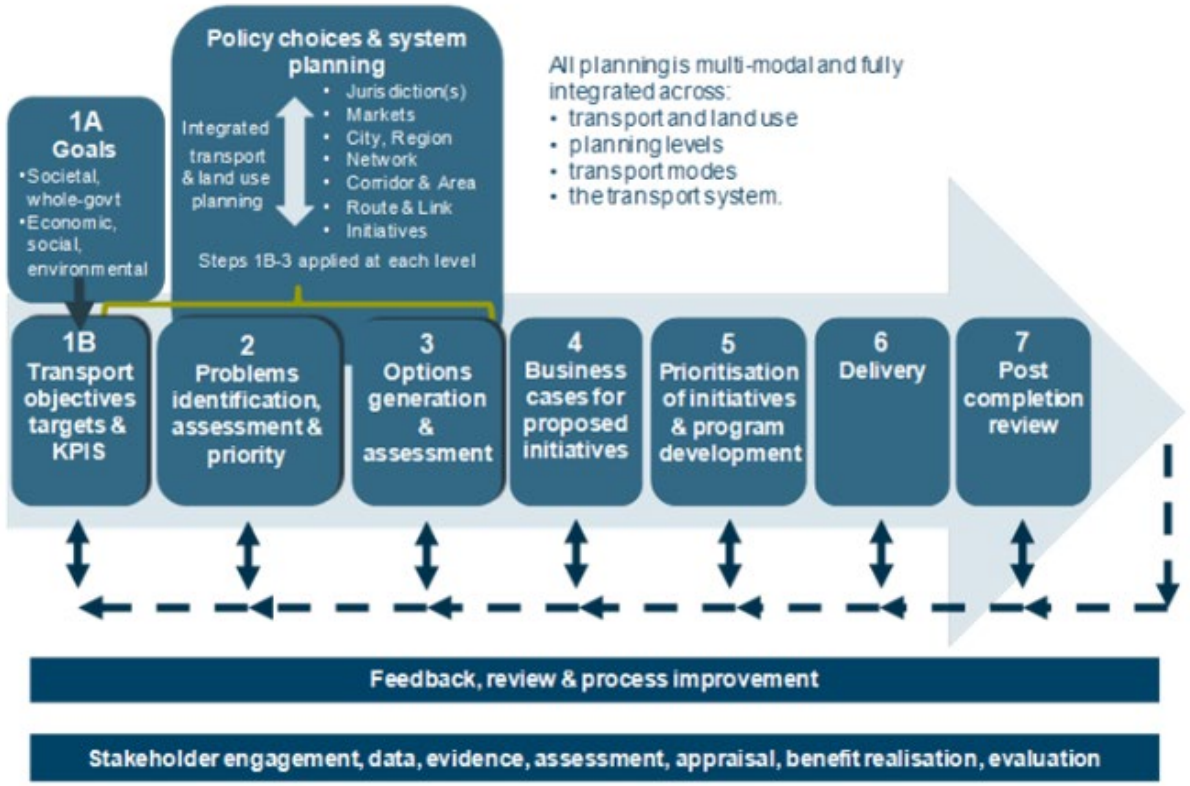


Figure 1 - ATAP Transport System Management Framework (ATAP 2016)

A more detailed assessment of the parameter values compared to the ATAP Guidelines is provided in Section 6.

4 APPROACH AND ASSUMPTIONS REVIEW

4.1 Base Case

A robust base case describes the situation in the absence of the project being implemented or a 'business as usual' or 'do minimum' scenario, or in other words maintaining existing service levels without capital upgrades. The description, including implications for the expected (continued) level of service, should be clear about will occur should the project not proceed, and the existing situation is continued.

4.1.1 Whole of life considerations

4.1.2 Level of service considerations

4.2 Project cases

4.3 Investment Logic Mapping

4.4 Demographic and employment projections

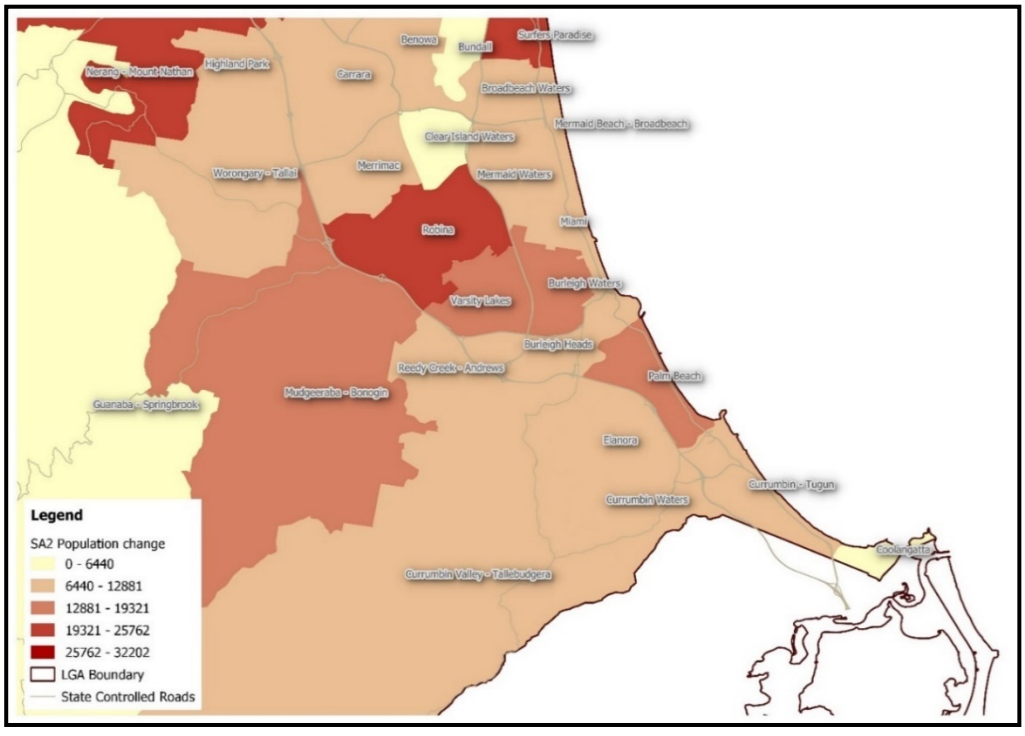


Figure 3 - Forecasted population SA2 population growth 2016-2041 (Source: QGSO 2018)

4.5 Land use planning assumptions

Upon review of the Priority Development Areas (PDAs) outlined in the *Economic Development Act 2012*, there are no declared PDAs that directly impact the VL2T Project.

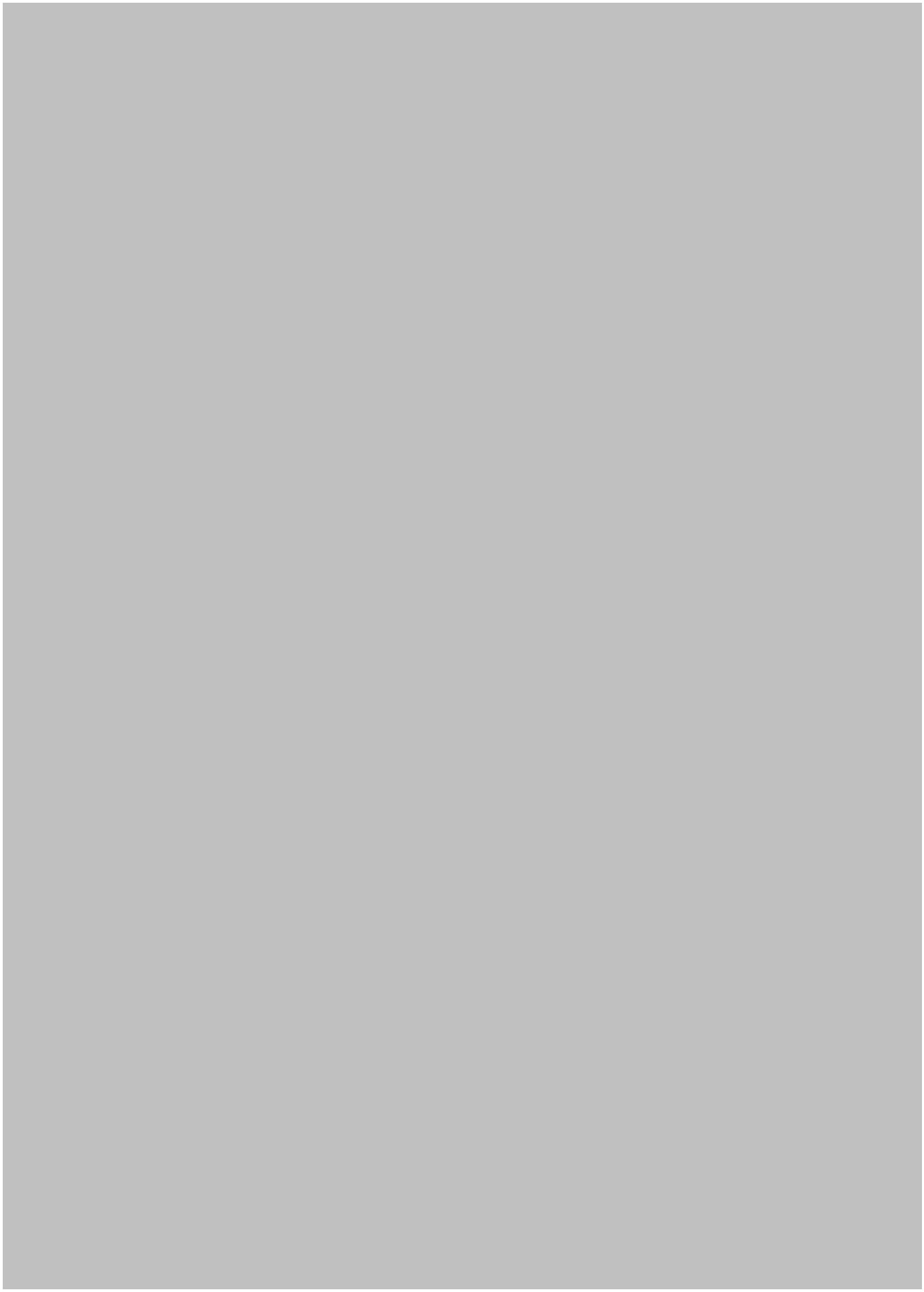
Upon review of the Gold Coast City Plan 2018, there are no areas adjacent to the M1 Pacific Motorway that are directly impacted by conceptual land use plans. The settlement pattern of the northern Varsity Lakes section of M1 corridor as identified in the City Plan is a mix of light rail urban renewal area, urban and suburban neighbourhoods, rural residential and industry and business areas. Further to the south of the M1 corridor towards Tugun are industry and business, natural landscape and urban and suburban neighbourhoods uses.

It should be noted that there are a number of District Centres identified in the Gold Coast City Plan that are located in and along the M1 Corridor. These include:

- Burleigh Waters
- Burleigh Heads
- Palm Beach
- Tugun.

Tugun is the closest business node to Gold Coast Airport. It is located on the northern approach and departure path for the airport and this effectively constraints higher residential development that would otherwise occur in this catchment.

4.6 Interface projects and impact on the M1 Pacific Motorway



4.7 Future active and public transport opportunities

ShapingSEQ identifies that repurposing the Gold Coast Highway (which currently functions as one of Gold Coast's two main north-south road routes, running parallel to the M1), can be redesignated as the 'Gold Coast Boulevard'. This would have the effect of giving priority to public transport, walking and cycling, with a focus on light rail and bus.

Opportunities exist to progress planning for increasing key east-west principal cycling routes to Priority Level A as designated in the South East Queensland Principal Cycle Network Plan 2016.

With the emergence of new technologies such as autonomous rail transit (ART) or 'trackless trams' come new opportunities to provide high-speed and high capacity public transport alternatives. There are opportunities to upgrade corridors on the Gold Coast to accommodate these vehicles on dedicated lanes.

Figure 4 - Operational ART in Zhuzhou (Source: CRRC)

In the context of the Gold Coast High Capacity Public Transport Corridor Studies 2015, there are three identified key High Capacity Public Transport (HCPT) corridors including:

- Surfers Paradise to Bundall
- Nobby Beach to Robina
- Broadbeach to Coolangatta.

ART presents the opportunity to provide efficient connections to key nodes on the network and replace existing high frequency bus services including Route 740 - Nerang to Broadbeach, Route 750 - Robina to Broadbeach and 765 - Robina to Elanora. There are opportunities to upgrade arterial roads such as the Gold Coast Highway between Broadbeach and Burleigh Heads or Tugun to operate the ART and preserve the corridor for GCLR Stage 3. Other high frequency routes are identified in the Gold Coast Transport Strategy 2031 (Figure 5).

To further encourage the use of alternative transport modes, land use planning should continue to encourage and identify opportunities increased development and residential density around key transport nodes such as GCLR interchanges, rail stations and employment and education hubs. This would build on previous work to develop transit-oriented development within the Varsity Lakes Station Precinct. These areas may include Southport, Nerang, Bundall, Broadbeach and Robina. Increased residential density around key activity centres would increase pedestrian accessibility to public transport, thereby encourage active and public transport and reduce private vehicle usage. Increased densities would be supported by updated Local Area Plans by the City of Gold Coast.

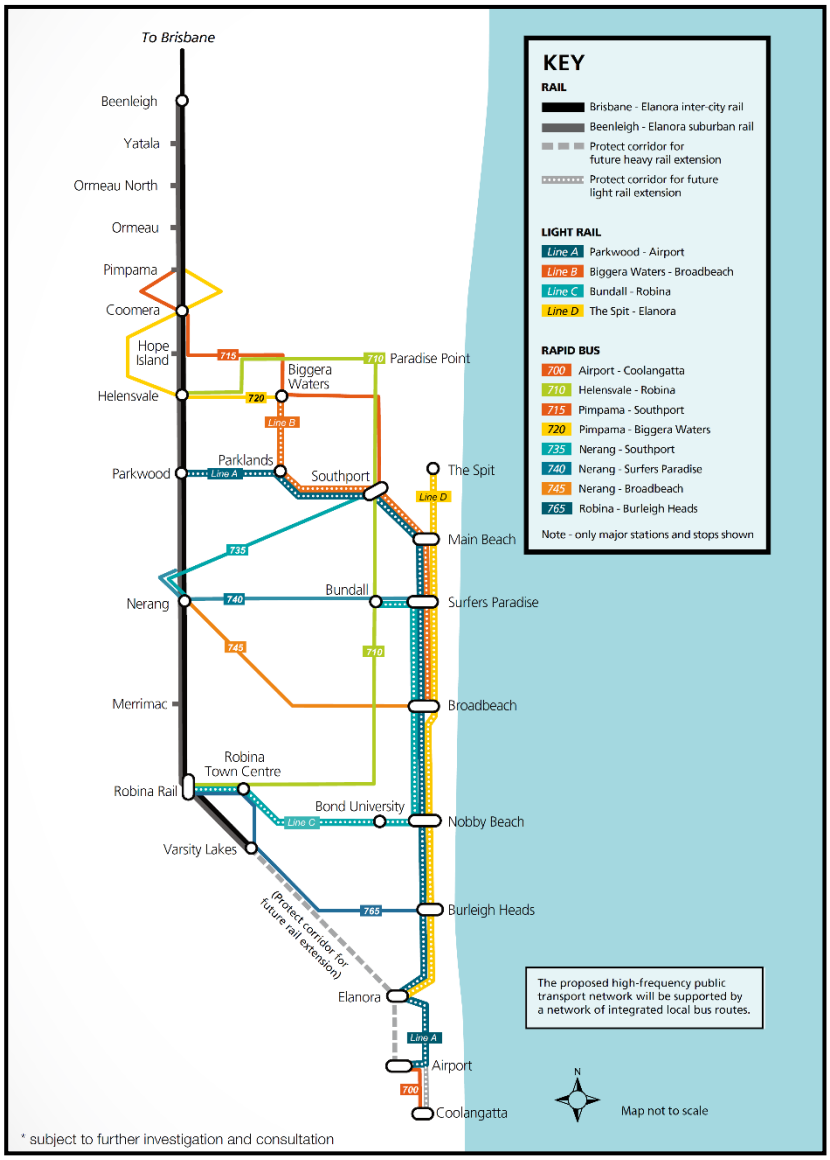


Figure 5 - Proposed 2031 high-frequency public transport network (Source: City of Gold Coast, 2013)

4.8 Sustainability assumptions

[redacted]

4.9 Environmental assumptions

Within the ATAP Guidelines (2016), parameter values are provided for biodiversity (losses due to air pollution from transport emissions), nature and landscape (such as loss of natural land area), reduction in the quality of landscape, and land pollution. [redacted]

4.10 Summary

[redacted]

5 TRAFFIC MODELLING REVIEW

5.1 Transport modelling procedure

The transport modelling is central to the estimation of benefits used in the economic assessment.

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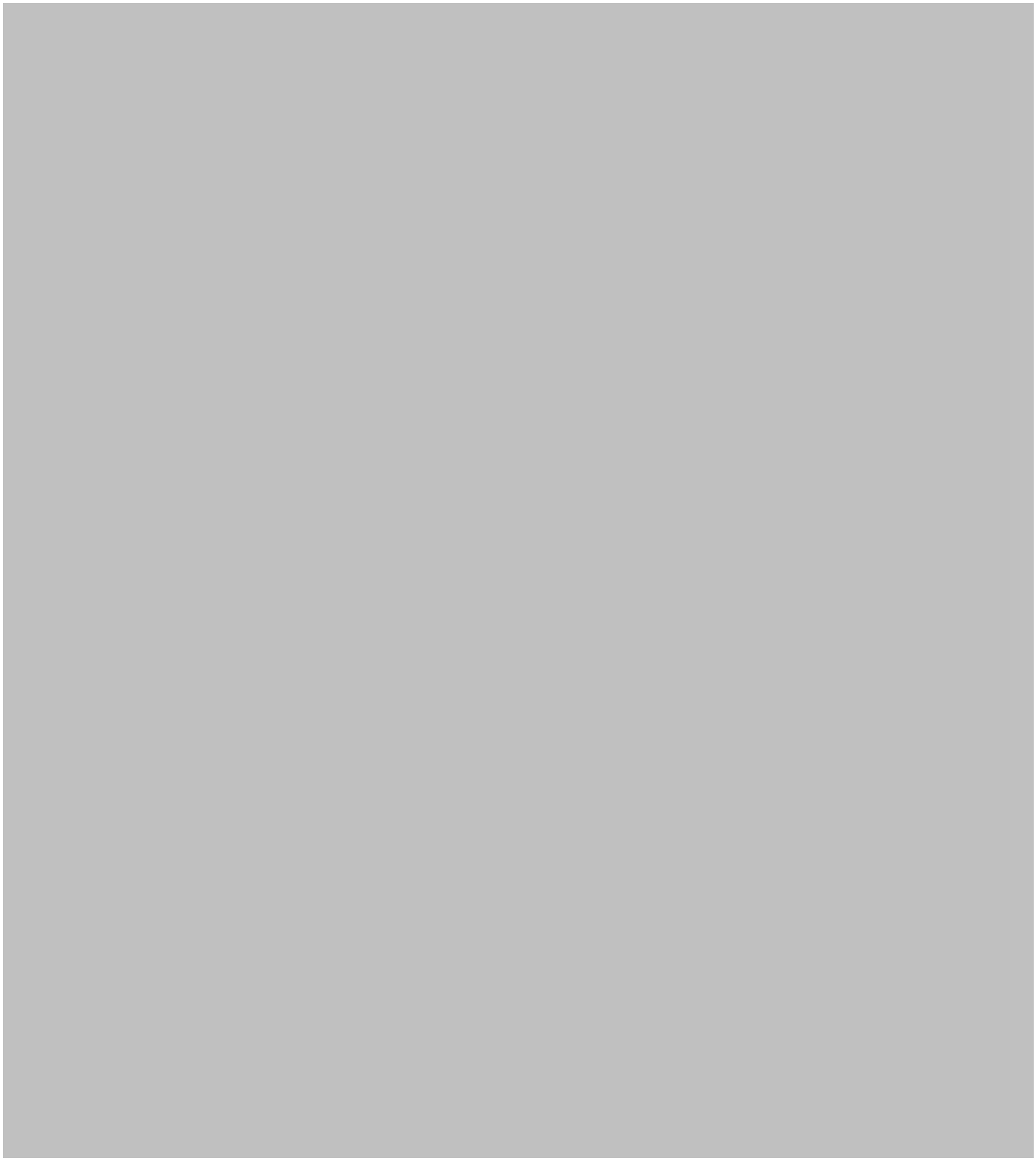
5.1.1 The strategic model

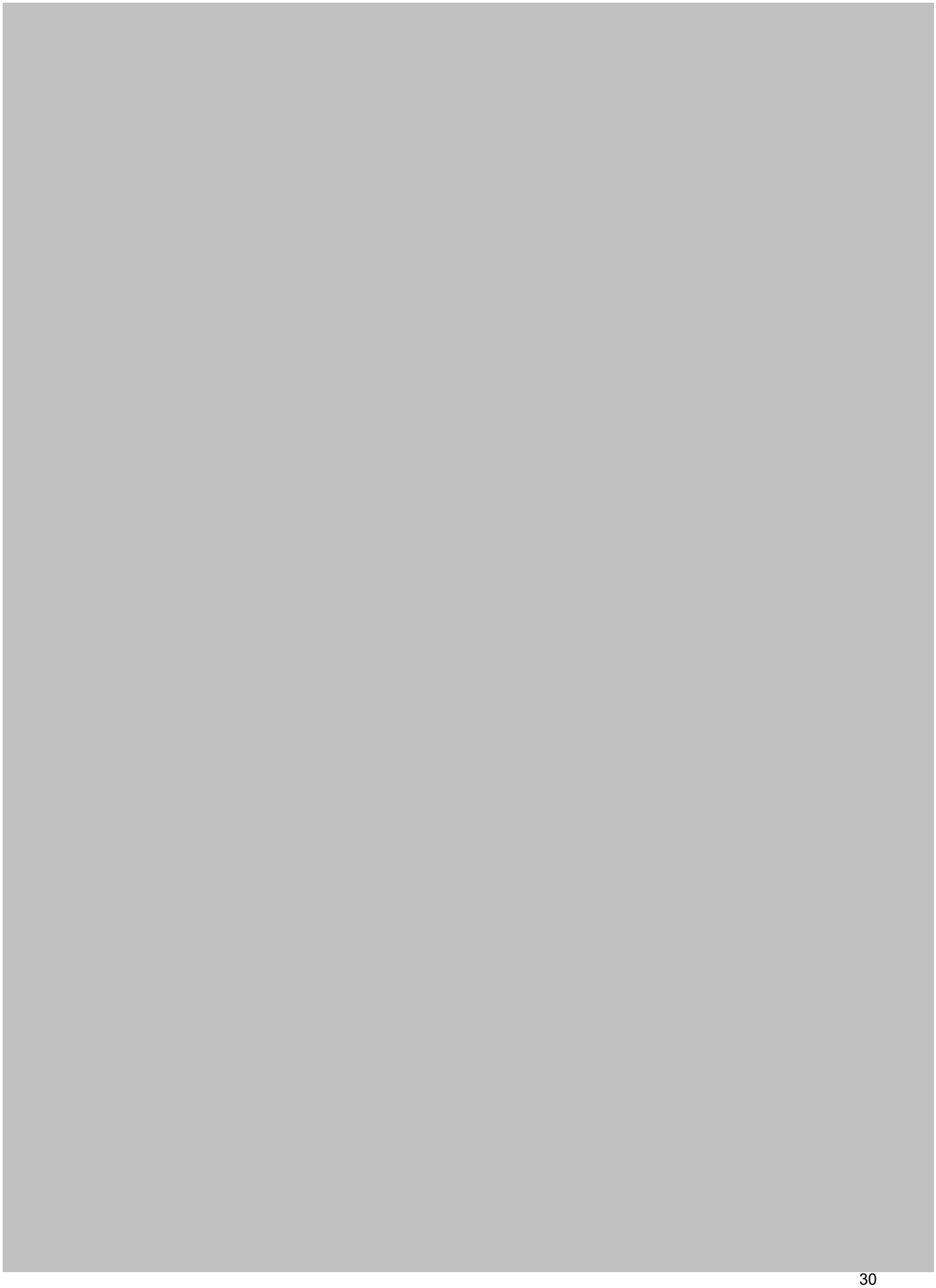
The main role of the strategic model is to forecast transport demand. Central to the forecasts are the costs of travel by car and public transport and these are developed in the strategic modelling process based on the paths that trips take through the transport networks. The costs themselves are used to develop origin-destination matrices and to split the trips into modes.

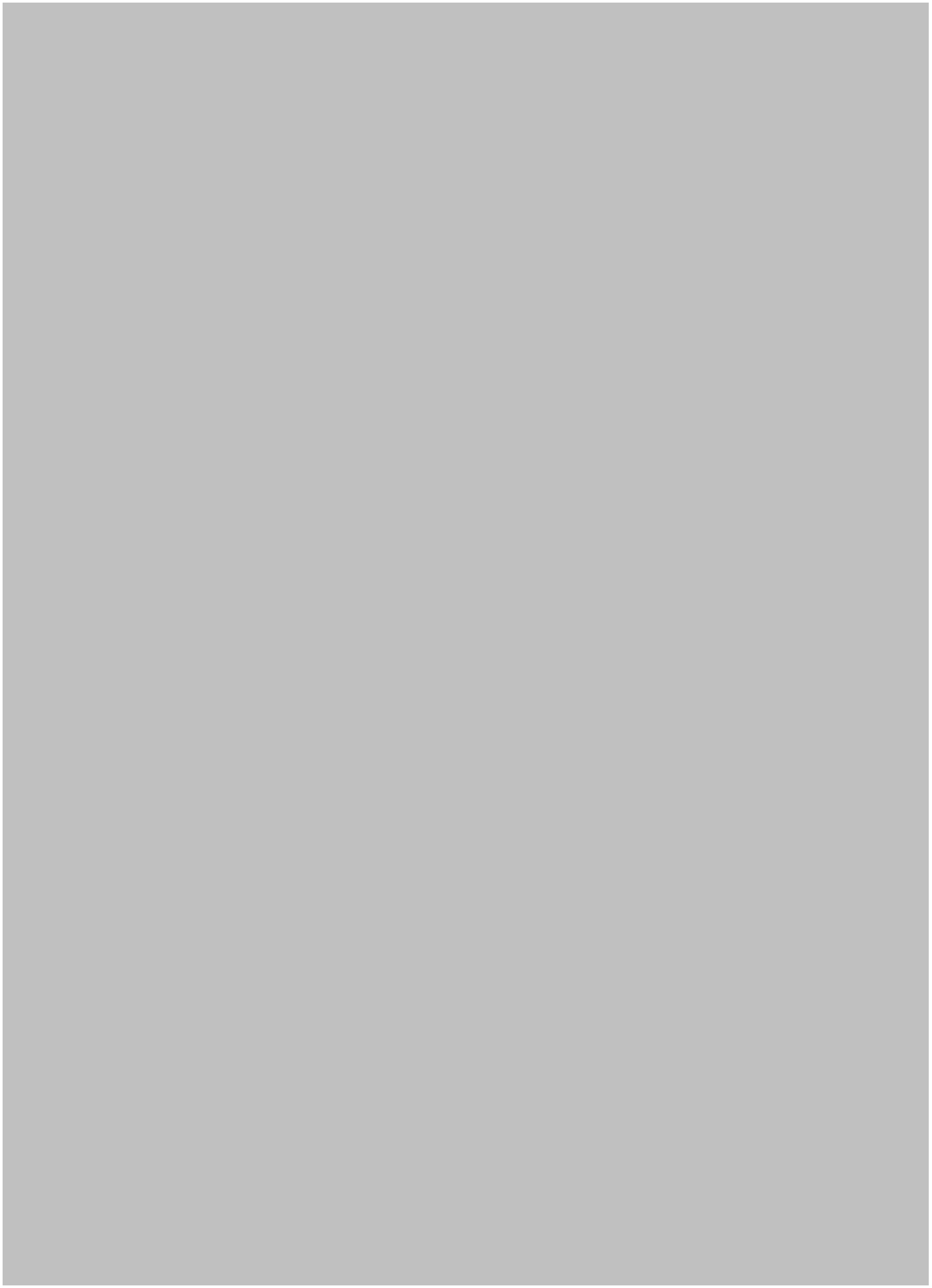
The important points to note about the strategic modelling are:

- The trips and costs are provided for three time periods:
  - Morning peak (7am to 9am)
  - Afternoon peak (4pm to 6pm)
  - Off peak (the remainder of the day).
- The public transport network's services are unconstrained. Effectively, this means that public transport has limitless capacity
- The highway network is constrained only by travel time or travel cost. That is, a road link may carry more than its capacity, but the cost of travel along the link will be high
- The mode choice is based on the difference between the cost of travel by public transport and the cost of travel by car
- No intersection delay or queues are represented in the model. One consequence of this is that a strategic model overestimates right turn movements because it does not consider the delays caused by opposing through-traffic
- The highway trip matrix (including cars and commercial vehicles) is passed to the dynamic traffic model.

5.1.3 Problems with the overall modelling methodology







5.1.4 Forecast travel times: Base Case

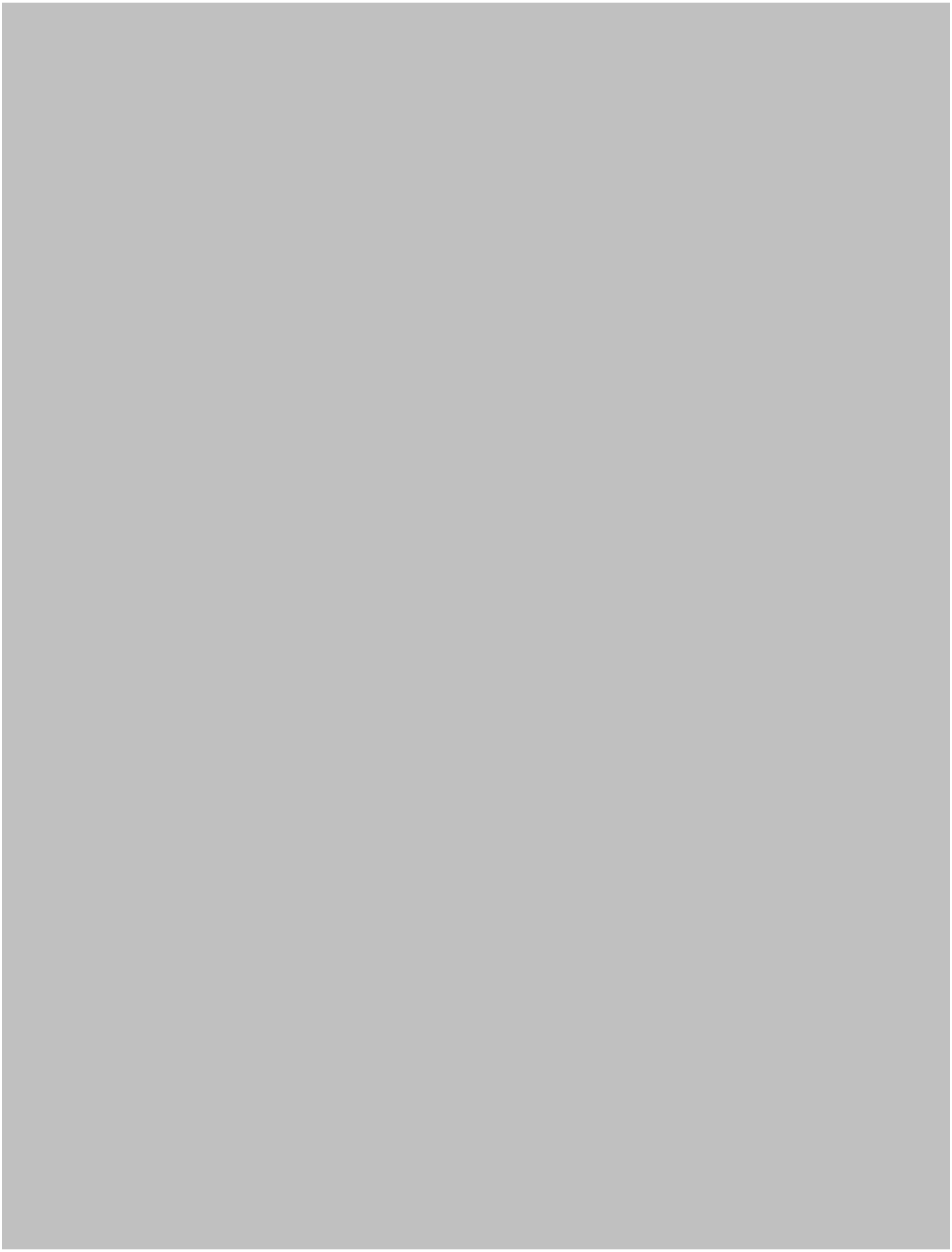
5.1.5 Forecast travel times: Project Case

5.2 Trip distribution

When distributing trips from origins, the general assumption is that more trips will travel to closer destinations than to those far from the origin. The measure of separation between origin and destination could be distance, time or generalised cost. In general, as time advances, demand for travel increases and so do the volumes on the roads. The resulting increased congestion increases the times or costs between origins and destinations.

5.3 Induced demand

The definition of induced demand is important in its measurement.



5.4 Input assumptions

5.4.1 Average weekly earnings

Historic changes in average weekly earnings and CPI from Australian Bureau Statistics are shown graphically in Figure 10. The data suggest that, over the past 35 years, there have only been seven years where the increase in average weekly earnings has been lower than the change in CPI. Overall, average earnings have increased by between 1% and 2% per year above CPI.

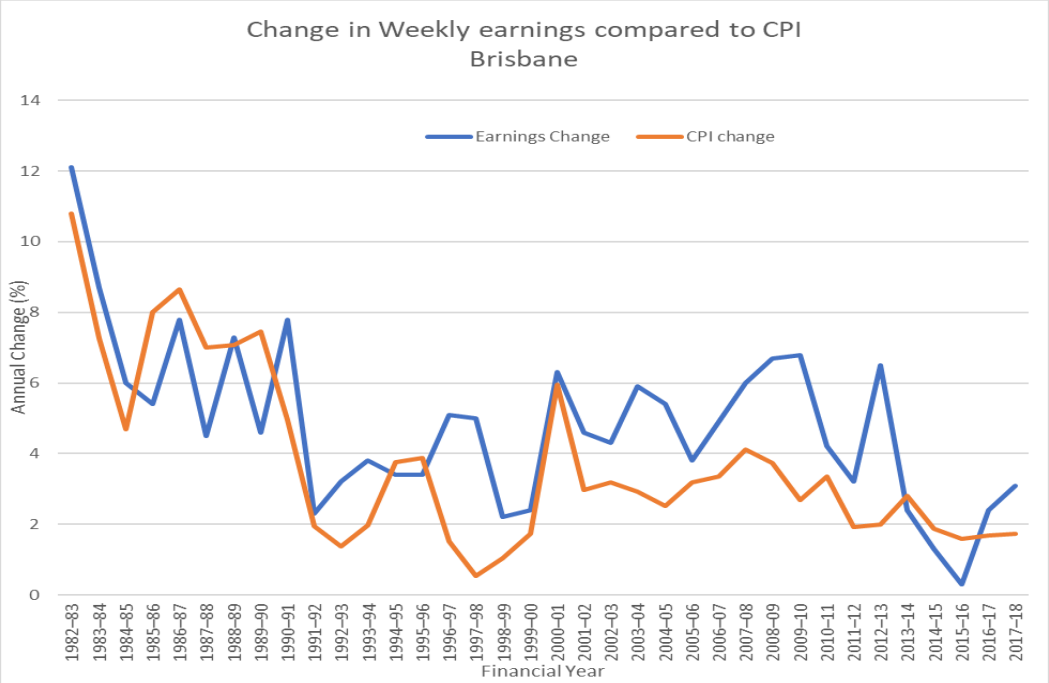


Figure 10 - The Change in Average Weekly Earnings compared to annual change in CPI for Brisbane (Source: Constructed from data from Australian Bureau of Statistics)

5.4.2 Fuel price

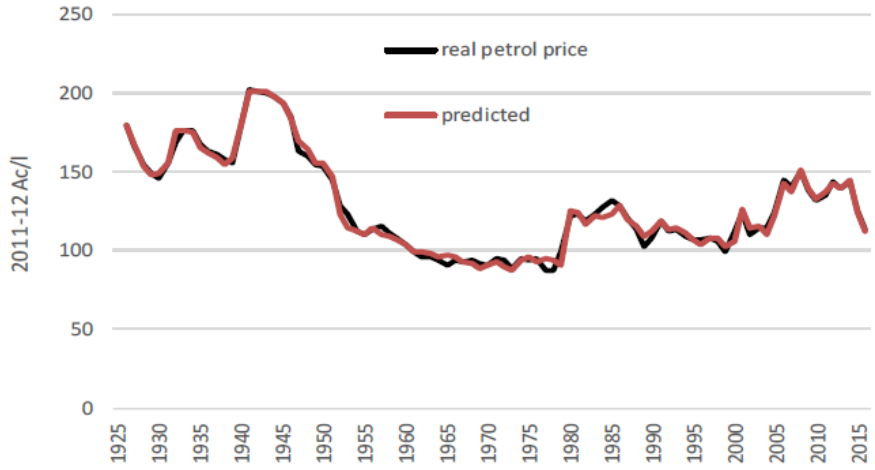


Figure 11 - Historical price of petrol from 1925 to 2015

5.5 Summary

6 ECONOMIC ASSESSMENT REVIEW

The economic assessment for the M1 Pacific Motorway Business Case (Varsity Lakes to Tugun) is documented in the following sections of the business case:

- Sections 5.5 – Economic Comparison
- Chapter 12 – Economic Assessment
- Appendix F – Economic Assessment Report
- Appendix G.2 – Economics Peer Review.

This objective of this review is to assess the appropriateness of the analysis and assumptions underpinning the economic benefits and costs stated in the business case. The review focuses on assessing:

- The accuracy of the broader macro-economic assumptions underpinning the CBA
- Adequacy and accuracy of economic factors including the treatment of travel time, vehicle operating costs, crash costs and externalities
- Consistency, reasonableness and scale of the benefits claimed for each of the projects (e.g. possible double-counting of benefits, which is a potential risk when two related business cases are produced)
- Reasonableness of traffic congestion assumptions. Given that the transport modelling is central to the economic analysis, many of the findings from the transport modelling review in Chapter 5 influence the economic assessment
- Other economic considerations.

Two project options were assessed in the CBA, in addition to the Base Case as described in Table 14.

Table 14 - Varsity Lakes to Tugun project options

Options	Description
Base Case (Jul 2019 to Dec 2027)	
Project Case 1	• Replacing the motorway pavement between Exit 85 and Exit 95, including concrete median barriers and additional geotechnical works to strength existing embankments if required.
Project Case 2	• The entire motorway between Reedy Creek Road (Exit 84) and Stewart Road (Exit 95) (approximately 10km in length) is increased from two to three lanes in each direction. This widening will also include the replacement of existing pavement and concrete median barriers and additional geotechnical works to strengthen existing embankments if required. • Auxiliary lanes are added

Options	Description

6.1 Economic assumptions overview

6.1.1 Macro-economic assumptions

6.1.2 Annualisation factor

6.2 Quantitative analysis review

6.2.1 Project costs

Assessment of road rehabilitation assumptions

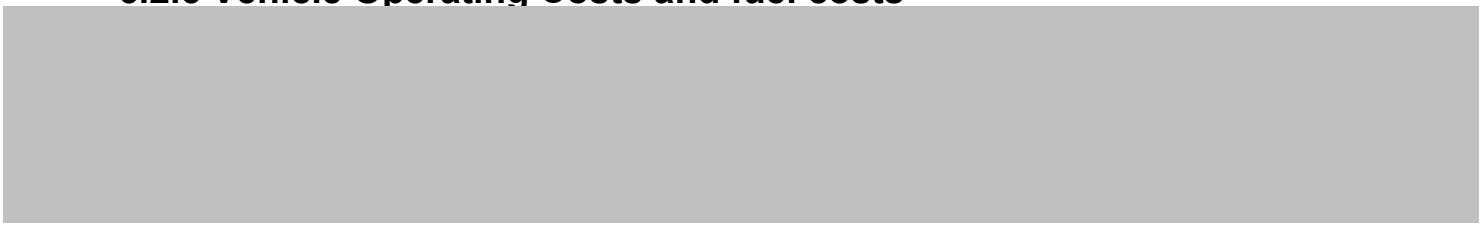
The existing M1 between Varsity Lakes and Tugun is a 10 kilometre, four lane dual carriageway with a posted speed limit of 100 km/h. Six interchanges and approximately 30 bridges (either over or under) are prevalent along the length of the 10 kilometre route.

6.2.2 Expected benefits

6.2.3 Travel time savings

6.2.4 Travel time reliability

6.2.5 Vehicle Operating Costs and fuel costs



Electric vehicles and fuel-efficient vehicles

Forecasts in a study commissioned by the Australian Government suggest that electric vehicles will account for a substantial portion of the total fleet mix over the next 30 years (Figure 12). By 2050, it is predicted that more than 75% of the fleet mix will be comprised of electric vehicles (ARENA and CEFC, 2018).

With the expected increase in electric vehicle uptake as an alternative to fossil fuel-based vehicles in the coming decades and the advancement of fuel efficiency in fossil-fuel based vehicles, VOC and fuel costs to users may significantly decrease. Queensland Government (2018) states that when compared with fossil fuel vehicles, electric vehicles can save users 60–90% off what they would pay for a tank of fuel. The typical fuel costs are reduced from $1.50 per litre to $0.50 equivalent-litre when converting from a traditional combustion engine vehicle to an electric vehicle. Additionally, maintenance savings are produced where electric vehicles have fewer moving parts and require less consumables (for example, oil and spark plugs) resulting in lower maintenance costs.

Furthermore, reduced demand for fossil fuels may cause oil prices to fall or rise at a slower rate than expected. As noted by Queensland Government (2018), Australia is highly reliant on imported oil for the

majority of its transport needs, in comparison Queensland is completely self-reliant in terms of electricity production. By using electricity instead of oil products, electric vehicles will help reduce the Queensland economy's dependency on oil, while supporting the use of renewable and locally-produced energy.

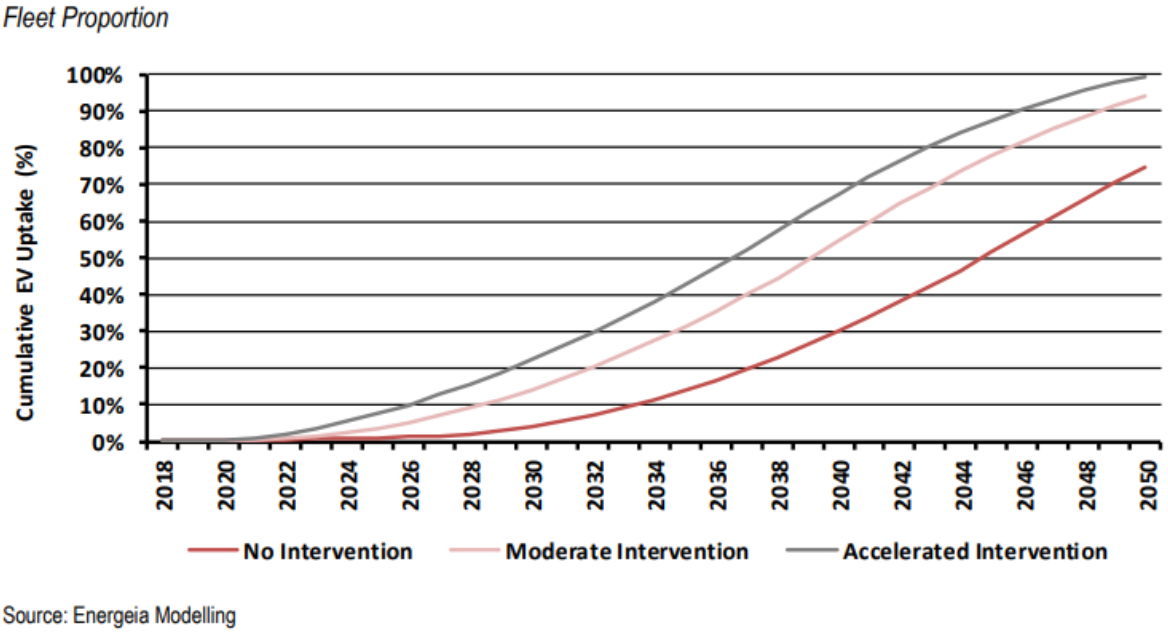


Figure 12 - EV uptake forecast (Energeia Modelling as cited by Australian Renewable Energy Agency and the Clean Energy Finance Corporation 2018)

Autonomous vehicles and disruptive technologies

Autonomous vehicle technology has the potential to significantly increase road capacities and speeds, as well as travel behaviour. In a recent report, The Future of Car Ownership, the NRMA suggests that in Australia over the next two decades, autonomous vehicles are likely to appear on Australian roads within eight years as the world's automotive manufacturers fast-track the new technology. It recommends that Australian transport planners need to develop mobility policies for the future, which should include next generation smart infrastructure to service autonomous vehicles, and that all levels of Government should facilitate autonomous vehicle trials and commence these trials as soon as possible (NRMA 2017). Trials are currently taking place through such initiatives as the Australia and New Zealand Driverless Vehicle Initiative (ADVI). ADVI has co-ordinated an on-road driverless car demonstration in Adelaide, South Australia in late 2015 – the first trial in the Southern Hemisphere (ADVI 2019).

Similarly, disruptive technologies refer to any enhanced or completely new technology that replaces and disrupts an existing technology, rendering it obsolete. It is designed to succeed similar technology that is already in use. Examples include the use of drones, ride-hailing applications such as Uber which are already changing the current state of play in the transport industry. Technology is already significantly changing travel patterns. With increasing popularity of flexible working arrangements, online shopping, and open university courses the demand for travel is already decreasing.

6.2.6 User benefits from increases in government revenue

This economic assessment captures user benefits reflected in changes to government revenue. The government revenue impacts assessed include fuel tax collected, GST collected on fuel sales and PT fare revenue collected. For example, if fuel consumption decreases, users would experience a benefit in the form of reduced tax payments, but the government would experience a disbenefit in the form of reduced fuel tax revenue (i.e. transfer).

6.2.7 Externalities

The uptake of electric vehicles in the future will also have an impact on these externality impacts in the future. Approximately 14% of Queensland total greenhouse gas emissions come from transport, making it the second highest emitting sector in the state (Queensland Government 2018). The average electric vehicle produces around 30% less greenhouse gas emissions compared to a conventional fossil fuel vehicle when using Queensland's current electricity grid mix, and as such will contribute towards the Queensland Government renewable energy target. This is shown in Figure 13 which compares the lifecycle emissions for tailpipe and life cycle emissions.

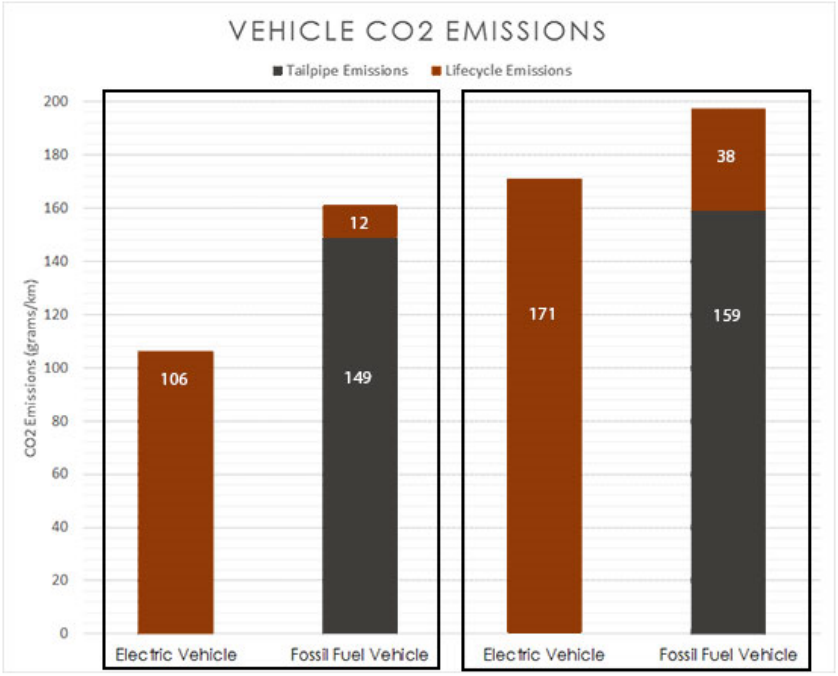


Figure 13 - Comparison of Vehicle CO2 Emissions for Electric Vehicles (Queensland Government 2018)

Other benefits also exist to improvements to urban amenity, where electric vehicles produce significantly less noise compared to fossil fuel vehicles – particularly at lower speeds. This means traffic noise will be reduced by electric vehicles, which will improve urban amenity.

Externality impacts are also affected by other impacts such as transport mode shift and telecommuting. The Cosgrove et al. (2012) notes that the expansion of information technology and the increased ability to work effectively and efficiently from non-work locations, has led to an increase in telecommuting which affects externalities and travel demand.

Additionally, mode shift away from the car has similar impacts in reducing greenhouse benefits.

6.2.8 Safety benefits

[redacted]

ATAP (2016) indicates that safety benefits could be calculated using the human capital approach, the willingness to pay (WTP) approach or a hybrid approach. [redacted]

[redacted] The human capital approach generally has lower values than the WTP approach as the human capital approach tends to "underestimate the actual cost of injuries due to under-reporting by police, forensics medicine organizations, and insurance companies, and omission of cost components such as lost output, decreased quality of life, and the costs of caring for injured victims and their elderly relatives and children" (Ainy et al., 2014).

[redacted]

Table 19 Estimation of crash costs by injury severity, WTP values, June $2013

State	Rural			Urban		
	Fatal crash ($)	Serious injury crash ($)	Other injury crash ($)	Fatal crash ($)	Serious injury crash ($)	Other injury crash ($)
New South Wales	7,848,085	216,675		6,476,155	136,505	
Victoria	8,319,000	289,604	31,747	8,217,515	407,930	24,226
Queensland	8,059,080	294,906	31,268	7,741,326	436,471	23,446
South Australia	8,725,853	297,940	31,580	7,625,611	424,018	23,169
Western Australia	8,537,385	294,498	35,079	7,796,363	423,650	26,544
Tasmania	8,087,424	267,428	34,368	7,525,710	386,849	25,831
Northern Territory	8,043,372	302,628	29,353	8,439,525	449,694	23,035
Australian Capital Territory				8,982,223	389,365	

Source: ARRB Group Ltd.

6.2.9 Wider Economic Benefits

There are three categories of WEBs that may be relevant for transport initiatives in Australia are:

- WEB1 – agglomeration economies
- WEB2 – output change in imperfectly competitive markets
- WEB3 – tax revenues from labour markets.

In Australia, as WEB measurement techniques are still in its infancy and are currently being developed by the Australian Government. Therefore, IA's advice is to present the CBA results without WEBs, and then with WEBs like a sensitivity test.

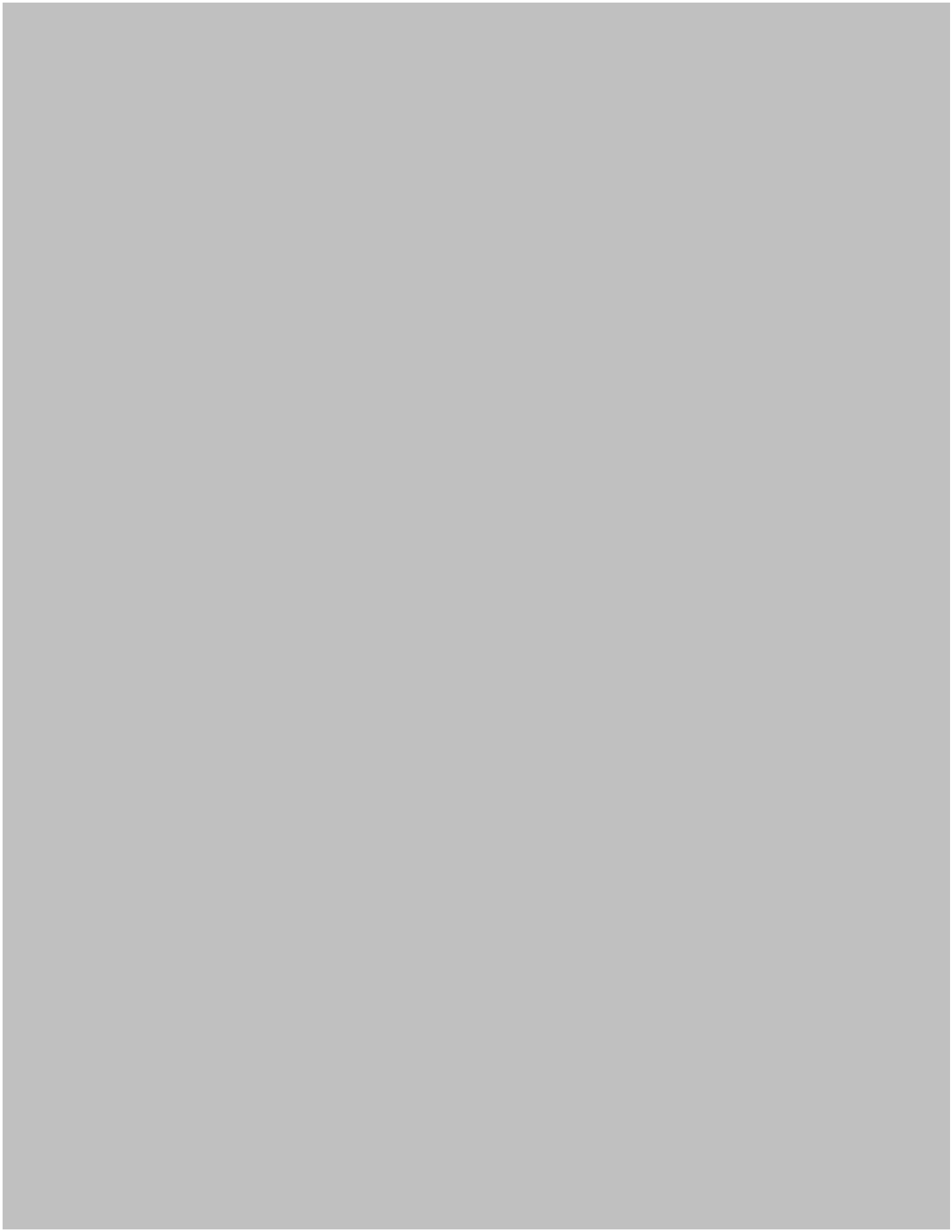
6.3 Qualitative analysis

6.4 Sensitivity tests

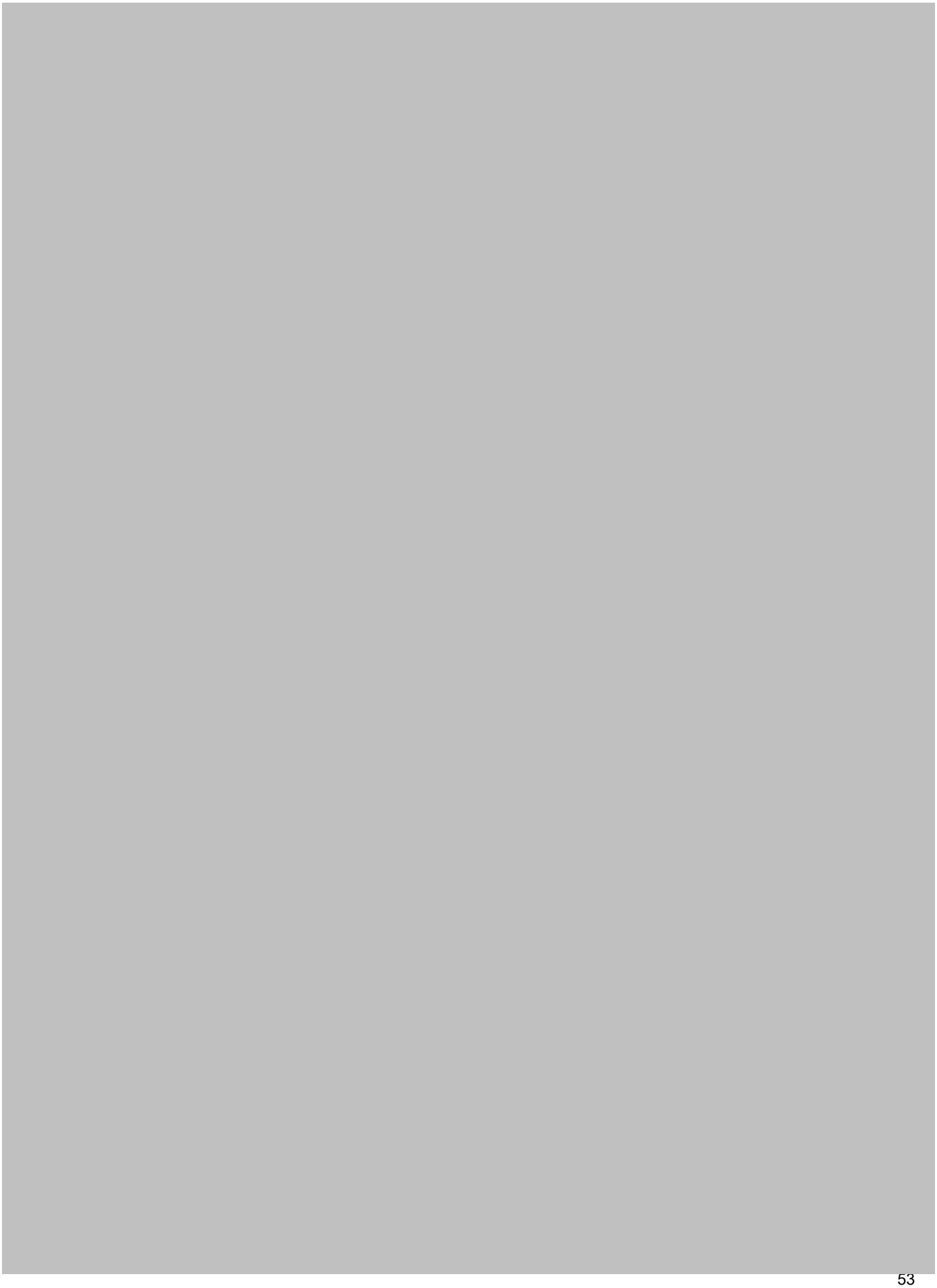
As stated in the IA Assessment Framework, the main sources of project risks include:

- Investment cost risks created by unforeseen construction, technical or other project scope issues
- Operating cost risks (including maintenance) created by unforeseen market impacts/changes and technical issues
- Demand forecast risks driven by changes in factors such as unforeseen population growth or cost of living
- Environmental impacts driven by unforeseen circumstances
- Network effects caused by unexpected and inter-related network projects/changes.

6.5 Summary



6.5.1 Impacts of individual issues



7 KEY REVIEW FINDINGS AND ACTIONS

The main findings of the independent review of the DBC for the VL2T Project undertaken by Arcadis are summarised in the following sections.

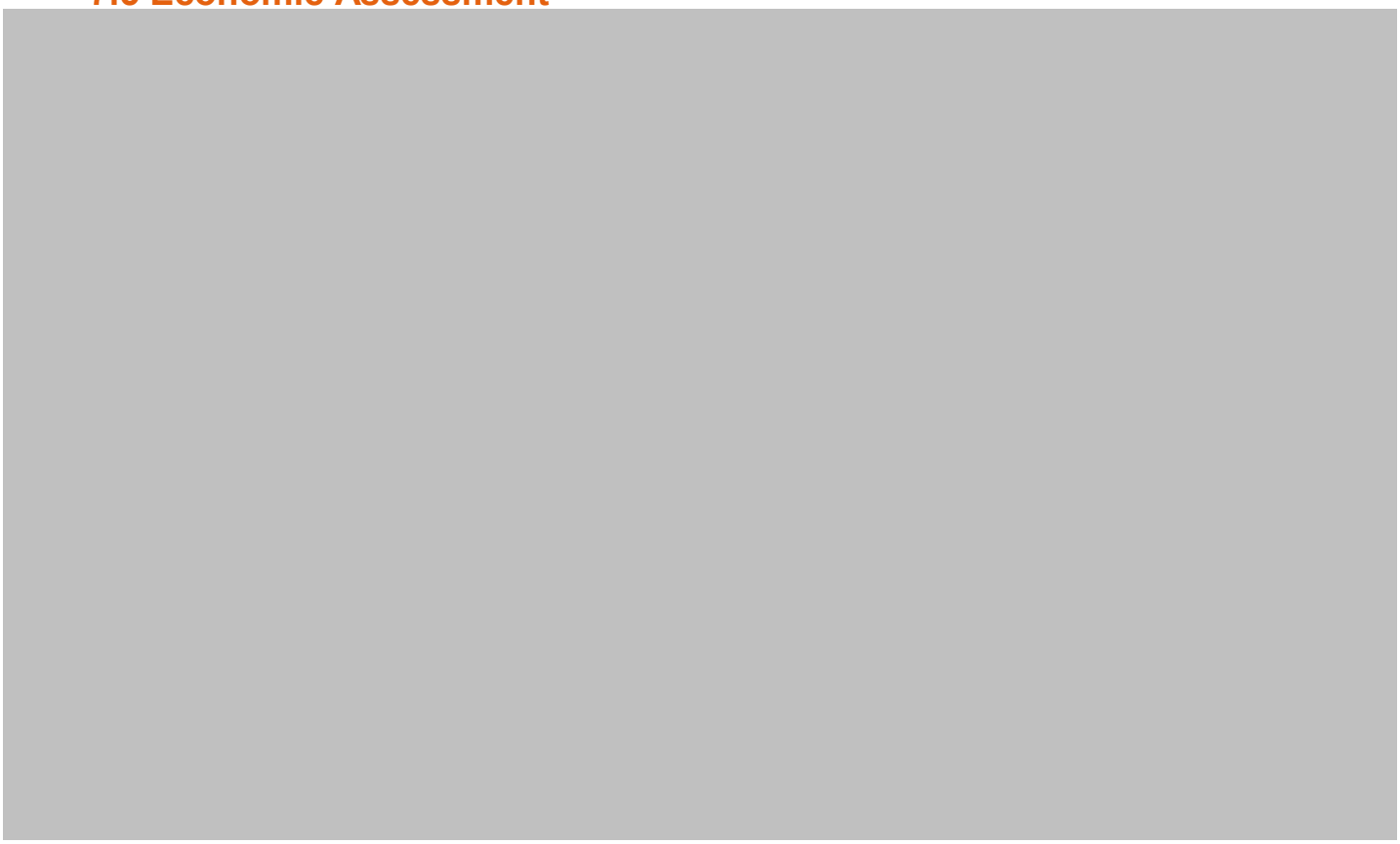
7.1 Base and Project Case Options

7.2 Demographic and Employment Projections

7.3 Sustainability and Environmental Assumptions

7.4 Transport Modelling

7.5 Economic Assessment



7.6 Recommendation

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APPENDIX A – LEVEL OF REVIEW OF EACH CHAPTER OF THE DBC

Chapter	Full/Partial/None	Chapter	Full/Partial/None
1	Full	16	Partial
2	Full	17	None
3	Full	18	Full
4	Full	19	None
5	Full	Appendix A	Partial
6	None	Appendix B	Partial
7	None	Appendix C	Partial
8	None	Appendix D	Partial
9	None	Appendix E	Full
10	None	Appendix F	Full
11	None	Appendix G	Partial
12	Full	Appendix H	Partial
13	Partial	Appendix I	Partial
14	None	Appendix J	None
15	None	Appendix K	None

APPENDIX B - THE TRANSPORT DEMAND MODELLING PROCEDURE

A.1 Transport modelling procedure

The transport modelling process is central to the estimation of benefits used in the economic assessment. It is therefore important to understand the transport modelling methodology that was applied for this project.

The transport modelling combines both strategic modelling and mesoscopic modelling.

A.1.1 The Strategic Model

The fundamental inputs to the Zenith model (and all other strategic transport model) are the demography of the modelled area and the transport networks. The demography is used in the estimation of demand for transport, while the transport networks represent the transport supply. In any strategic model, the transport demand and supply are always balanced.

The Zenith series of models aim to reflect the response of transport demand to external changes including factors such as growth of population, employment, travel times, parking charges, fuel prices and public transport fares. Each Zenith model, including the South East Queensland model, follows the same four-step modelling procedure.

These four steps are:

1. Trip Generation (How many people will travel?)
2. Trip Distribution, also called Destination Choice in Zenith (Where will people at each origin travel to?)
3. Mode Choice (What mode will people choose to travel on?)
4. Trip Assignment (What roads and public transport services will people travel on?)

In Zenith, the costs of travel are estimated in the Trip Assignment stage and fed back into Mode Choice stage. This loop is repeated until the changes from one loop to the next are small enough to accept that the model has reached an equilibrium.

The costs of travel by public transport and by car are used to split trips into public transport trips, car trips and active modes trips. In many models, the costs also have a substantial influence on the distribution of trips; destinations with lower costs from an origin typically attract more trips from that origin. In Zenith models, however, the costs determine a single set of destinations, but a loop between assignment and mode choice allow the model to re-estimate mode choice until it reaches equilibrium.

The travel costs are represented by a combination of:

- Fuel price
- Other vehicle costs
- Toll charges
- Travel time
- Parking charge
- Public transport fare
- Access time to station or stop
- Waiting time for service
- In-vehicle travel time.

Costs and times are converted to each other by a value of time.

The costs have a crucial role in the mode choice. Furthermore, for economic assessment of a project, the cost of travelling by public transport and by roads for the Project Case from the trip assignment in the last loop are used are compared to those of the base case to estimate the benefits that a project provides.

The important points to note about the strategic modelling are:

- The trips and costs are provided for three time periods:
  - Morning peak (7am to 9am)
  - Afternoon peak (4pm to 6pm)
  - Off peak (the remainder of the day)
- The public transport network's services are unconstrained. Effectively, this means that public transport has limitless capacity
- The highway network is constrained only by travel time or travel cost. That is, a road link may carry more than its capacity, but the cost of travel along the link will be high
- The mode choice is based on the difference between the cost of travel by public transport and the cost of travel by car.
- No intersection delay or queues are represented in the model
- The highway trip matrix (including cars and commercial vehicles) is passed to the Dynamic traffic model.

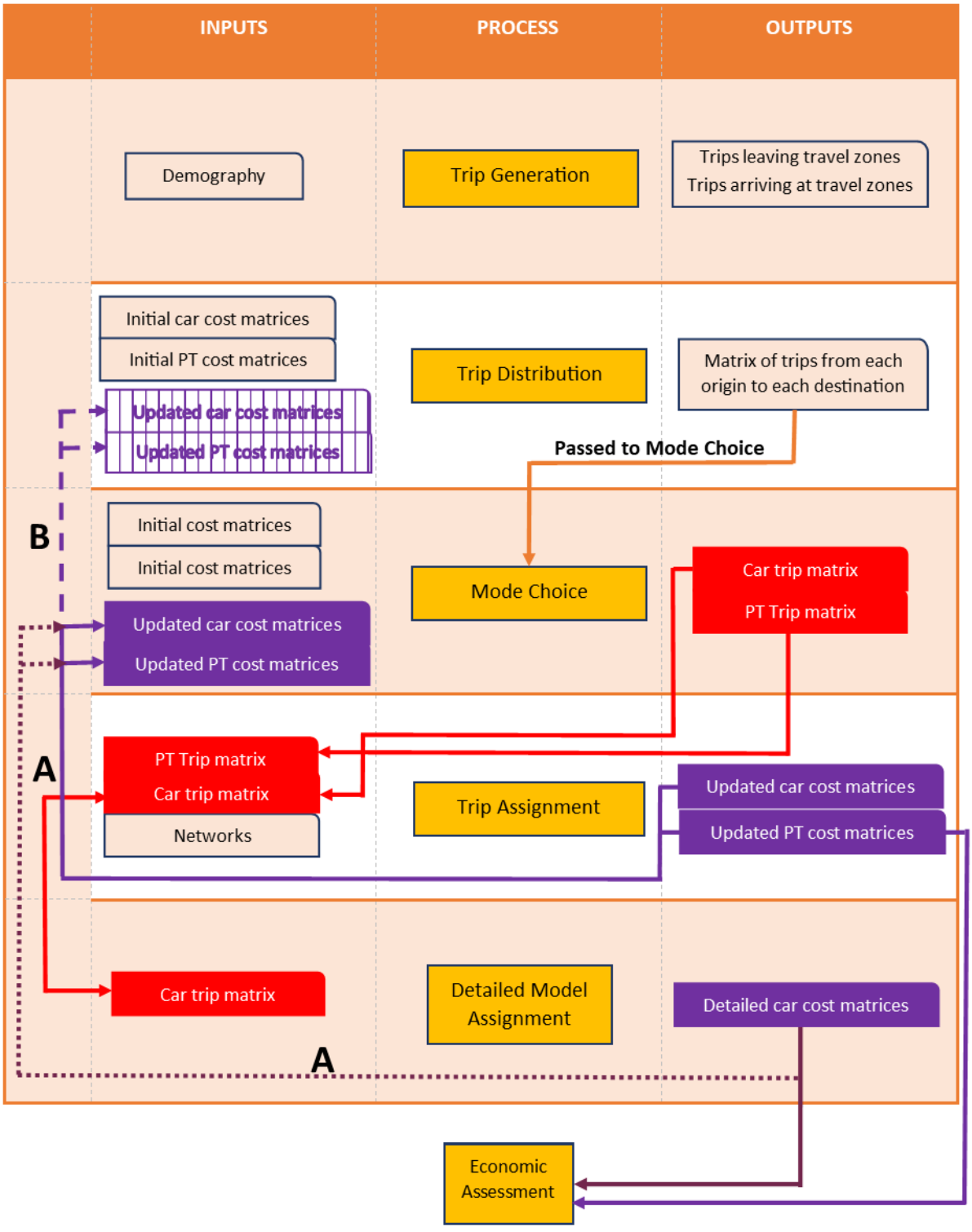


Figure 14 - Figurative representation of the modelling process

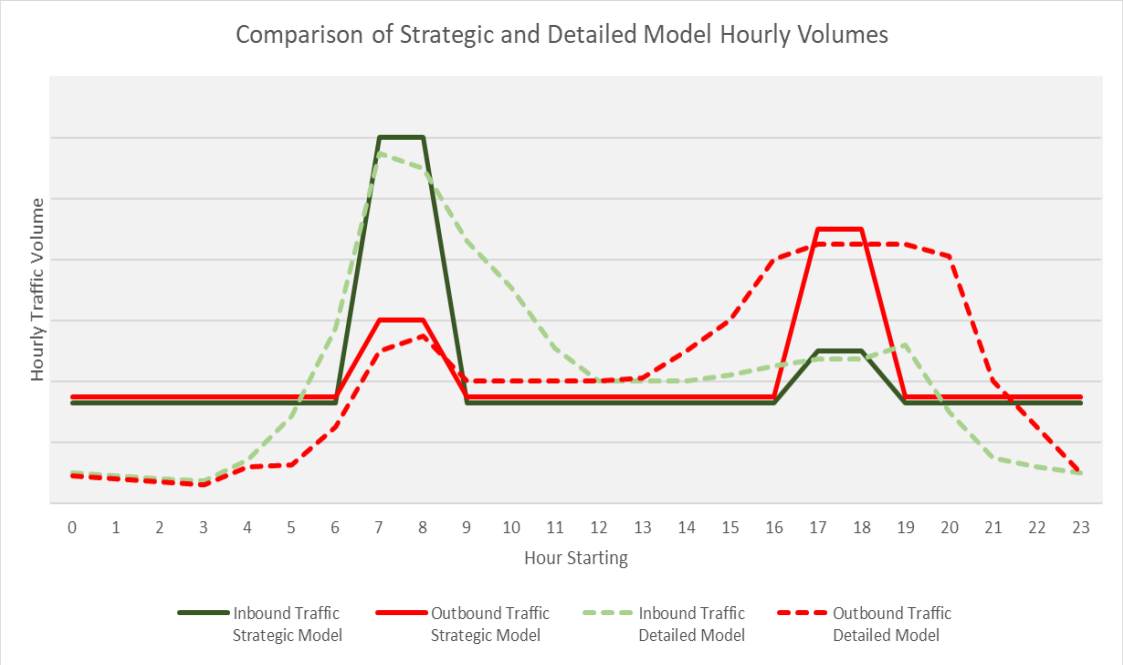


Figure 15 - Example of a typical daily time profile as represented by the Strategic Model and the Dynamic traffic model

ARCADIS Design & Consultancy for natural and built assets

ARCADIS Design & Consultancy for natural and built assets

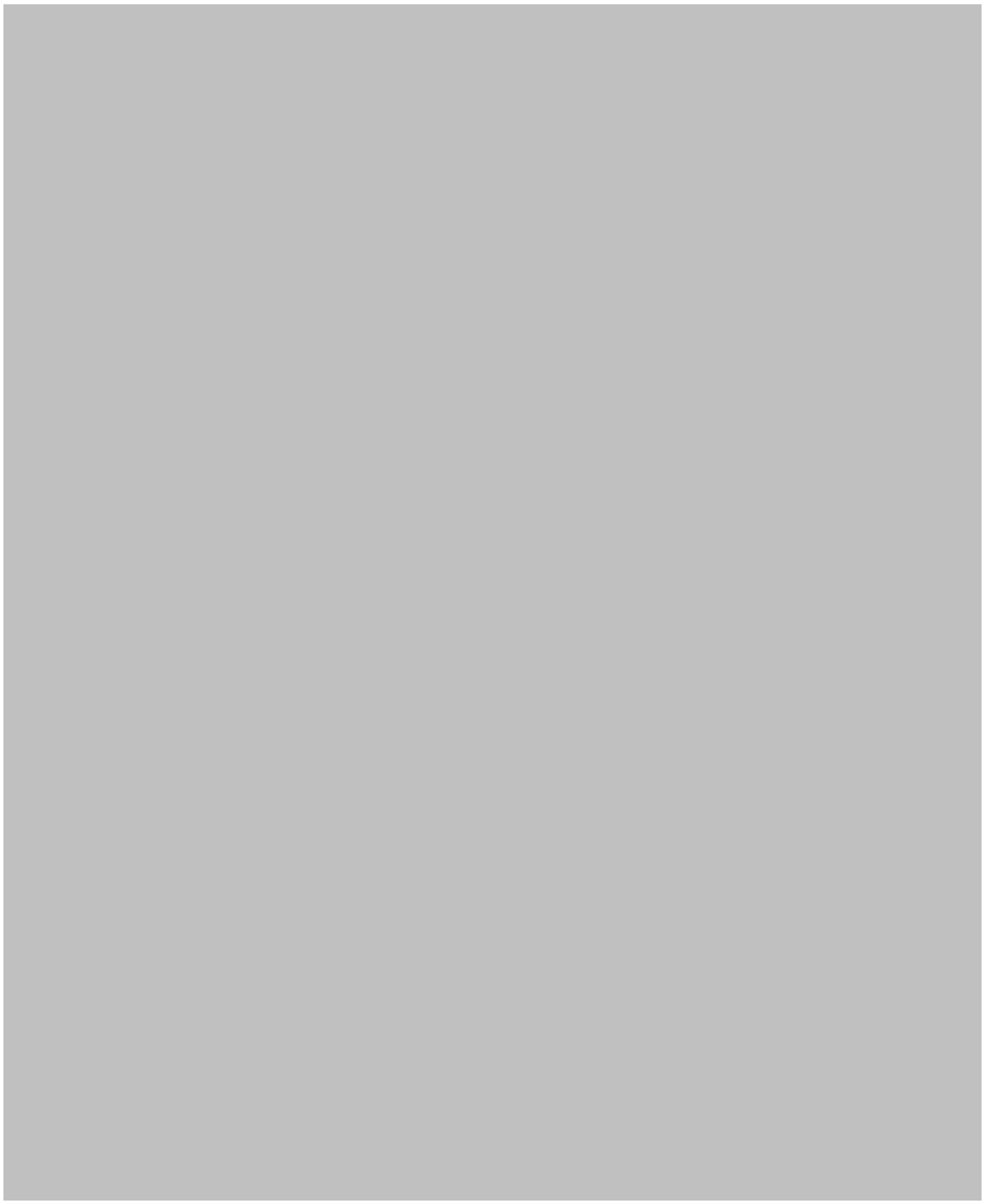
M1 PACIFIC MOTORWAY
EIGHT MILE PLAINS TO DAISY HILL
BUSINESS CASE REVIEW

20 MARCH 2019

CONTACT

s47F

M1 PACIFIC MOTORWAY (EIGHT MILE PLAINS TO DAISY HILL)



CONTENTS

EXECUTIVE SUMMARY

Overview

Arcadis Australia Pacific Pty Ltd (Arcadis) was appointed by Department of Infrastructure, Regional Development and Cities (DIRDC) in February 2019 to undertake an independent high-level review of the detailed business case (DBC) for the M1 Eight Mile Plains to Daisy Hill (EMP2DH) Project in Queensland.

The M1 Pacific Motorway is an important multimodal transport corridor providing a connection between New South Wales and South East Queensland. Apart from being an important carrier of commuters and tourists, it is a key road link in the transport of freight between Queensland and the domestic and international markets.

The standard and quality of the road is generally not commensurate with its strategic function and role. It currently operates at capacity during the elongated peak periods with associated delays and queues. The shoulder lanes are narrow and below standard width for long sections of the M1 Pacific Motorway. Distances between interchanges are relatively short [redacted] There are major issues with flooding along parts of the M1 Pacific Motorway corridor.

[redacted]

Project options

[redacted]

Table ES 1 - EMP2DH Project Options

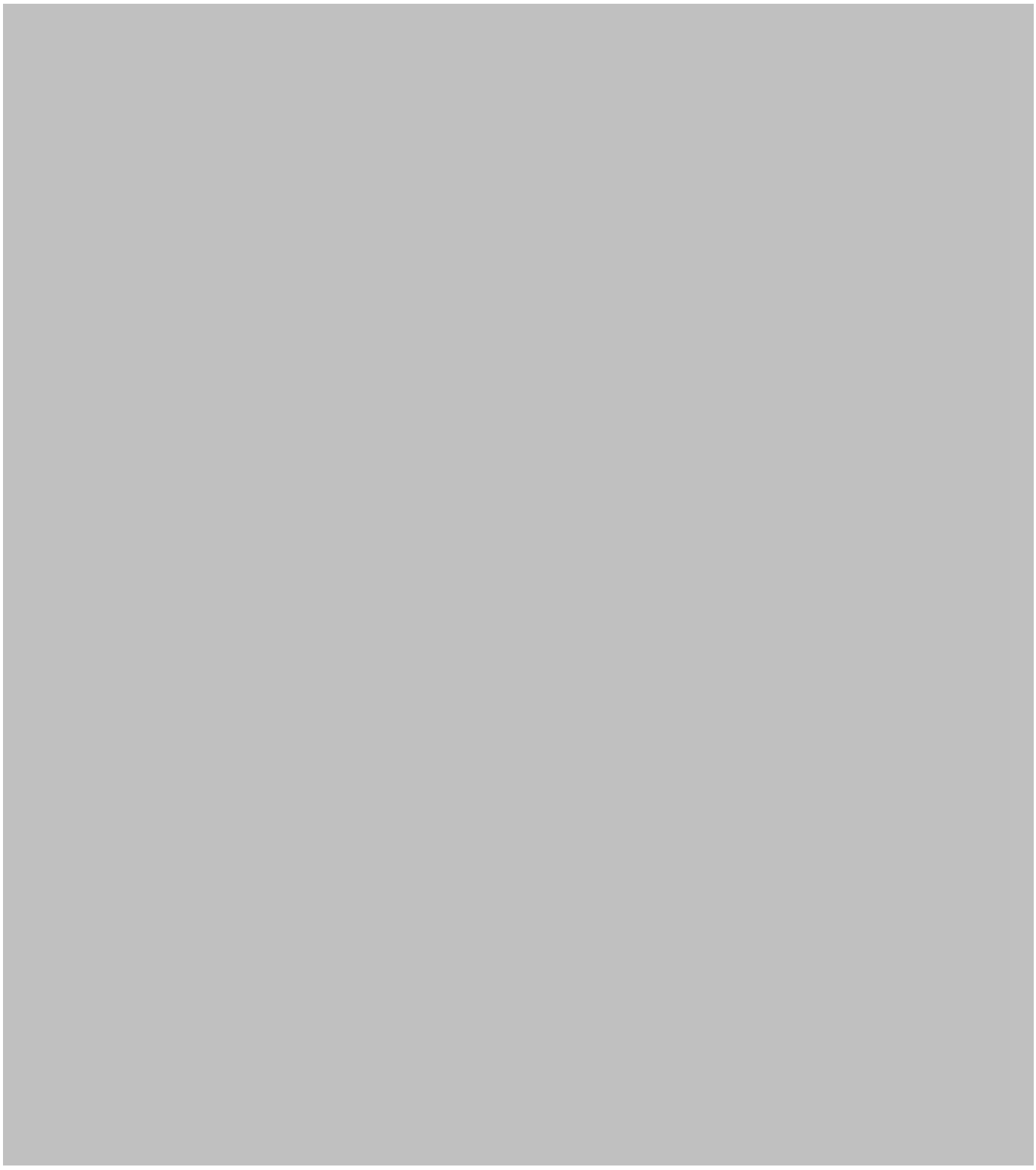
Options	Description
Base Case	• Committed government transport projects [redacted] • [redacted]
Project Case 1	• Committed government transport projects [redacted] • Upgrading motorway to increase capacity, upgrade substandard design sections, reduction in the number of ramps. The upgrades are primarily located on the northbound direction. • [redacted] • Bus priority – separated busway extending from Eight Mile Plains through to Springwood and a new Rochedale Park n' Ride. • Extension of the V1 Veloway (dedicated cycling facility) between the Gateway Motorway and Paradise Road.
Project Case 2	• Base Case plus bus priority measures including a separated busway extending from Eight Mile Plains through to Springwood Bus Station and a new Rochedale Park n' Ride. [redacted]

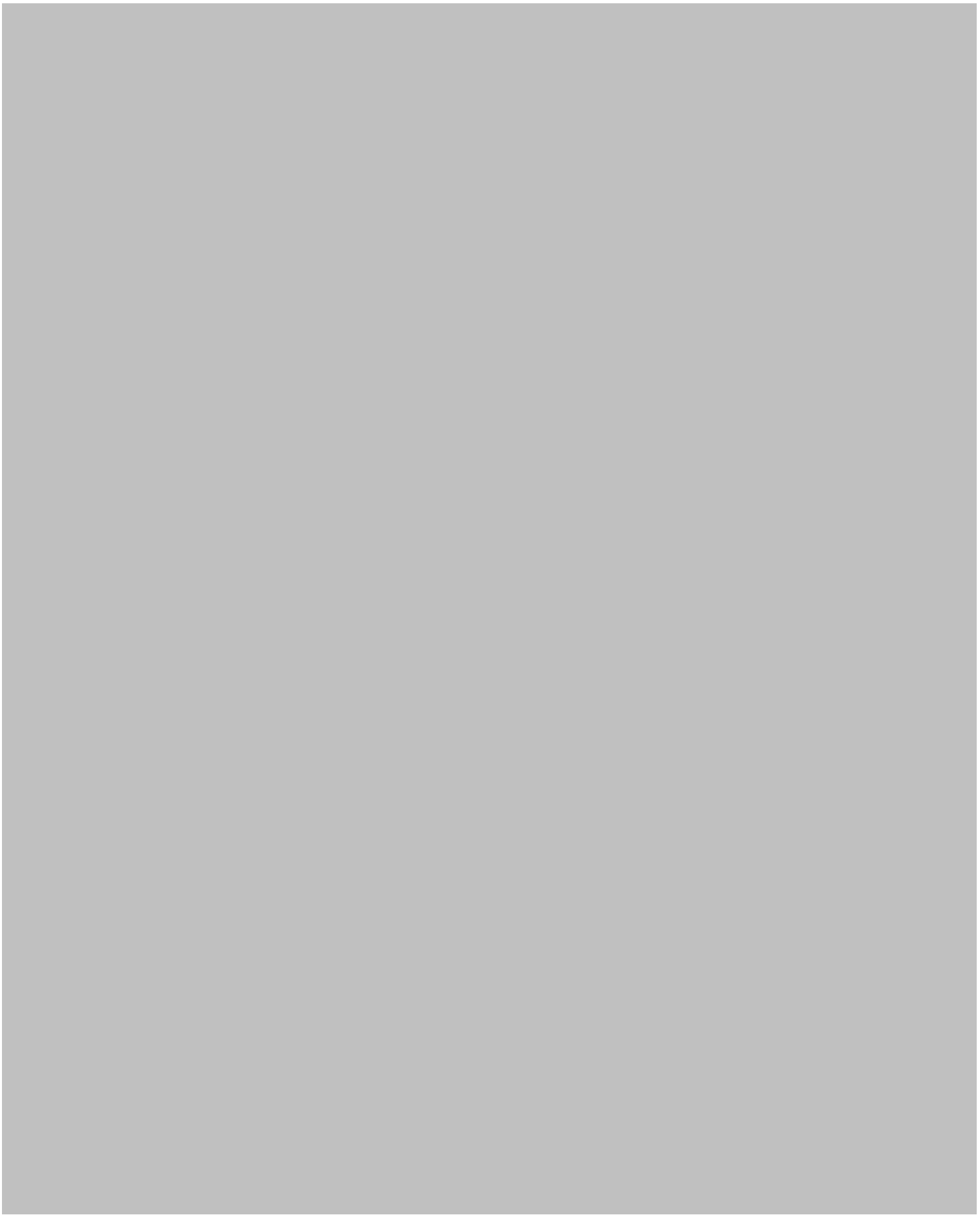
Methodology

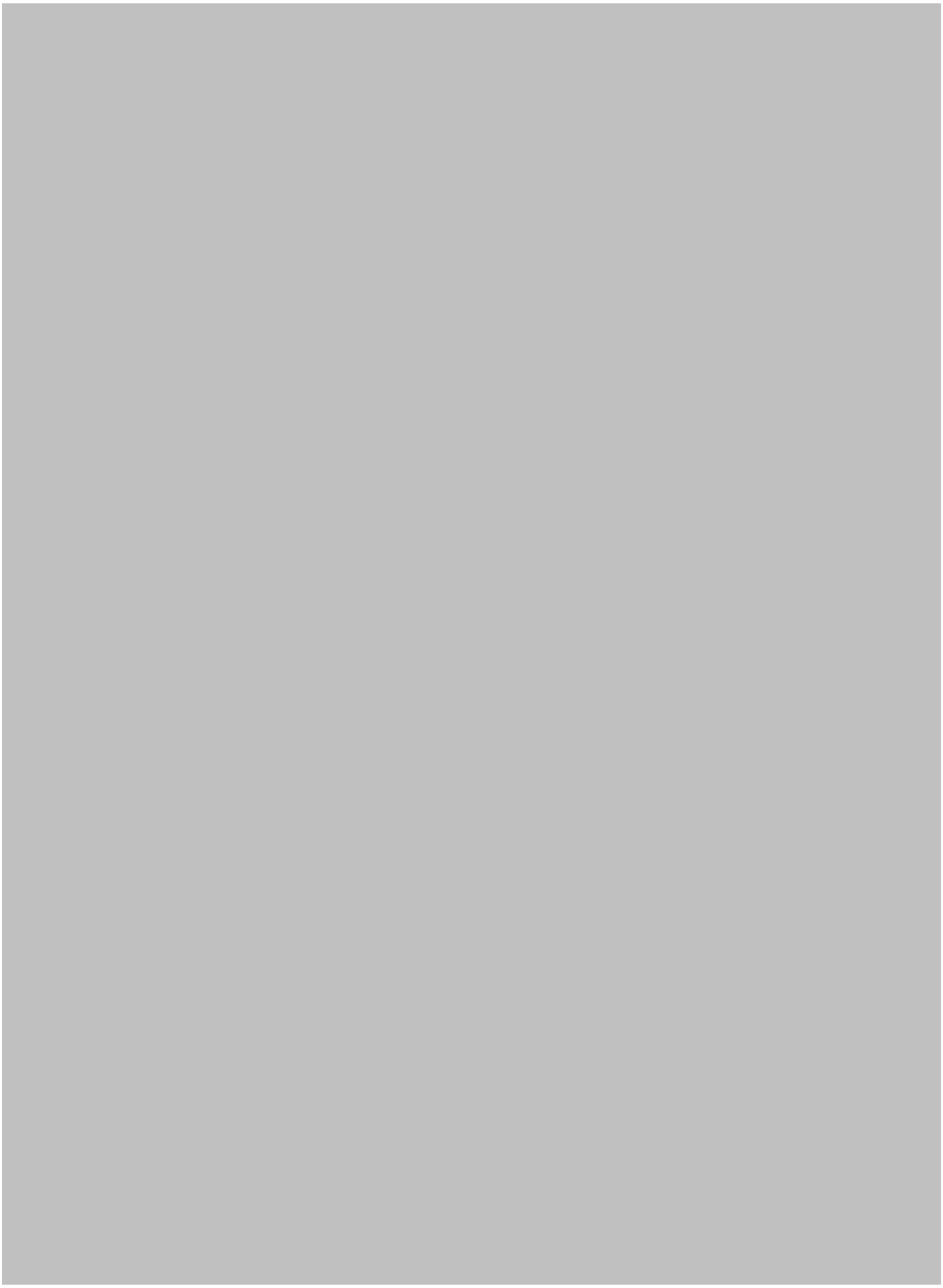
For this commission, Arcadis has reviewed the DBC and relevant appendices for the EMP2DH Project. The documentation was provided by DIRDC. To complete the independent review in the required timeframe, the chapters of the DBC were prioritised in order of likely impact on the validity and outcomes sought by the overall business case document.

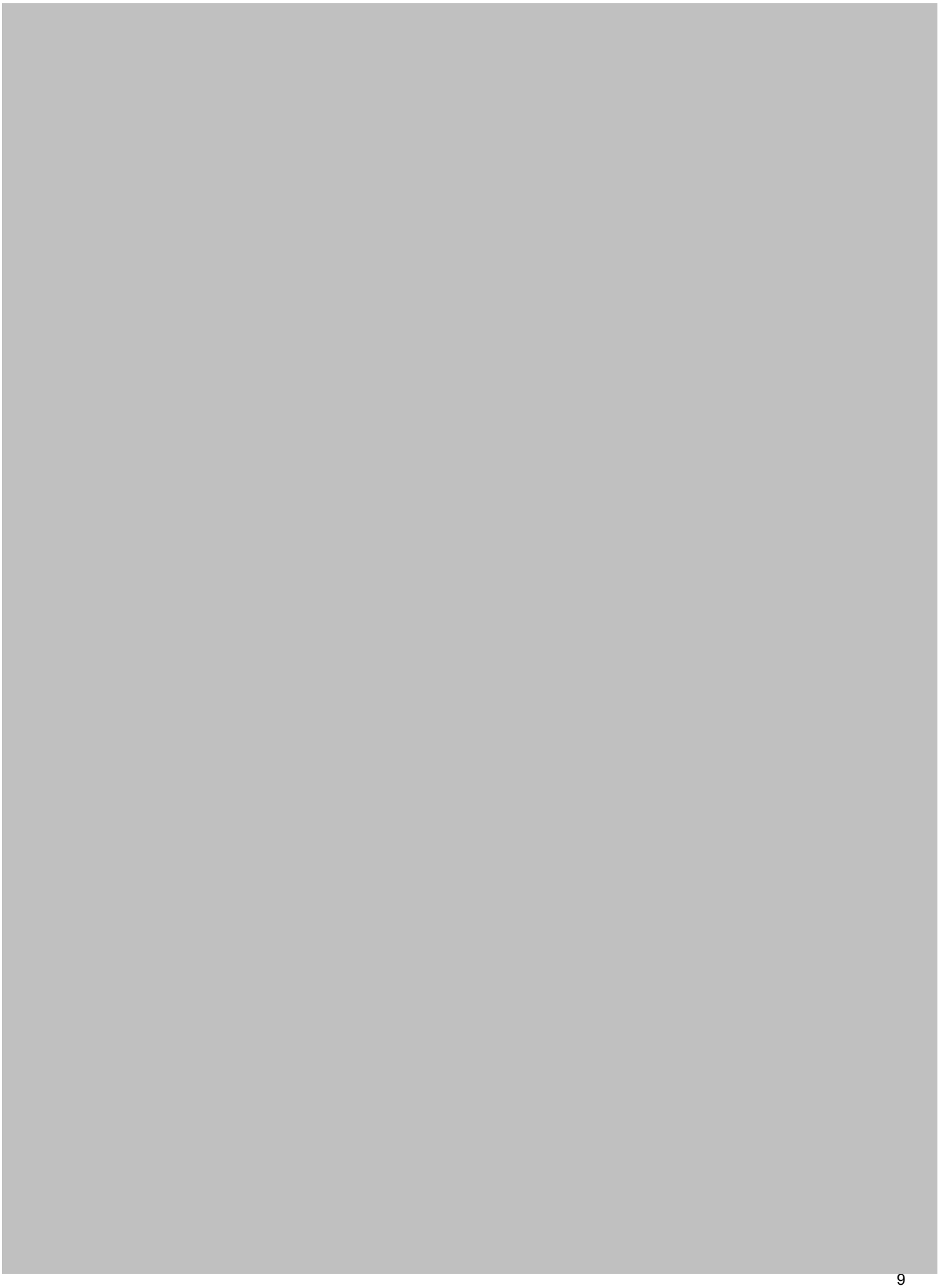
Key review findings

The main findings of the independent review of the DBC for the EMP2DH Project can be summarised as follows:









Recommendation

Based on Arcadis' review of the EMP2DH DBC, the recommendation is to accept the DBC with the understanding that some of the benefits are likely to have been overstated, but it is unlikely that the BCR would fall below 1.

1 INTRODUCTION

Arcadis Australia Pacific Pty Ltd (Arcadis) was appointed by Department of Infrastructure, Regional Development and Cities (DIRDC) in February 2019 to undertake an independent high-level review of the detailed business case (DBC) for the Eight Mile Plains to Daisy Hill (EMP2DH) Project (the Project) in Queensland. This report details the findings and recommendations of the Arcadis review.

1.1 Overview

The M1 Pacific Motorway is an important transport corridor providing a connection between New South Wales and South East Queensland. Apart from being an important carrier of commuters and tourists, it is a key road link in the transport of freight between Queensland and the domestic and international markets.

The Queensland Department of Transport and Main Roads (TMR) developed a strategy in 2016 (known as the M1 Master Plan) to guide the upgrade of the motorway between its interchanges with the Gateway Motorway in the north and the Logan Motorway in the south. The upgrade of the M1 Pacific Motorway between Eight Mile Plains and Daisy Hill represents the second stage of the overall M1 Master Plan. A Preliminary Evaluation of this stage was completed in 2016.

Preceding it is the Gateway Merge Project, which is currently in early stages of construction. The Daisy Hill to Loganholme Project located to the south of EMP2DH Project is currently in the planning phase. The next stage will be development of the business case.

1.2 Need for the project

The M1 Pacific Motorway is the most intensely used highway route in Queensland. It caters for commuters and tourists and is a major land-based freight transport route.

The standard and quality of the road is generally not commensurate with its strategic function and role. It currently operates at capacity during the elongated peak periods with associated delays and queues. The shoulder lanes are narrow and below a standard width for long sections of the M1 Pacific Motorway. Distances between interchanges are relatively short

There are major issues with flooding along parts of the M1 Pacific Motorway corridor. Sections of the corridor do not comply with current road infrastructure flood immunity standards. The road is inundated at several locations during heavy rain events. An example is the March 2017 flooding due to Cyclone Debbie where portions of the M1 Pacific Motorway was inundated.

1.3 Options considered

Two project options in addition to the Base Case were assessed as part of the DBC. These are described in Table 1.

Table 1 - DBC options considered

Options	Description
Base Case	• Committed government transport projects

Options	Description
Project Case 1	• Committed government transport projects • Upgrading motorway to increase capacity, upgrade substandard design sections, reduction in the number of ramps. The upgrades are primarily located on the northbound direction. • Bus priority – separated busway extending from Eight Mile Plains through to Springwood and a new Rochedale Park n' Ride. • Extension of the V1 Veloway (dedicated cycling facility) between the Gateway Motorway and Paradise Road.
Project Case 2	• Base Case plus bus priority measures including a separated busway extending from Eight Mile Plains through to Springwood Bus Station and a new Rochedale Park n' Ride.

1.4 Report purpose

The purpose of this report is to document a high-level review of the forecasts that underpin the EMP2DH DBC. It reports the findings associated with:

- Assumptions made in the business case, including inputs like demography and employment, changes in economic conditions and community expectations
- The transport modelling that informs economic assessment and planning of the upgrades
- The procedures associated with the economic evaluation of the project.

1.5 Report structure

The sections of this report are arranged as shown in Table 2.

Table 2 - Report structure

Chapter	Contents
2	Summarises our approach to undertaking this independent review
3	Provides a review of the overall alignment of the business case to policies, plans and guidelines
4	Addresses the business case broadly and issues identified during the inception meeting
5	Contains a detailed review of the transport modelling and forecasts used during the project
6	Reports on the review of the economic assessment in the business case
7	Summarises the findings and recommendations of this review

2 OUR APPROACH

Our approach to conducting an independent review of the DBC of the proposed M1 Pacific Motorway upgrades between Eight Mile Plains and Daisy Hill is based on the following considerations:

- The need to address the itemised scope of works specified in the request for tender issued by DIRDC
- Completion, as far as possible, of the nominated tasks outlined in the Arcadis proposal

Our overall approach for the review of the DBC for the EMP2DH report has been to review the documentation provided by DIRDC and establish at a high level:

- The internal consistency of the document, ensuring the there are no contradictions of ambiguities through the report
- The consistency of the business case assumptions, forecasts, results and conclusions with existing policies and evidence
- That there are no omissions or misleading statements in the documents.

The following section details the methodology employed for Arcadis' independent review of the DBC for the EMP2DH Project.

2.1 Methodology

For this commission, Arcadis has reviewed the DBC and relevant appendices provided by DIRDC. To complete the independent review in the required timeframe, the chapters of the DBC were prioritised in order of likely impact on the validity and outcomes sought by the overall business case document. Appendix A lists the level of review for each chapter of the business case.

The business case review for the EMP2DH Project contained a number of discrete tasks, including:

- Familiarisation, during which the documents were reviewed
- Analysis of internal consistency, with a focus on identifying omissions, inconsistencies and misleading statements and understanding the business case in more detail
- Assessment of the assumptions associated with business case forecasts
- Analysis and evaluation of the transport modelling and forecasts
- Evaluation of the economic assessment
- Assessment of the level of compliance with Infrastructure Australia (IA) and Australian Transport Assessment and Planning (ATAP) requirements
- Evaluation of the projects to current policies and plans
- Examination of the specific issues identified by DIRDC.

To complete each of these tasks, additional information, statistics and documents were sourced and evaluated. These additional documents and information included:

- Demography forecasts from the Queensland Government Statistician's Office, 2015 version
- Demography forecasts from the Queensland Government Statistician's Office, 2018 version
- Australian Census data from 2011 and 2016
- Various strategy documents of the Federal and State Governments
- Local plans from Brisbane, Logan, and Gold Coast local government areas
- Technical notes regarding the modelling, from Veitch Lister Consulting's website.

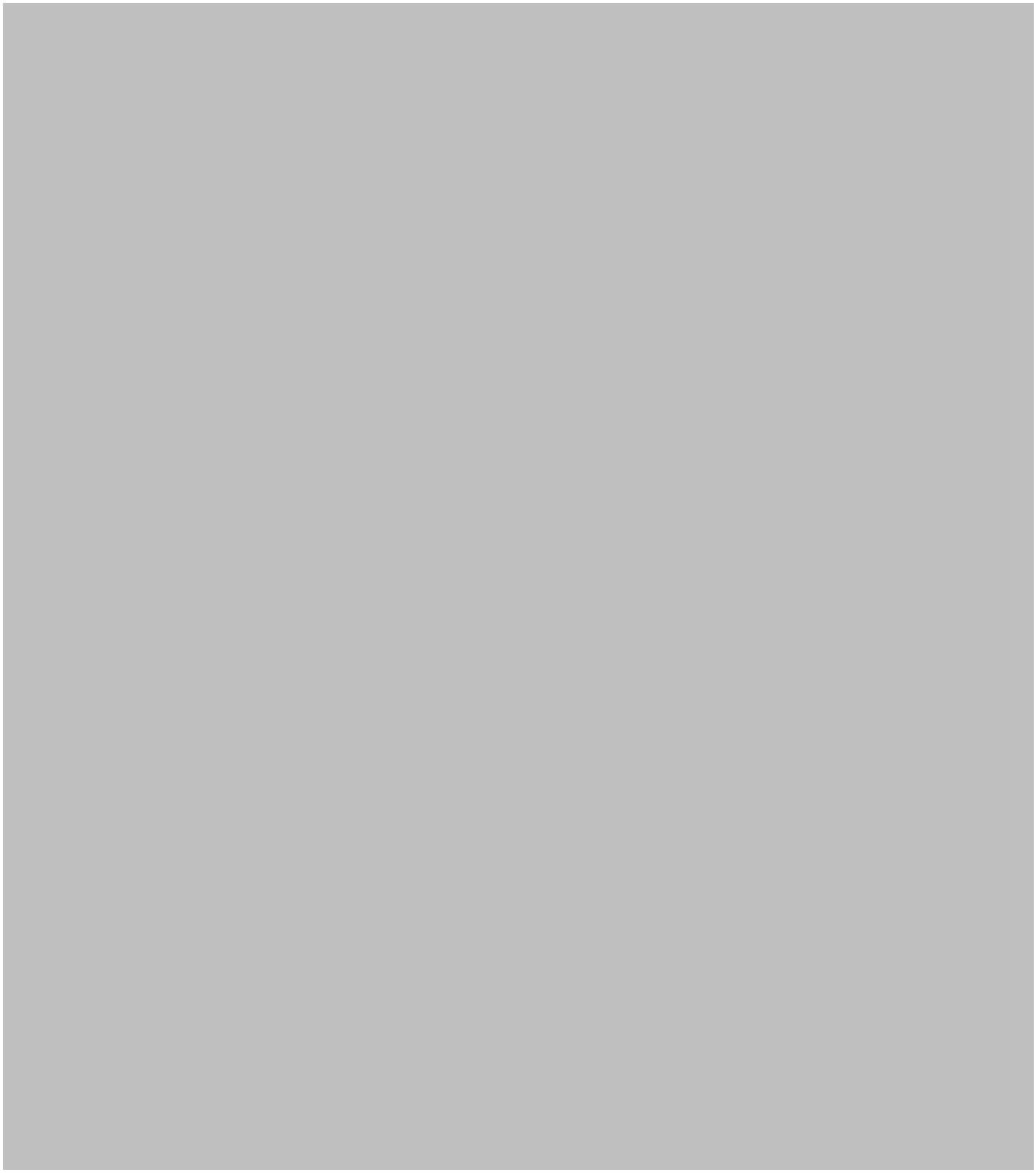
Wherever an issue was identified, its impact on the outcome of the business case has been evaluated, either quantitatively where possible and qualitatively where not possible.

2.2 Assumptions and limitations

The independent review by Arcadis was undertaken on the basis of the following assumptions and limitations:

- The findings of this review are limited by the documentation contained in the business case document
- Areas and topics in the DBC that contain incomplete information have been identified but not completed
- Any project cost review or advice is based on a high-level indicative assessment and is intended for discussion only
- Arcadis was not provided with any of the models from the DBC (i.e. Cost Benefit Analysis spreadsheets or traffic models) and therefore any calculations undertaken in this review are indicative and intended for discussion only.

3 POLICY CONTEXT AND STRATEGIC FIT



3.4 How Local Governments influence land use planning

State and Territory governments generally set the overarching legislative and regulatory framework for land use planning and development in Australia. They provide the machinery that gives effect to State planning strategies and policies. Strategically, State and Territory governments have responsibility for the development of State and Territory as well as regional level strategies and policies. From a statutory perspective, State and Territory Governments, via sub-ordinate legislation, set the structure for land use planning through local environmental plans, planning schemes and development plans. These key planning instruments provide for the implementation of State, regional and local policies affecting land use and development.

Changes to zoning has the potential to increase the residential population density and/or employment population density. Future zoning changes have the potential to increase traffic demand in the study area.

Local governments set the overall direction for the use, development and conservation on land within their municipal area. They provide a clear and consistent framework within which local decisions about the use and development of land can be made. Local government further influences land use planning by expressing local and community expectations for discrete areas and land uses. Planning at the local government level seeks to anticipate and respond to the needs of existing and future communities through provision of zoned and serviced land for housing, employment, recreation and open space, commercial and community facilities and infrastructure.

In certain instances, regional groupings of Councils pool together human and financial resources to exert a greater level of influence on key land use planning issues. Land use planning issues rarely stop at municipal boundaries and the ability to act as a group of Councils helps deliver both economies of scale and additional funding opportunities. The SEQ Council of Mayors is a leading example of a group of Councils collaborating and acting as a regional local government advocacy organisation.

3.5 IA guidelines

The Business Case draws on a series of state and national guidelines which are noted to have been applied in the order of the listing provided in the document. The IA Assessment Framework (2018) has been listed as the first source of reference.

The IA Assessment Framework provides a structured and objective approach to infrastructure decision-making. It sets out the criteria used to assess and prioritise submissions as Initiatives and Projects for inclusion on the Infrastructure Priority List. This comprises

- strategic fit;
- economic, social and environmental value; and
- deliverability.

Alignment of other projects against the *IA Priority List 2019* was also considered in this document for further consideration in any further revisions of Project Case scenarios. For example, *Building Queensland's Infrastructure Pipeline 2018* and the IA Priority List 2019 identify the Gold Coast Rail Line Capacity Improvement-Kuraby to Beenleigh as a priority near term project, of future relevance.

A more detailed assessment of the economic appraisal compared to the IA Assessment Framework is provided in Section 6.

3.6 Australian Transport Assessment and Planning guidelines

The ATAP Guidelines (the Guidelines) provide a comprehensive framework for planning, assessing and developing transport systems and related initiatives. The Guidelines provide a transport planning and decision-support framework and set out best-practice for planning and assessing transport systems and initiatives in a consistent and harmonised way across jurisdictions.

They are endorsed by all Australian jurisdictions and are published by the Transport and Infrastructure Council. They are closely aligned with the IA Assessment Framework (IA 2017).

The ATAP Guidelines are structured around a Transport System Management Framework (the ATAP Framework or the Framework) shown in Figure 1.

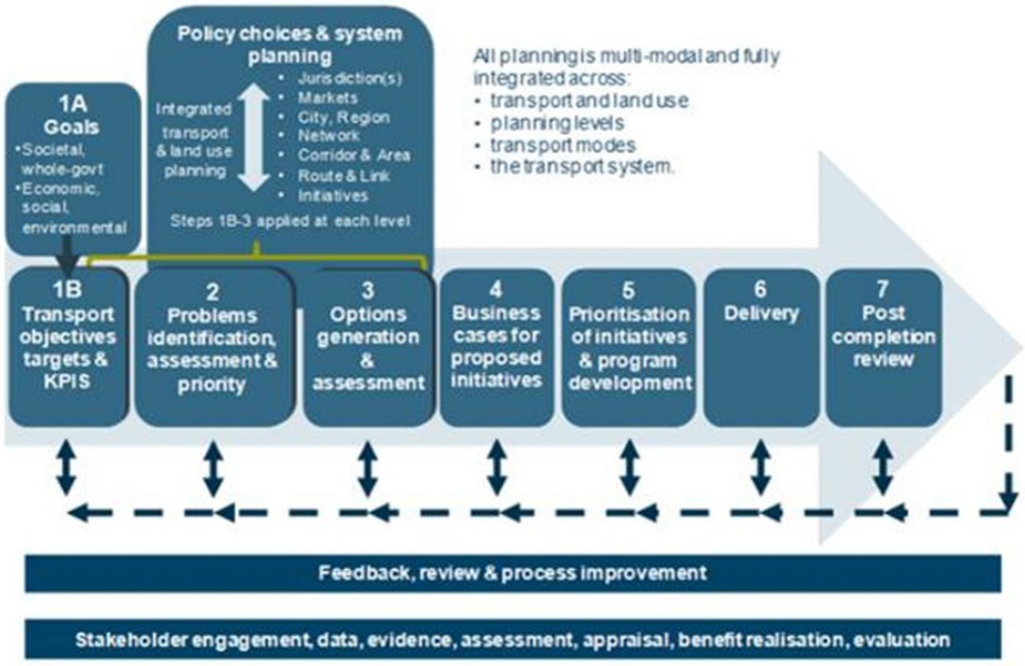


Figure 1 - ATAP Framework (Source: IA,2018)

Within the Guidelines, specific guidance is provided on tools and techniques relating to:

- *T1 Travel Demand Modelling*

- *T2 Cost Benefit Analysis* –
- *T3 Wider Economic Benefits*
- *T4 Productivity Metrics*
- *T5 Distributional (Equity) Effects* – not applicable
- *T6 Benefit Management* – not applicable.

4 APPROACH AND ASSUMPTIONS REVIEW

4.1 Base Case (do minimum)

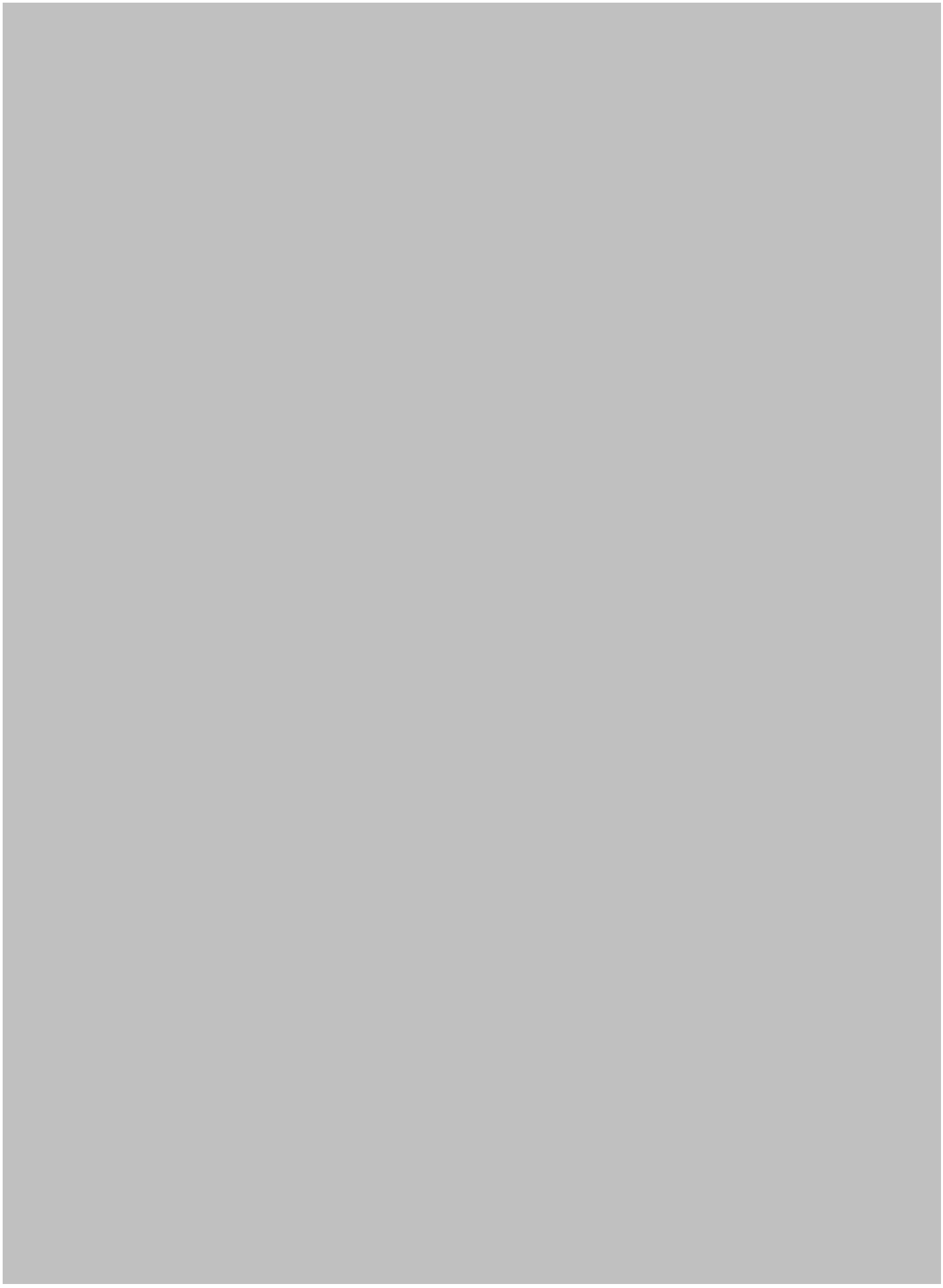
A robust base case describes the situation in the absence of the project being implemented or a 'business as usual' or 'do minimum' scenario, or in other words maintaining existing service levels without capital upgrades. The description, including implications for the expected (continued) level of service, should be clear about what will occur should the project not proceed, and the existing situation is continued.

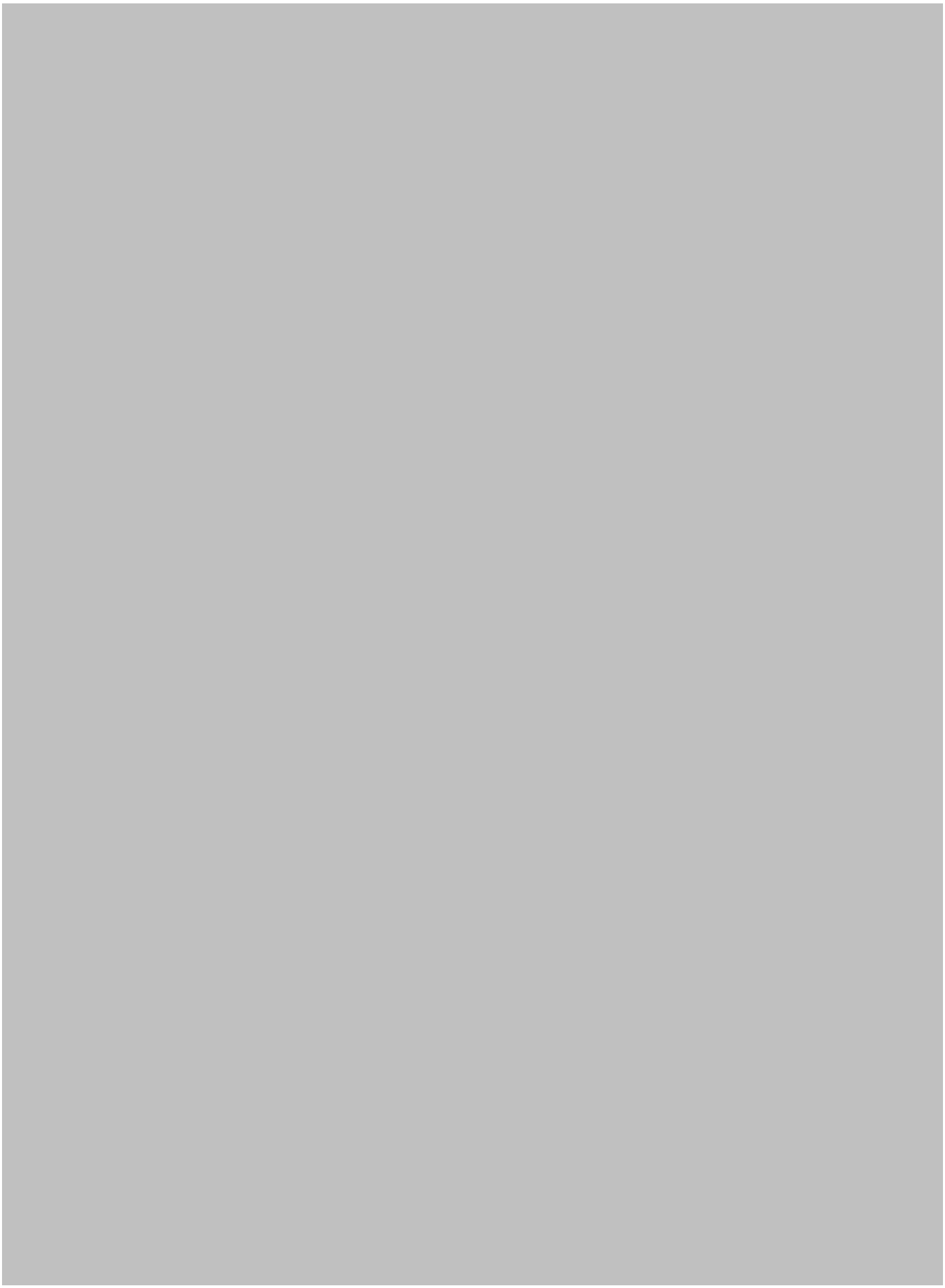
4.2 Project options (strategic interventions)

Two options were considered alongside the Base Case, with Project Case 1 proposing extension of the busway, expansion of the walking and cycling network and upgrading of the motorway from six to eight lanes and Project Case 2 only increasing the busway and introducing ramp metering and variable speed limits to manage traffic flow.

Options were evaluated against specific criteria with the objectives to:

- Upgrade motorway capacity to improve travel times, reliability and safety
- Optimise efficiency for freight
- Promote travel behaviour change and mode shifts to public and active transport
- Provide value for investment
- Optimise time frame for delivery.





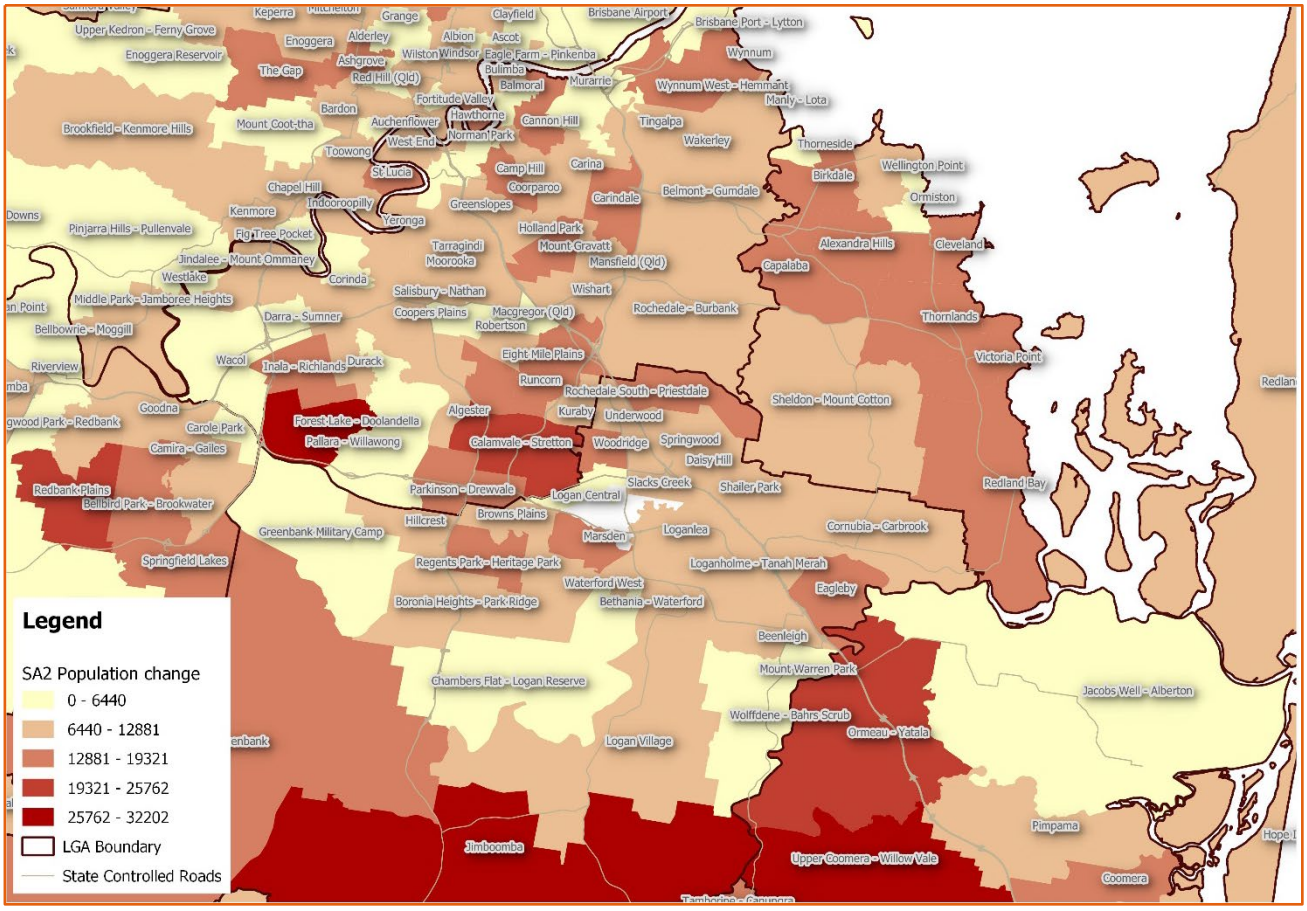
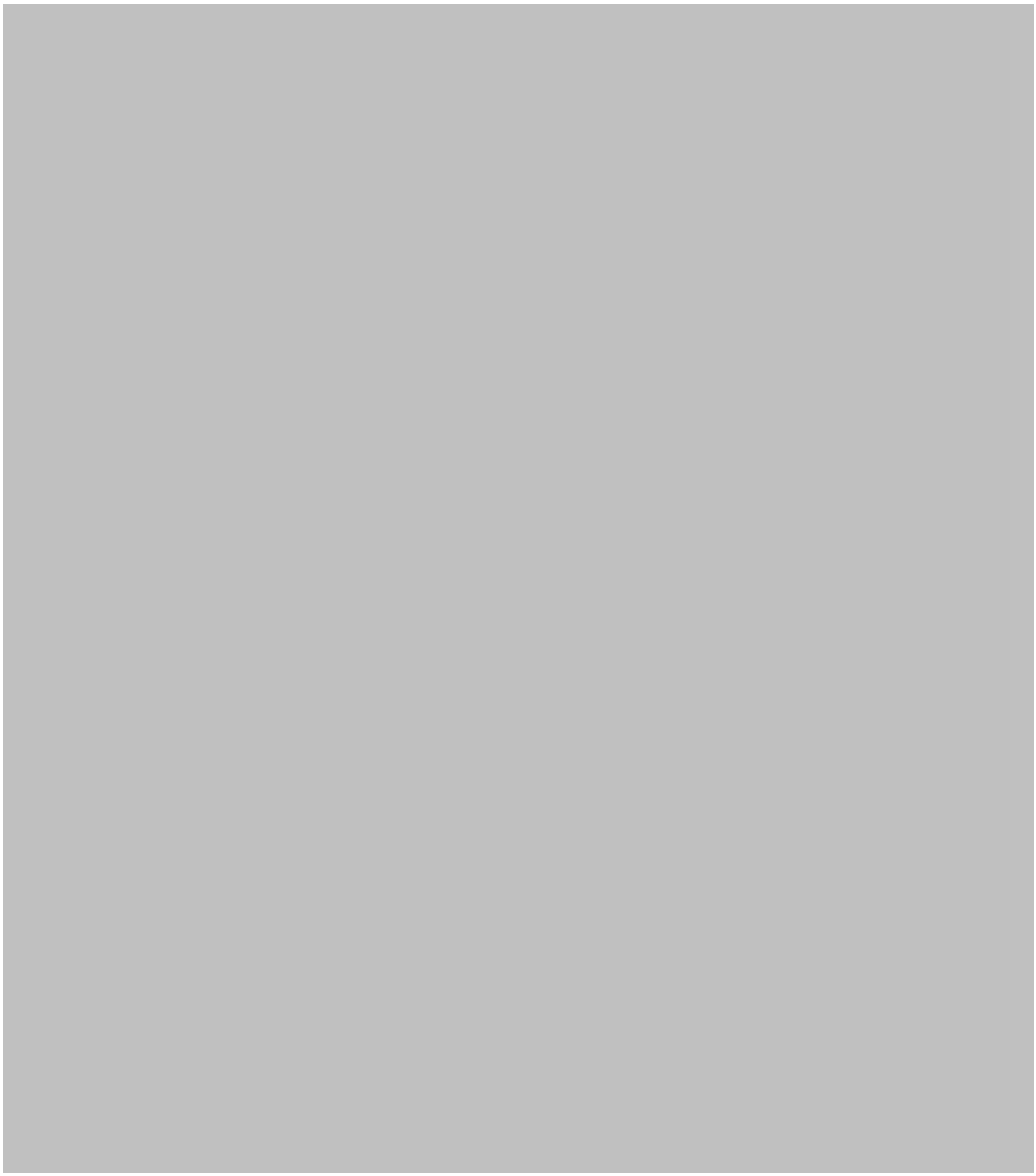
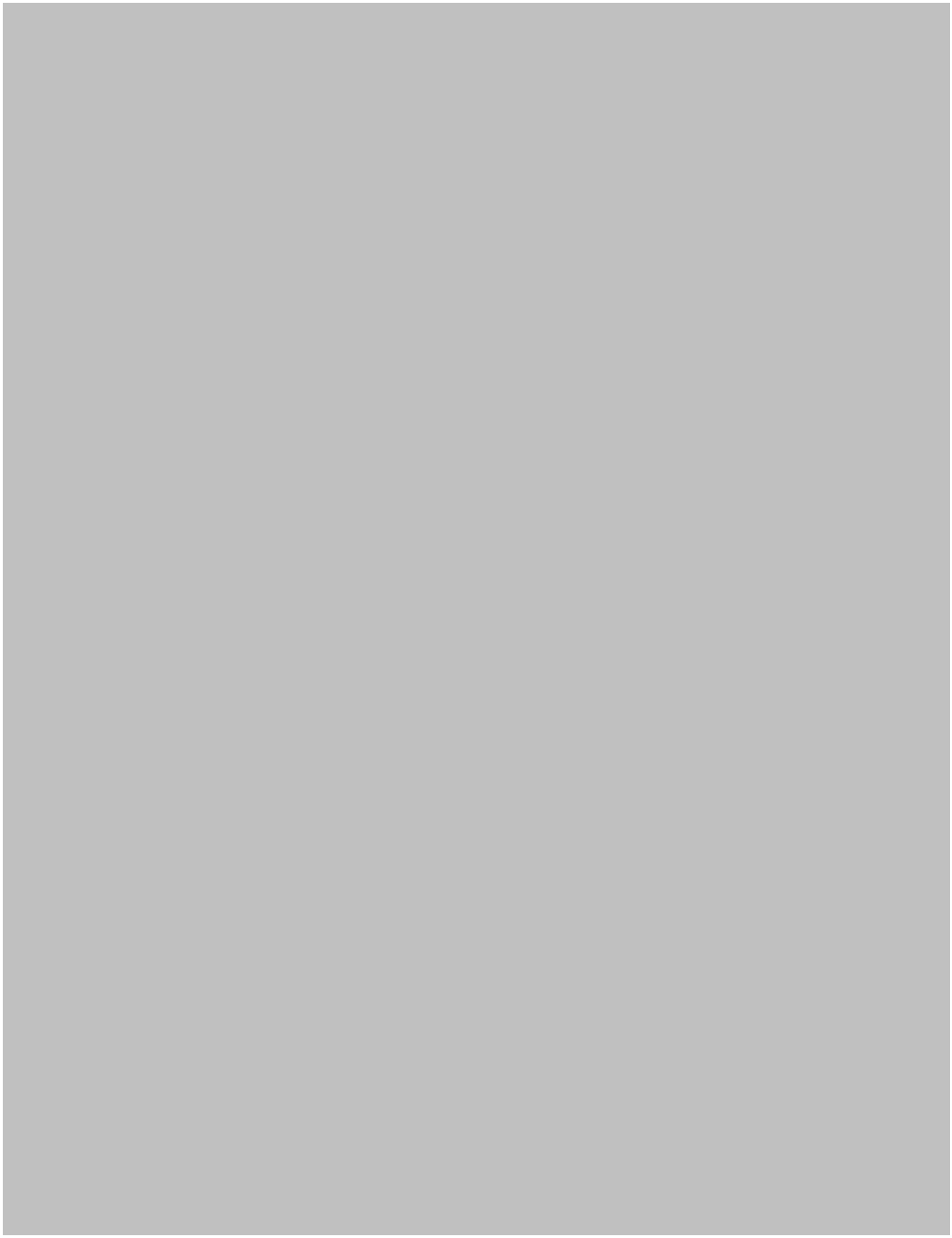


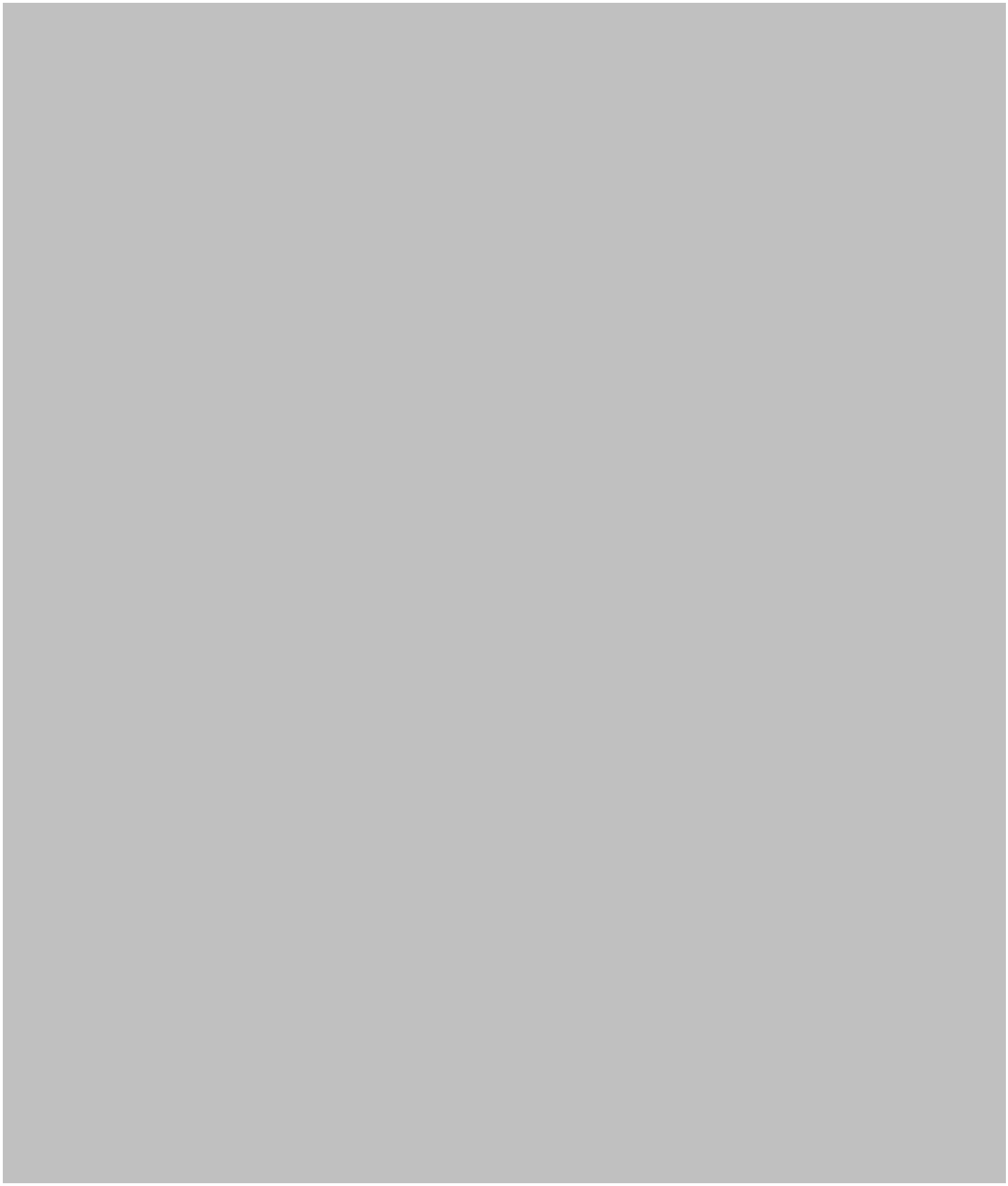
Figure 3 - Forecasted population growth 2016-2041 (Source: QGSO 2018)

4.4 Land use planning assumptions

Upon review of the Priority Development Areas (PDAs) outlined in the *Economic Development Act 2012*, there are no declared PDAs that directly impact the proposed M1 Pacific Motorway upgrade between Eight Mile Plains and Daisy Hill.







4.8 Environmental assumptions

Within the ATAP Guidelines (2016), parameter values are provided for biodiversity (losses due to air pollution from transport emissions), and nature and landscape (nature (including biodiversity) and landscape (such as loss of natural land area, reduction in the quality of landscape, and land pollution).

5 TRAFFIC MODELLING REVIEW

5.1 Transport modelling procedure

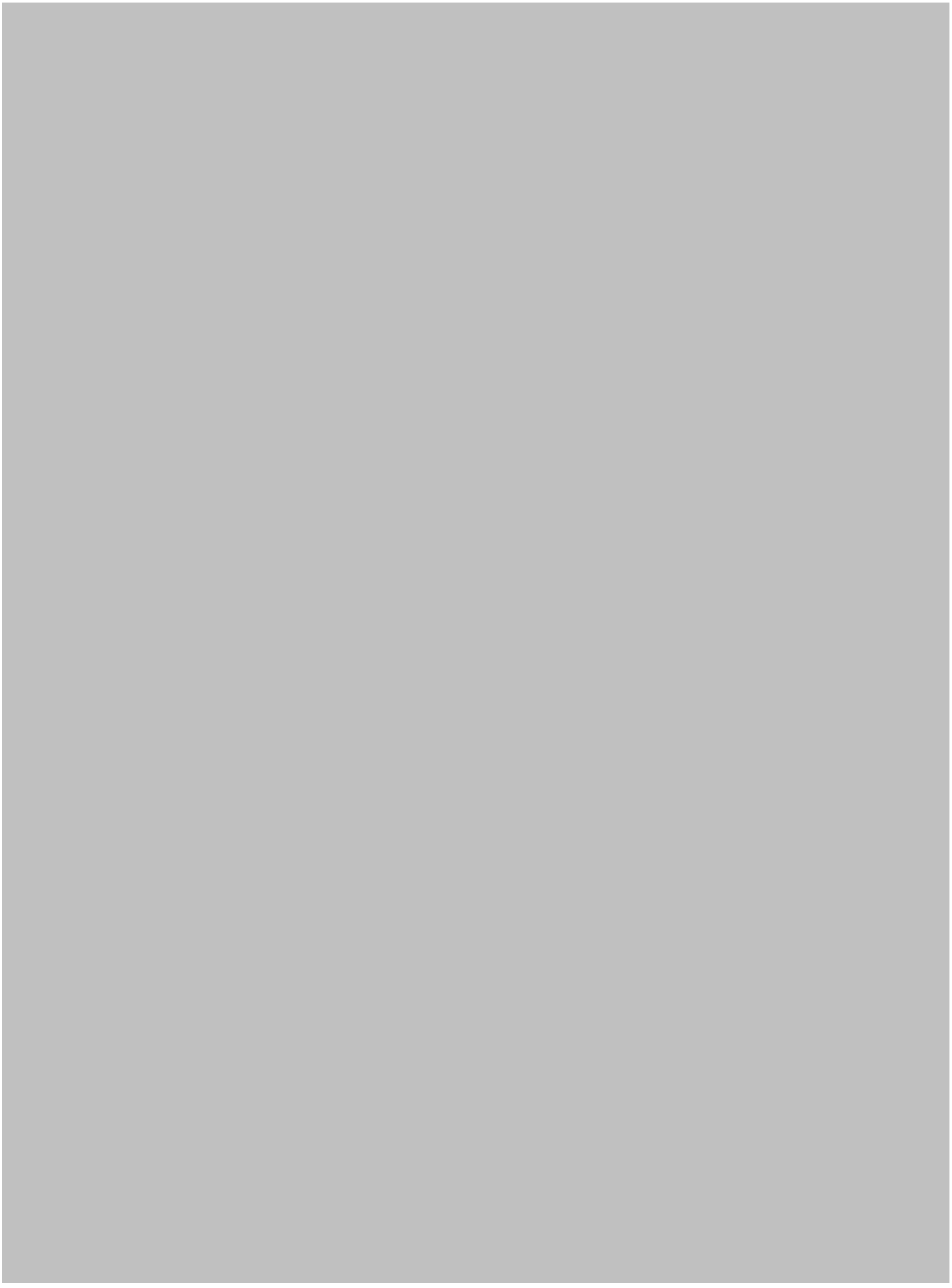
The transport modelling process is central to the estimation of benefits used in the economic assessment.

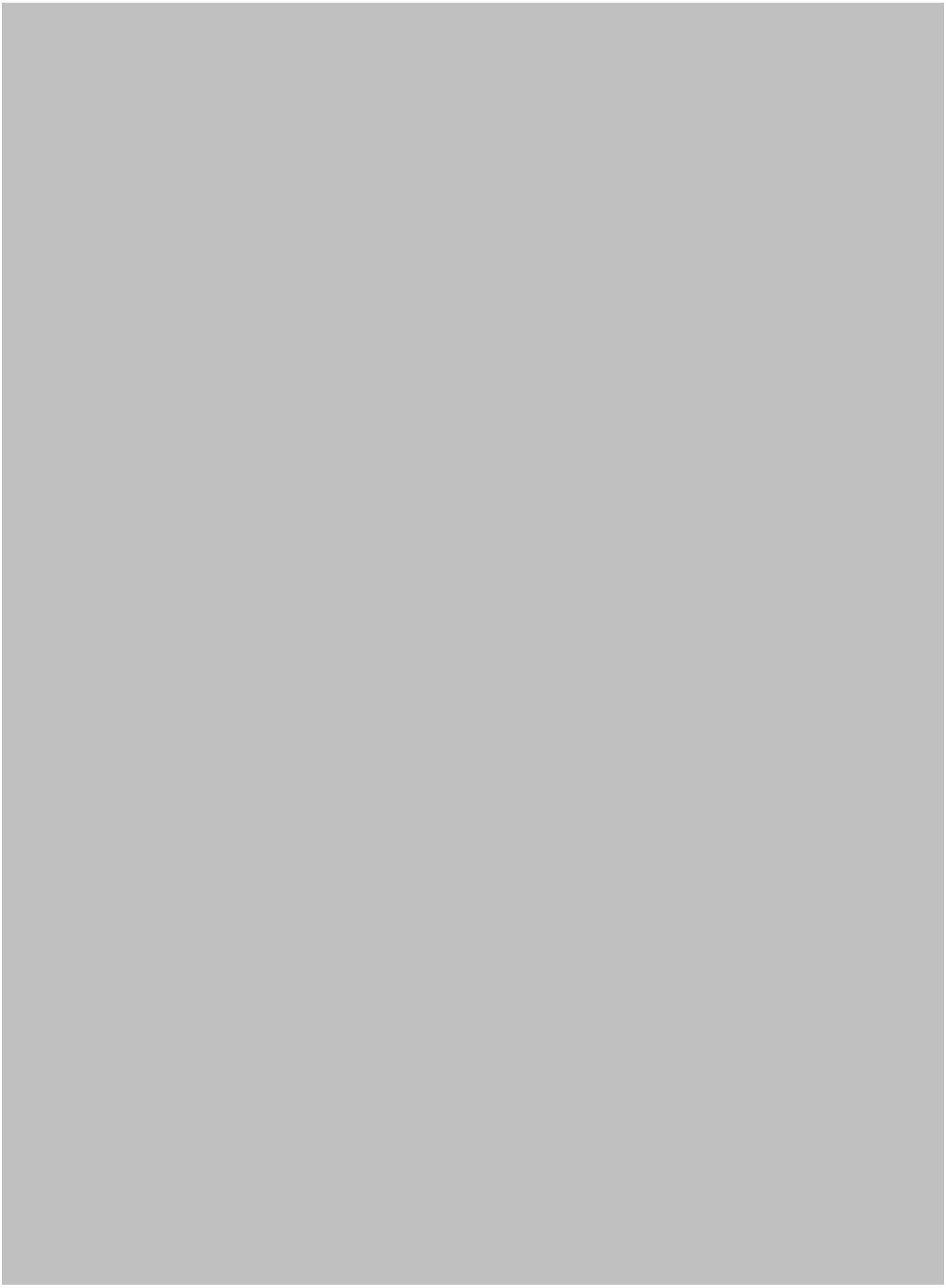
5.1.1 The strategic model

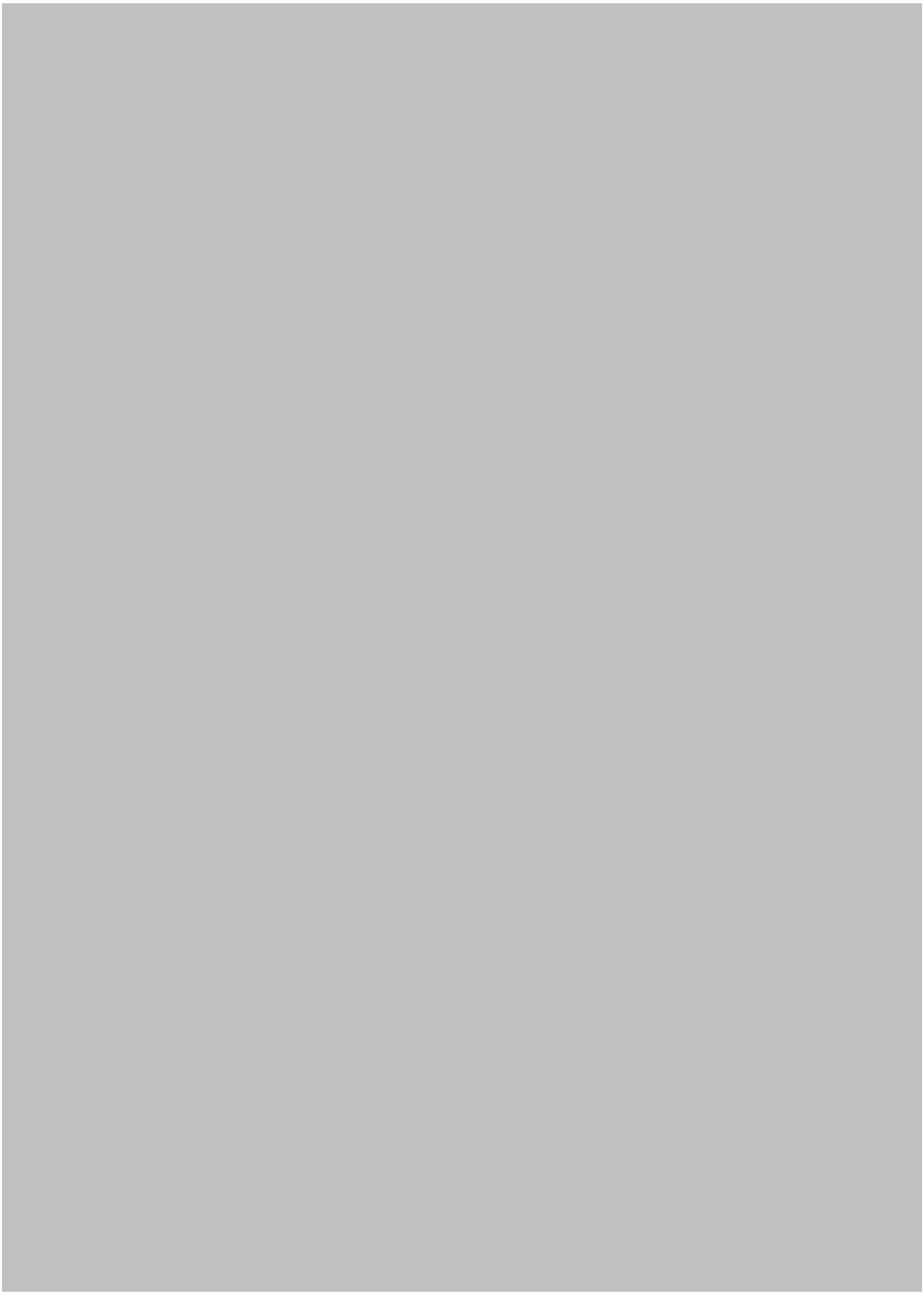
The main role of the strategic model is to forecast transport demand. Central to the forecasts are the costs of travel by car and public transport and these are developed in the strategic modelling process based on the paths that trips take through the transport networks. The costs themselves are used to develop origin-destination matrices and to split the trips into modes.

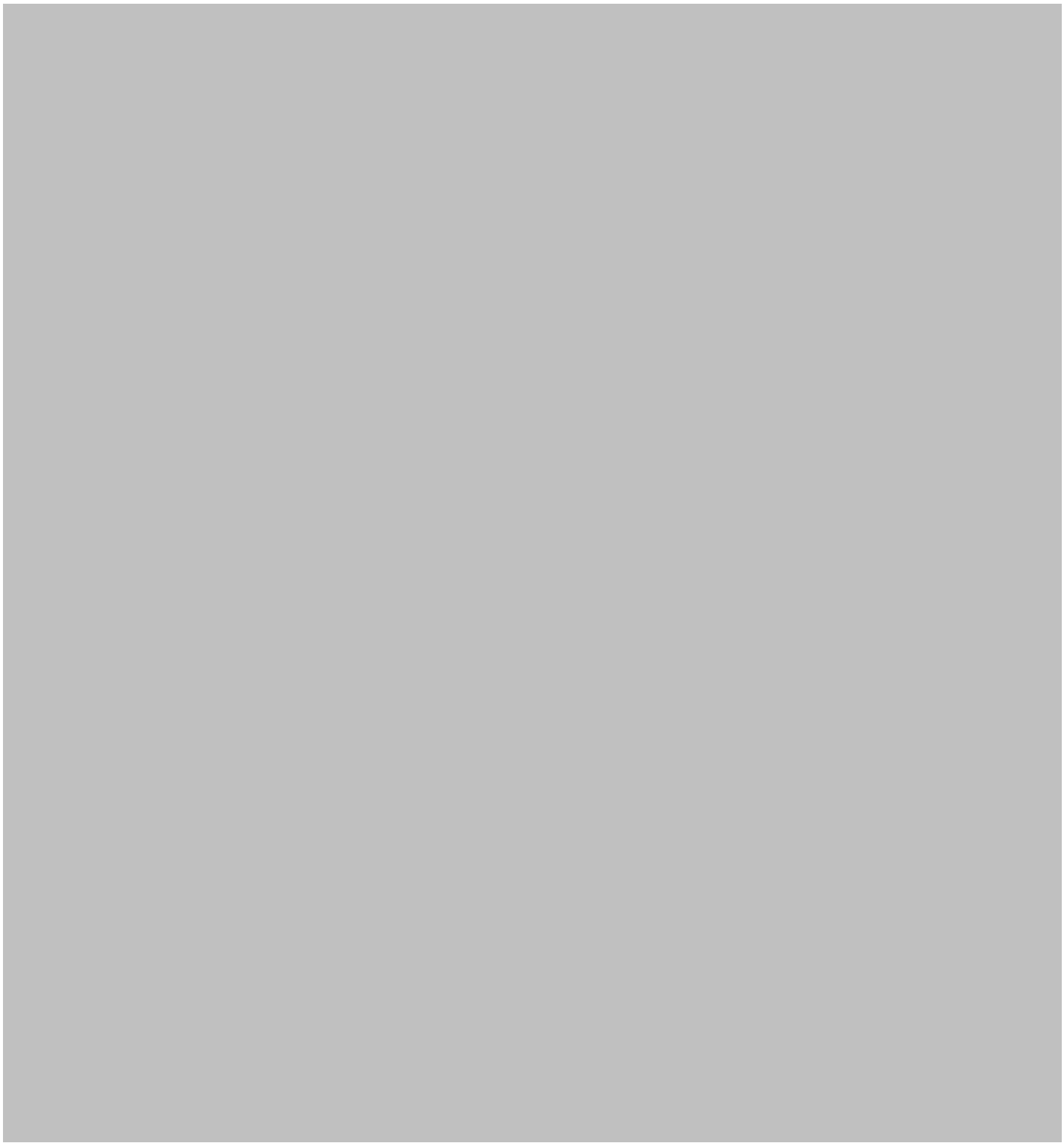
The important points to note about the strategic modelling are:

- The trips and costs are provided for three time periods:
  - Morning peak (7am to 9am)
  - Afternoon peak (4pm to 6pm)
  - Off peak (the remainder of the day)
- The public transport network's services are unconstrained. Effectively, this means that public transport has limitless capacity
- The highway network is constrained only by travel time or travel cost. That is, a road link may carry more than its capacity, but the cost of travel along the link will be high
- The mode choice is based on the difference between the cost of travel by public transport and the cost of travel by car.
- No intersection delay or queues are represented in the model. One consequence of this is that a strategic model overestimates right turn movements because it does not consider the delays caused by opposing through-traffic
- The highway trip matrix (including cars and commercial vehicles) is passed to the dynamic traffic model.









5.2 Trip distribution

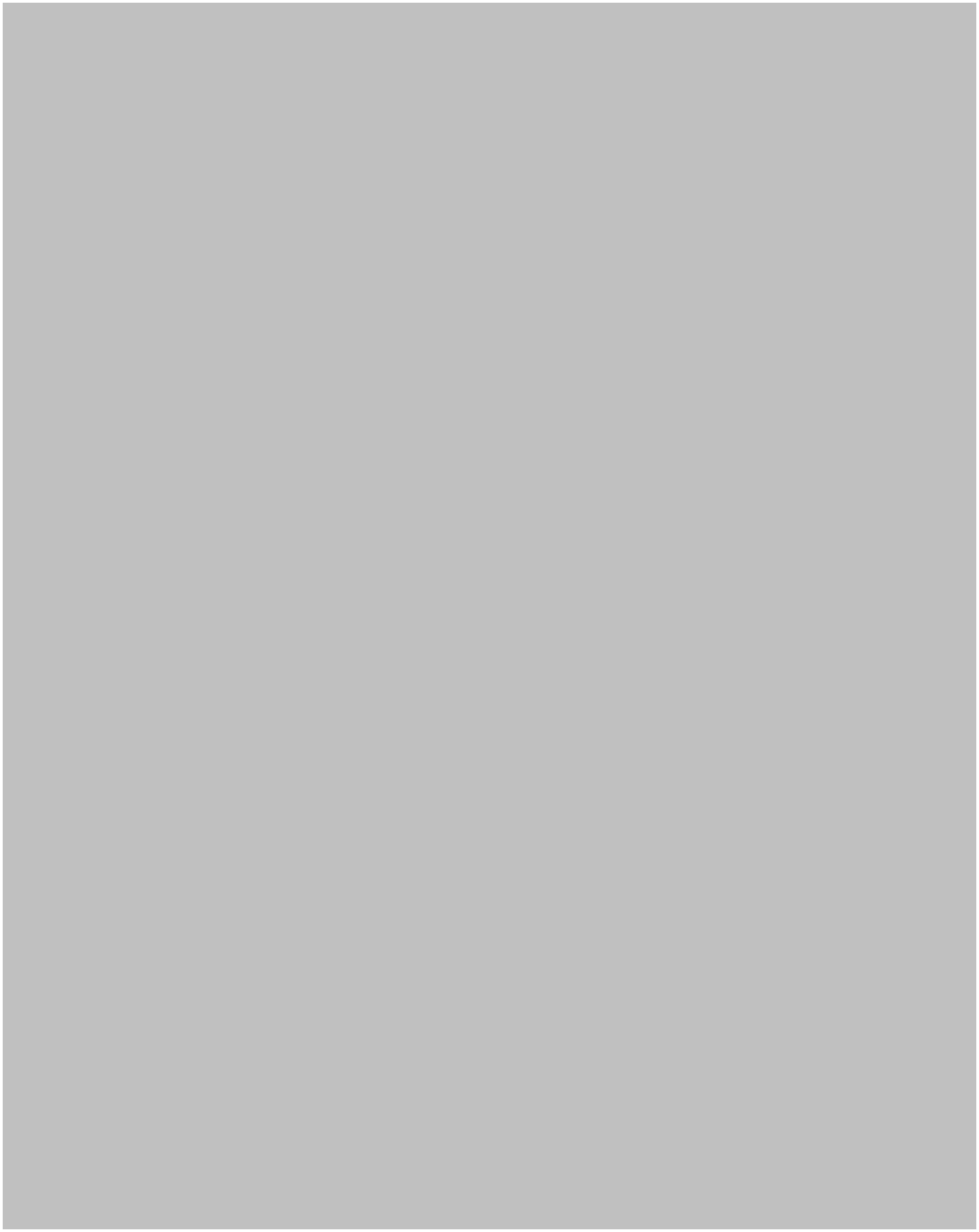
When distributing trips from origins, the general assumption is that more trips will travel to closer destinations than to those far from the origin. The measure of separation between origin and destination could be distance, time or generalised cost. In general, as time advances, demand for travel increases and so do the volumes on the roads. The resulting increased congestion increases the times or costs between origins and destinations.

5.3 Mode choice model

There are Zenith models for several regions around Australia and they are broadly similar in their processes and approach. However, the Technical Note[5] on Zenith mode shift published on VLC's website states that:

[5] *VLC, Zenith Model Framework Papers – Version 3.0.1 Paper G – Mode Choice Model - Draft Report*

In the Victorian and ACT models, the Mode Choice Model is more sophisticated and takes into account the generalised cost of full *return* journeys. Therefore, for a trip maker who travels to work in the morning peak, and returns home in the evening peak, the mode choice model will take into account the relative cost of each mode for the full return journey, reflecting the times at which the outward and return journeys are made. This is effectively a limited form of tour based modelling.



5.5.1 Average weekly earnings

Historic changes in average weekly earnings and CPI from Australian Bureau Statistics are shown graphically in Figure 9. The data suggest that, over the past 35 years, there have only been seven years where the increase in average weekly earnings has been lower than the change in CPI. Overall, average earnings have increased by between 1% and 2% per year above CPI.

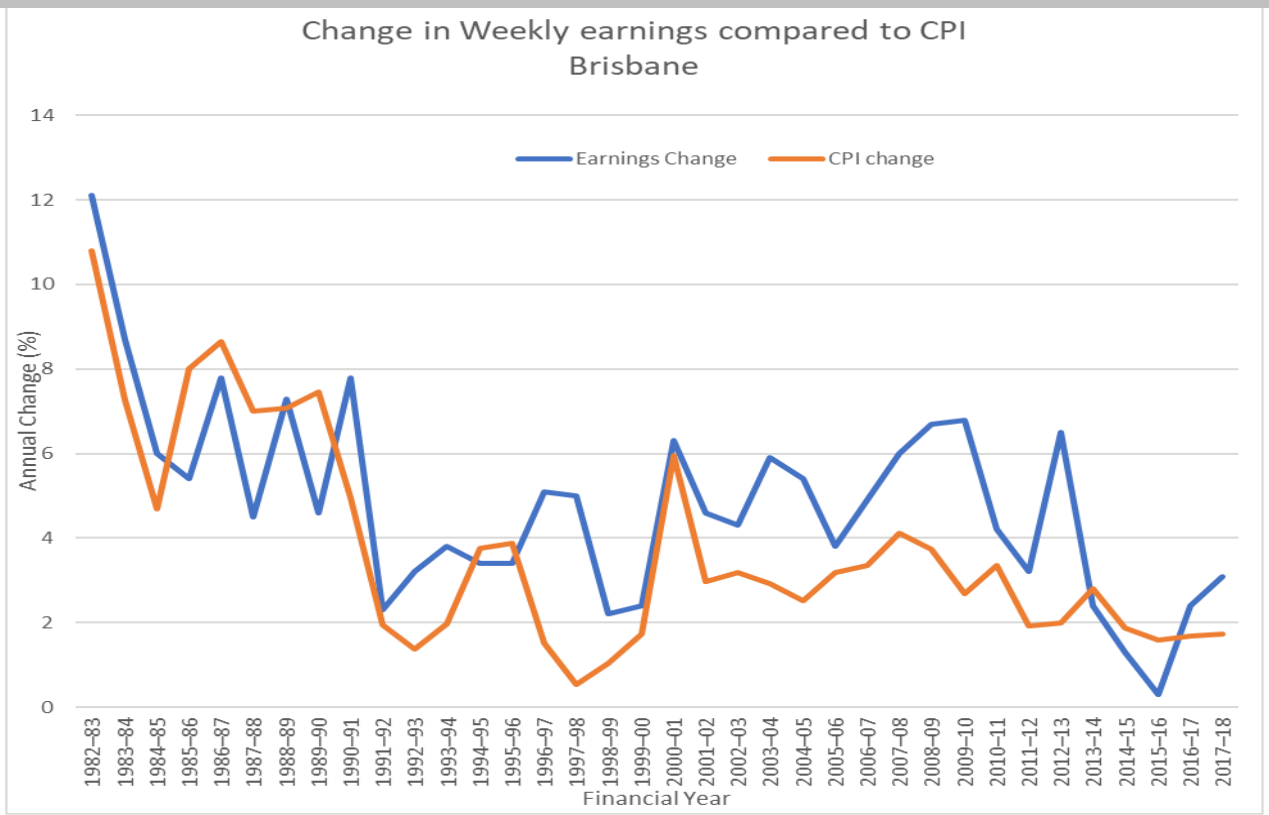


Figure 9 - The Change in Average Weekly Earnings compared to annual change in CPI for Brisbane

Source: Constructed from data from Australian Bureau of Statistics

5.5.2 Parking charges

RACQ published a report into a study of parking charges in Brisbane[6]. This report stated that:

Since 2001, average weekday casual car parking rates in Brisbane's CBD have more than quadrupled. RACQ believes that the increased revenue being pocketed by Brisbane parking operators is a function of constrained competition in the market as well as Brisbane City Council policies designed to limit CBD office parking.

This means that, over the 14-year period between 2011 and 2015, the parking prices increased at an average rate of 10%, considerably higher than CPI.

5.5.3 Fuel price

[6] RACQ, Brisbane Sydney and Melbourne Casual Off-street Parking Prices, 2015

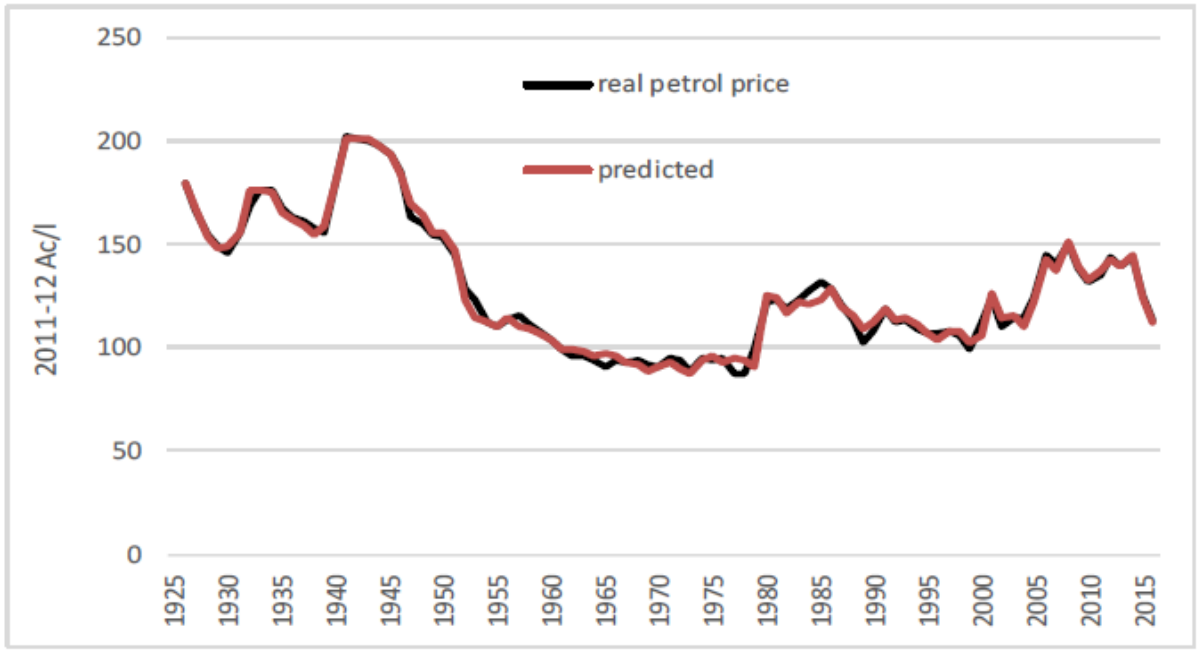


Figure 10 - Historical price of petrol from 1925 to 2015

5.6 Summary

6 ECONOMIC ASSESSMENT REVIEW

The economic assessment for the M1 Pacific Motorway Business Case (Eight Mile Plains to Daisy Hill) is documented in the following sections of the DBC:

- Sections 5.5 – Economic Comparison
- Chapter 12 – Economic Assessment
- Appendix F – Economic Assessment Approach
- Appendix G.2 – Economic Peer Review Summary Report.

This objective of this independent review is to assess the appropriateness of the analysis and assumptions underpinning the economic benefits and costs stated in the DBC.

The review focuses on assessing:

- The accuracy of the broader macro-economic assumptions underpinning the cost benefit analysis (CBA)
- Adequacy and accuracy of economic factors including the treatment of travel time, vehicle operating costs, crash costs and externalities
- Consistency, reasonableness and scale of the benefits claimed for each of the projects (e.g. possible double-counting of benefits, which is a potential risk when two related business cases are produced)
- Reasonableness of traffic congestion assumptions. Given that the transport modelling is central to the economic analysis, many of the findings from the transport modelling review in chapter 5 influence the economic assessment
- Other economic considerations.

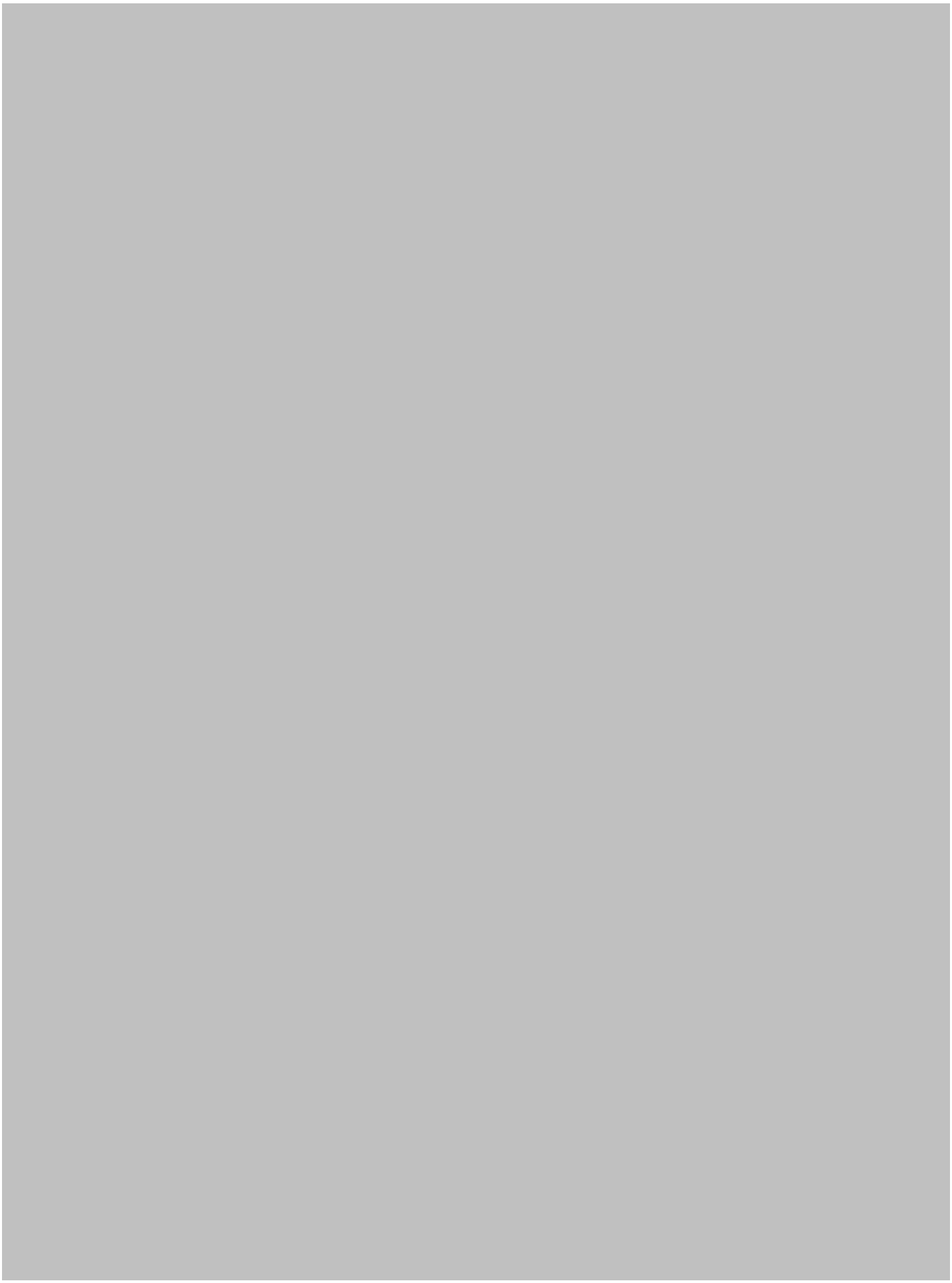
Two project options were assessed in the CBA, in addition to the Base Case as described in Table 15.

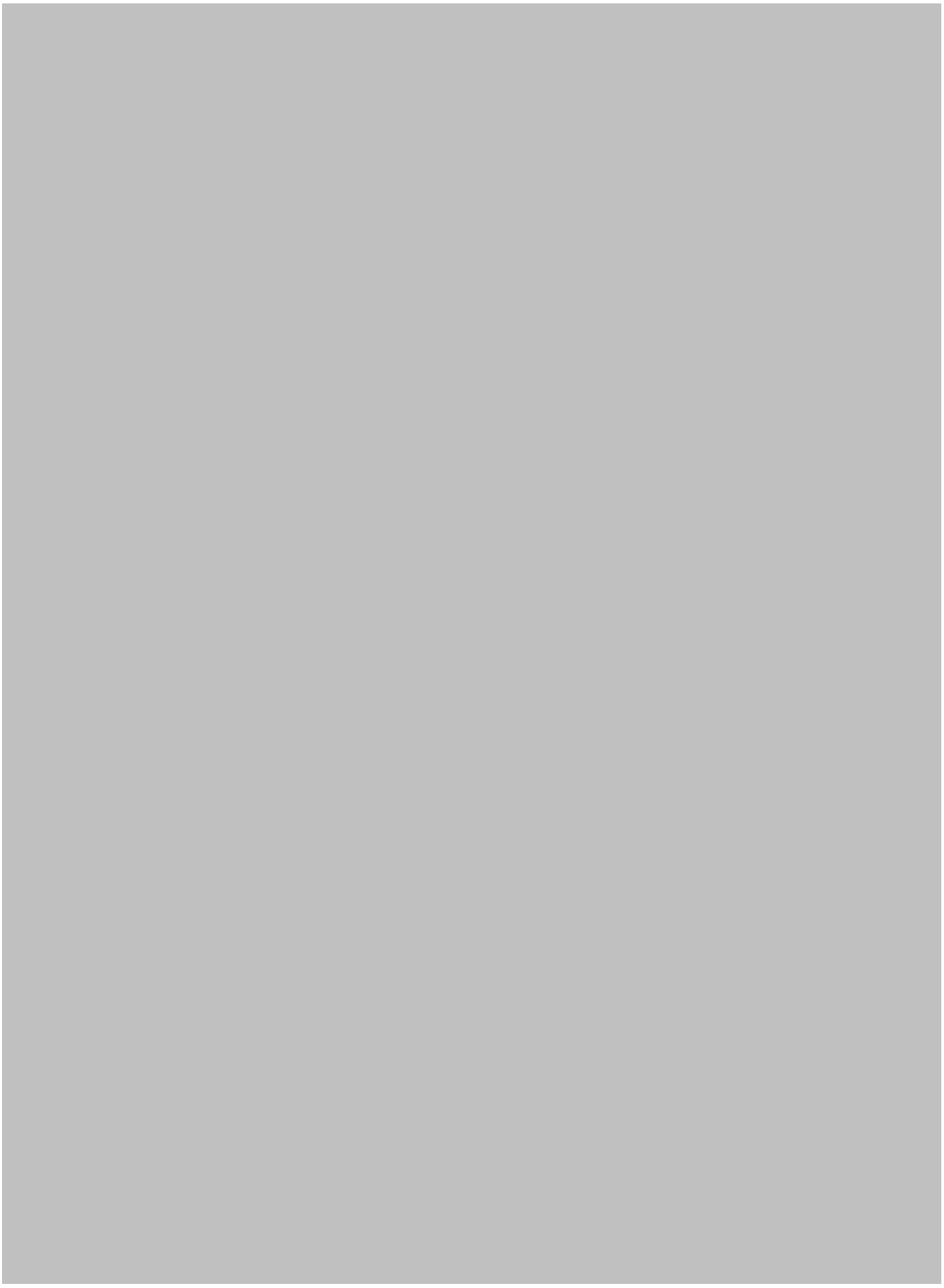
Table 15 - Project options

Options	Description
Base Case	• Committed government transport projects [redacted]
Project Case 1	• Committed government transport projects [redacted] • Upgrading motorway to increase capacity, upgrade substandard design sections, reduction in the number of ramps. The upgrades are primarily in the northbound direction. [redacted] • Bus priority – separated busway extending from Eight Mile Plains through to Springwood and a new Rochedale Park n' Ride • Extension of the V1 Veloway (dedicated cycling facility) between the Gateway Motorway and Paradise Road.
Project Case 2	• Base Case plus bus priority – separated busway extending from Eight Mile Plains through to Springwood Bus Station and a new Rochedale Park n' Ride. [redacted]

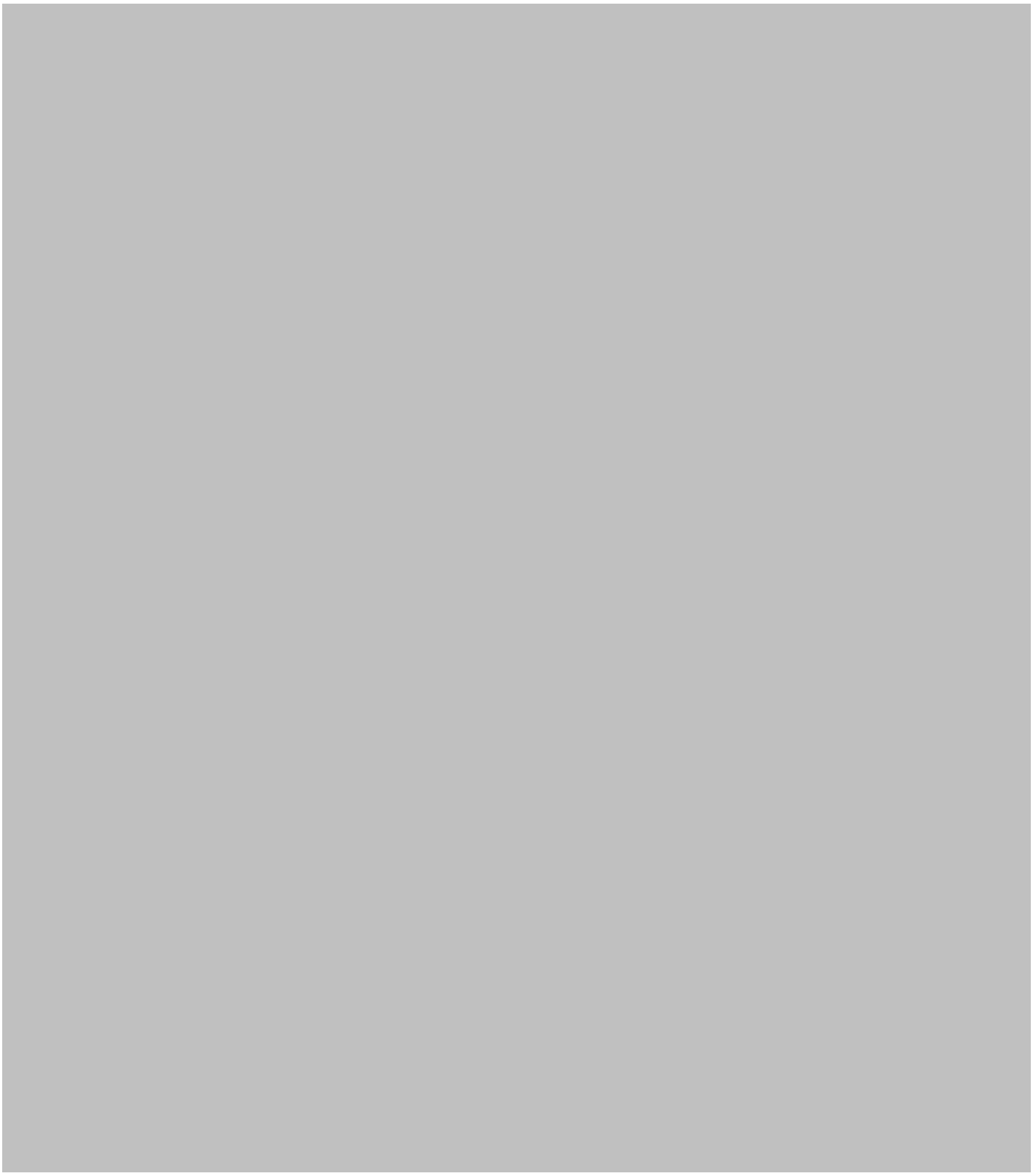
6.1 Economic assumptions overview

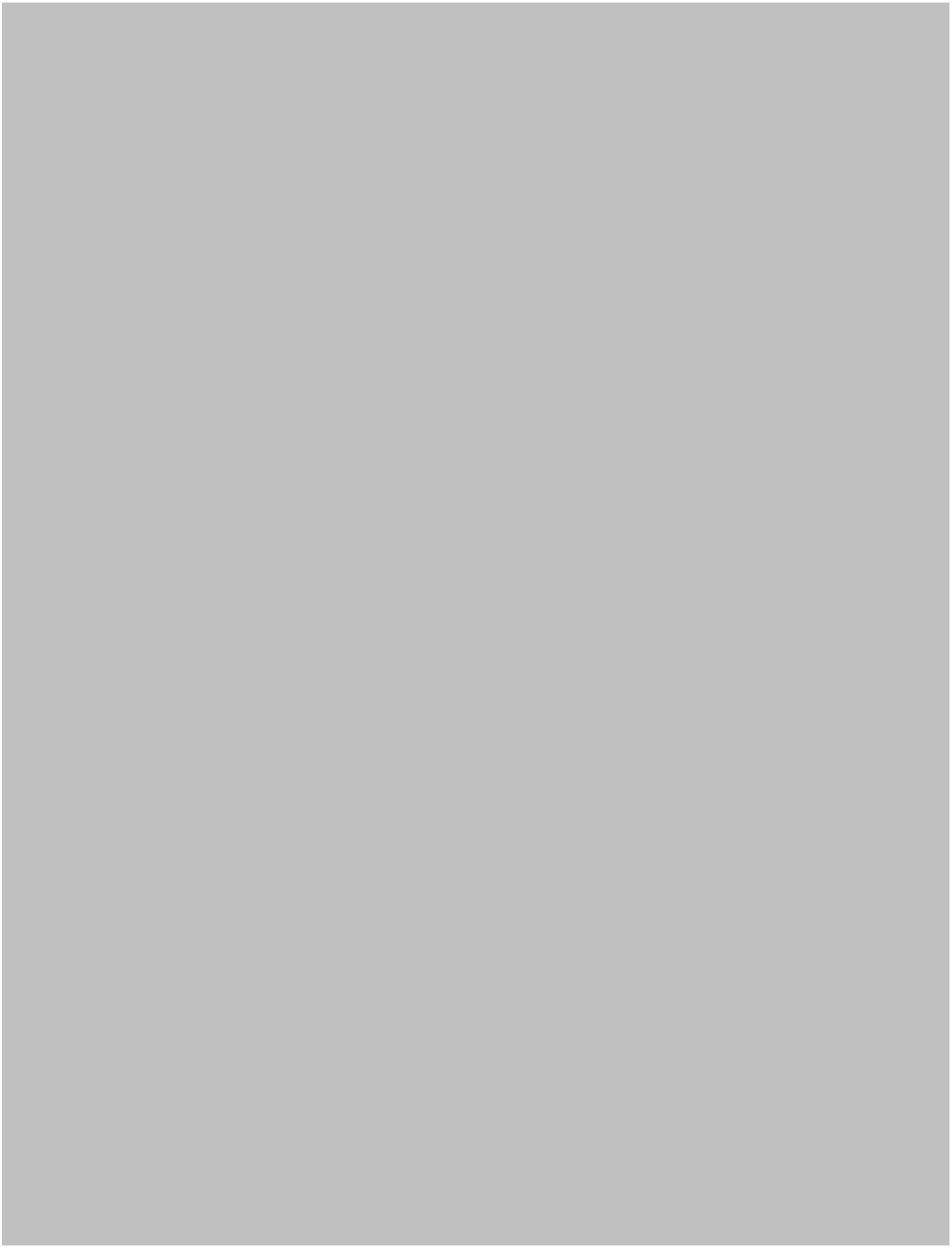
CBA is a standard and acceptable technique that is widely employed across Australia and other parts of the world to assess the merit of infrastructure investment proposals.





6.2 Quantitative analysis review

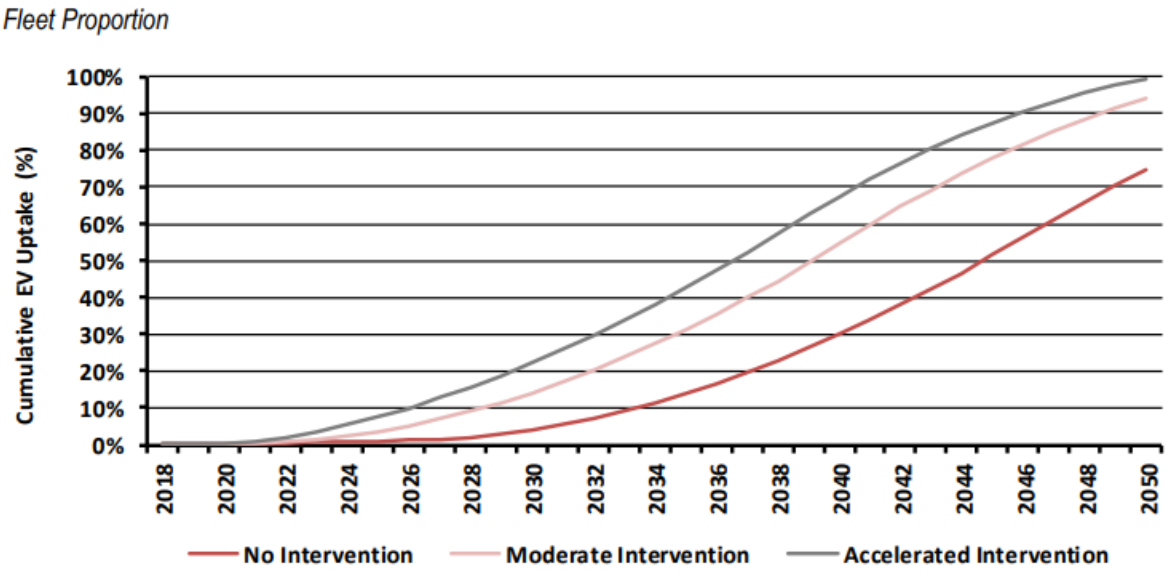




Forecasts in a study commissioned by the Australian Government suggest that electric vehicles will account for a substantial portion of the total fleet mix over the next 30 years (Figure 13). By 2050, it is predicted that more than 75% of the fleet mix will be comprised of electric vehicles (ARENA and CEFC, 2018).

With the expected increase in electric vehicle uptake as an alternative to fossil fuel-based vehicles in the coming decades and the advancement of fuel efficiency in fossil-fuel based vehicles, VOC and fuel costs to users may significantly decrease. Queensland Government (2018) states that when compared with fossil fuel vehicles, electric vehicles can save users 60 to 90% off what they would pay for a tank of fuel. The typical fuel costs are reduced from $1.50 per litre to $0.50 equivalent-litre when converting from a traditional combustion engine vehicle to an electric vehicle. Additionally, maintenance savings are produced where electric vehicles have fewer moving parts and require less consumables (for example, oil and spark plugs) resulting in lower maintenance costs.

Furthermore, reduced demand for fossil fuels may cause oil prices to fall or rise at a slower rate than expected. As noted by Queensland Government (2018), Australia is highly reliant on imported oil for the majority of its transport needs. By comparison Queensland is completely self-reliant in terms of electricity production. By using electricity instead of oil products, electric vehicles will help reduce the Queensland economy's dependency on oil, while supporting the use of renewable and locally-produced energy.



Source: Energeia Modelling

Figure 13 - EV uptake forecast (Energeia Modelling as cited by Australian Renewable Energy Agency and the Clean Energy Finance Corporation, 2018)

Autonomous vehicles and disruptive technologies

Autonomous vehicle technology has the potential to significantly increase road capacities and speeds, as well as travel behaviour. In a recent report, *The Future of Car Ownership*, the NRMA suggests that in Australia over the next two decades, autonomous vehicles are likely to appear on Australian roads within eight years as the world's automotive manufacturers fast-track the new technology. It recommends that Australian transport planners need to develop mobility policies for the future, which should include next generation smart infrastructure to service autonomous vehicles, and that all levels of Government should facilitate autonomous vehicle trials and commence these trials as soon as possible (NRMA 2017). Trials are currently taking place through such initiatives as the Australia and New Zealand Driverless Vehicle Initiative (ADVI). ADVI has co-ordinated an on-road driverless car demonstration in Adelaide, South Australia in late 2015 – the first trial in the Southern Hemisphere (ADVI 2019).

Similarly, disruptive technologies refer to any enhanced or completely new technology that replaces and disrupts an existing technology, rendering it obsolete. It is designed to succeed similar technology that is already in use. Examples include the use of drones, ride-hailing applications such as Uber which are already changing the current state of play in the transport industry.

6.2.7 User benefits from increases in government revenue

This economic assessment captures user benefits reflected in changes to government revenue. The government revenue impacts assessed include fuel tax collected, GST collected on fuel sales and public transport fare revenue collected. For example, if fuel consumption decreases, users would experience a benefit in the form of reduced tax payments, but the government would experience a disbenefit in the form of reduced fuel tax revenue (i.e. transfer).

6.2.8 Externalities

Significant work has been undertaken in Queensland to increase the usage of electric vehicles. The Queensland Government's Electric Vehicle Strategy aims to prepare Queensland for the uptake of electric vehicles by assessing the initiatives to increase electric vehicle awareness and experience; electric infrastructure, and assistance with electric vehicle costs. A key example is the Queensland Electric Super Highway, which has been built to assist in increasing the number of fast-charging stations available for electric vehicles to promote the uptake of these vehicles by users. This is the world's longest electric super highway in a single state, allowing travel from Coolangatta to Cairns and from Brisbane to Toowoomba in a low or zero emissions vehicle.

The uptake of electric vehicles in the future will also have an impact on these externality impacts in the future. Approximately 14% of Queensland total greenhouse gas emissions come from transport, making it the second highest emitting sector in the state (Queensland Government 2018). In Australia the uptake of electric vehicles in tandem with a decarbonisation of the electricity grid or sourcing electricity from low carbon sources, could provide emission reductions of 9 MtCO2e by 2030 and 27 MTCO2e by 2050 (ClimateWorks Australia 2015). The average electric vehicle produces around 30% less greenhouse gas emissions compared to a conventional fossil fuel vehicle when using Queensland's current electricity grid mix, and as such will contribute towards the Queensland Government renewable energy target.

As brown coal is a major energy source in the production of electricity for electric vehicles the life cycle of electricity generation and tailpipe emissions needs to be considered. Queensland Government (2018) states that electric vehicles emit less CO2 emissions when considering the lifecycle of tailpipe and electricity generation. This is shown in Figure 14 which compares the lifecycle emissions for tailpipe and life cycle emissions.

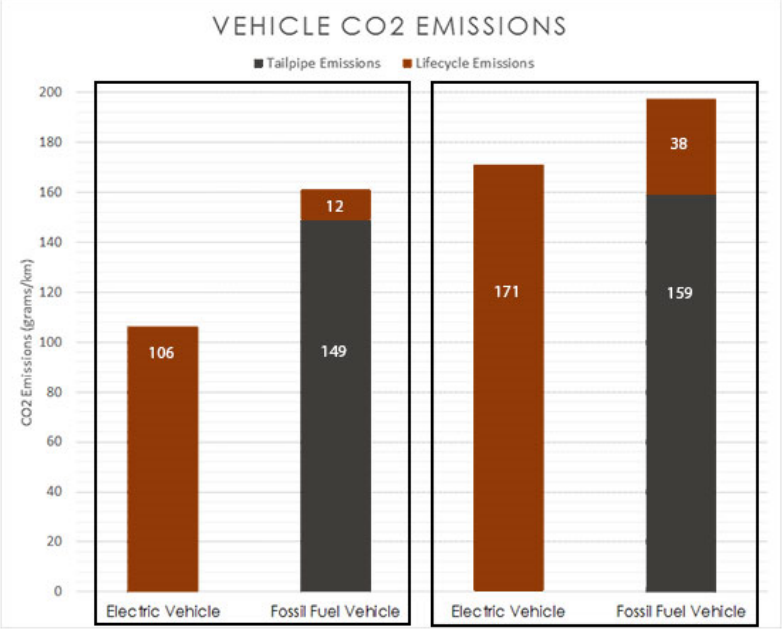


Figure 14 - Comparison of Vehicle CO2 Emissions for Electric Vehicles (Queensland Government, 2018)

Other benefits also exist to improvements to urban amenity, where electric vehicles produce significantly less noise compared to fossil fuel vehicles – particularly at lower speeds. This means traffic noise will be reduced by electric vehicles, which will improve urban amenity.

Externality impacts are also affected by other impacts such as transport mode shift and telecommuting. The Cosgrove et al. (2012) notes that the expansion of information technology and the increased ability to work effectively and efficiently from non-work locations, has led to an increase in telecommuting which affects externalities and travel demand.

Additionally, mode shift options from car-walking, car-cycling, car-public transport modes, vehicle downsizing, or carpooling has similar impacts in reducing greenhouse benefits

6.2.9 Safety benefits

ATAP (2016) indicates that safety benefits could be calculated using the human capital approach, the willingness to pay (WTP) approach or a hybrid approach.

The human capital approach generally has lower values than the WTP approach as the human capital approach tends to "underestimate the actual cost of injuries due to under-reporting by police, forensics medicine organizations, and insurance companies, and omission of cost components such as lost output, decreased quality of life, and the costs of caring for injured victims and their elderly relatives and children" (Ainy et al., 2014).

Table 22 - Estimation of crash costs by injury severity, WTP values, June $2013 (ATAP, 2016)

Table 19 Estimation of crash costs by injury severity, WTP values, June $2013

State	Rural			Urban		
	Fatal crash ($)	Serious injury crash ($)	Other injury crash ($)	Fatal crash ($)	Serious injury crash ($)	Other injury crash ($)
New South Wales	7,848,085	216,675		6,476,155	136,505	
Victoria	8,319,000	289,604	31,747	8,217,515	407,930	24,226
Queensland	8,059,080	294,906	31,268	7,741,326	436,471	23,446
South Australia	8,725,853	297,940	31,580	7,625,611	424,018	23,169
Western Australia	8,537,385	294,498	35,079	7,796,363	423,650	26,544
Tasmania	8,087,424	267,428	34,368	7,525,710	386,849	25,831
Northern Territory	8,043,372	302,628	29,353	8,439,525	449,694	23,035
Australian Capital Territory				8,982,223	389,365	

Source: ARRB Group Ltd.

6.2.10 Wider economic benefits (WEBs)

There are three categories of WEBs that may be relevant for transport initiatives in Australia. They are:

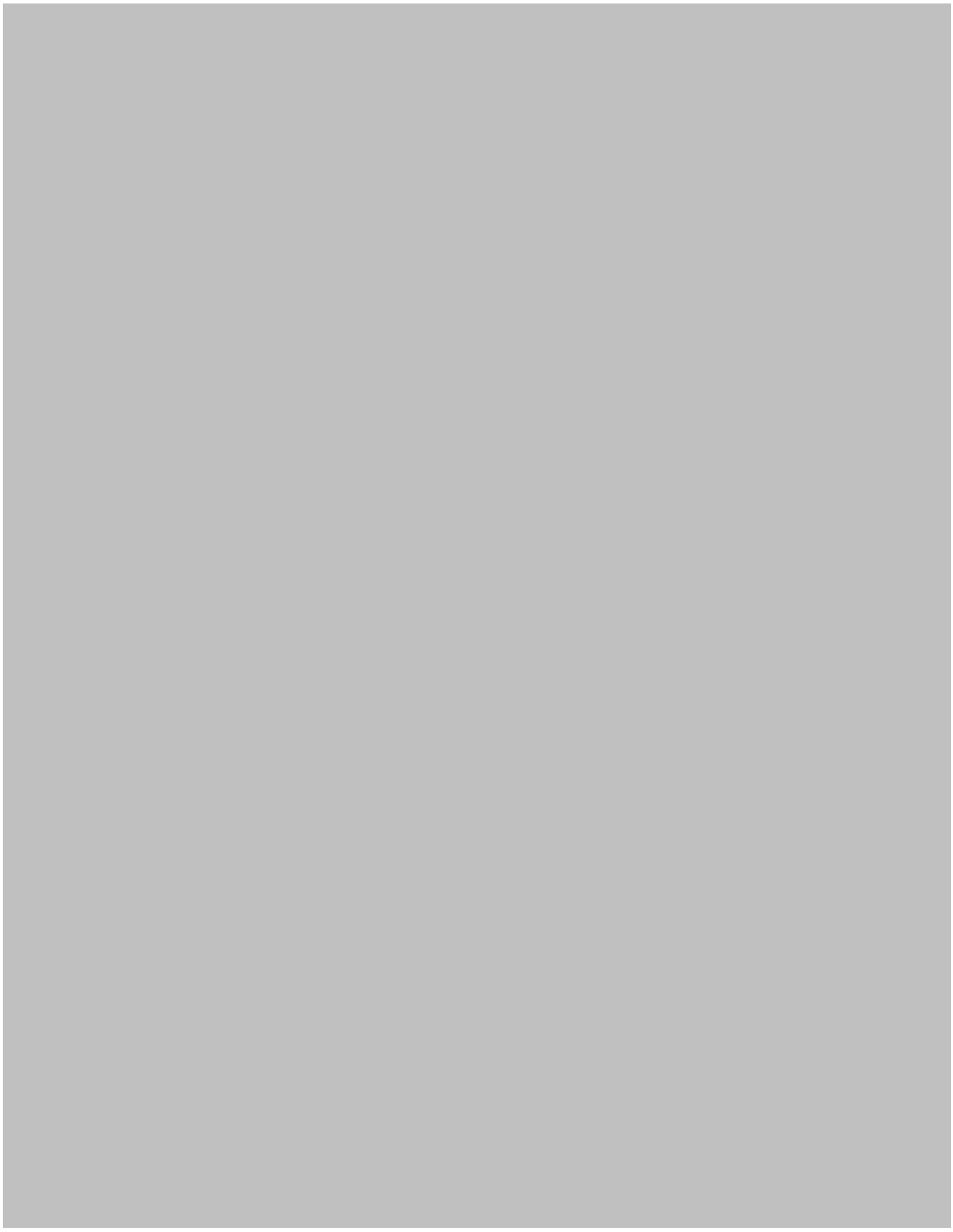
- WEB1 – agglomeration economies
- WEB2 – output change in imperfectly competitive markets
- WEB3 – tax revenues from labour markets.

In Australia, as WEB measurement techniques are still in its infancy and are currently being developed by the Australian Government. Therefore, IA's advice is to present the CBA results without WEBs, and then with WEBs like a sensitivity test.

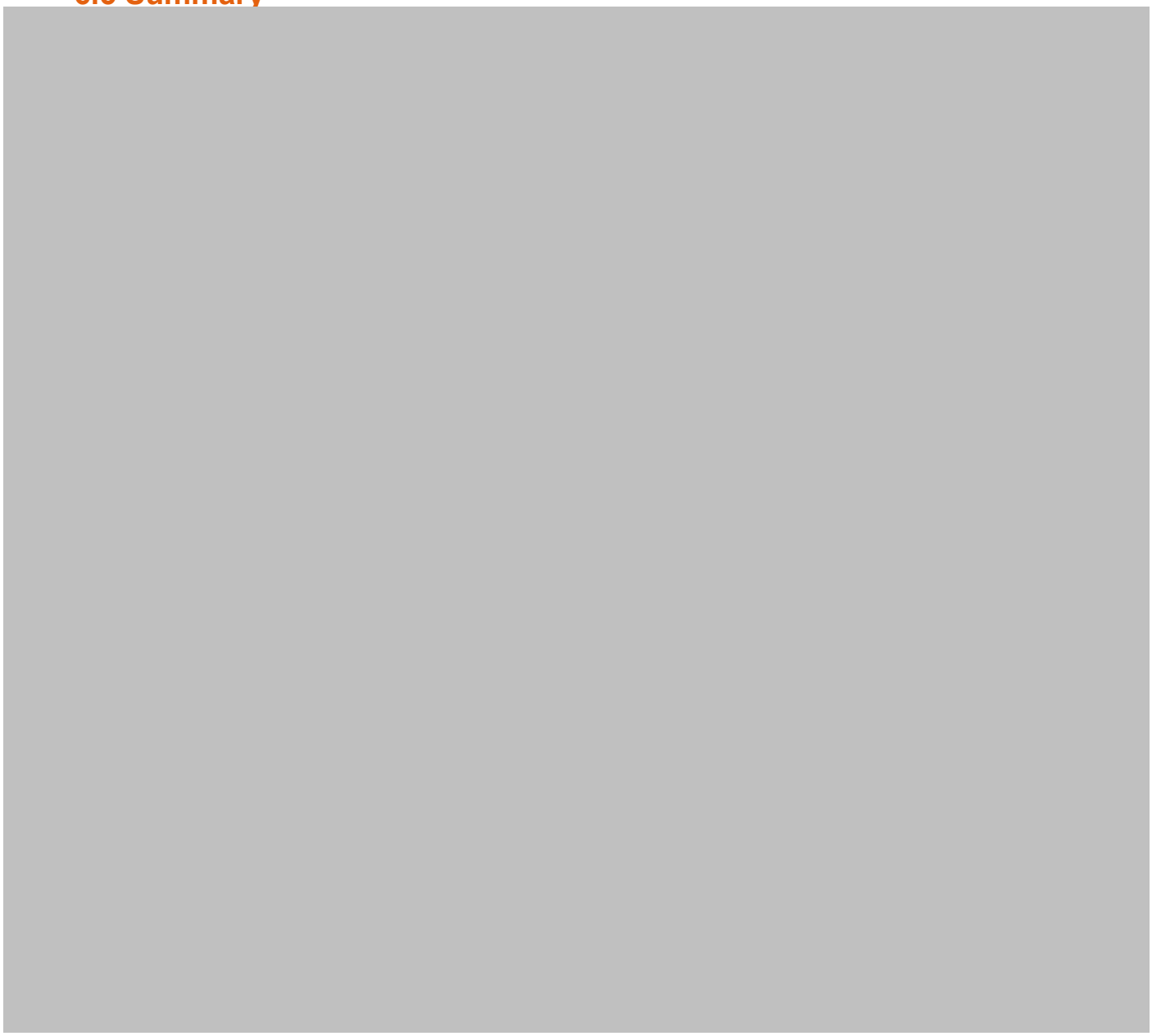
6.2.11 Active transport benefits

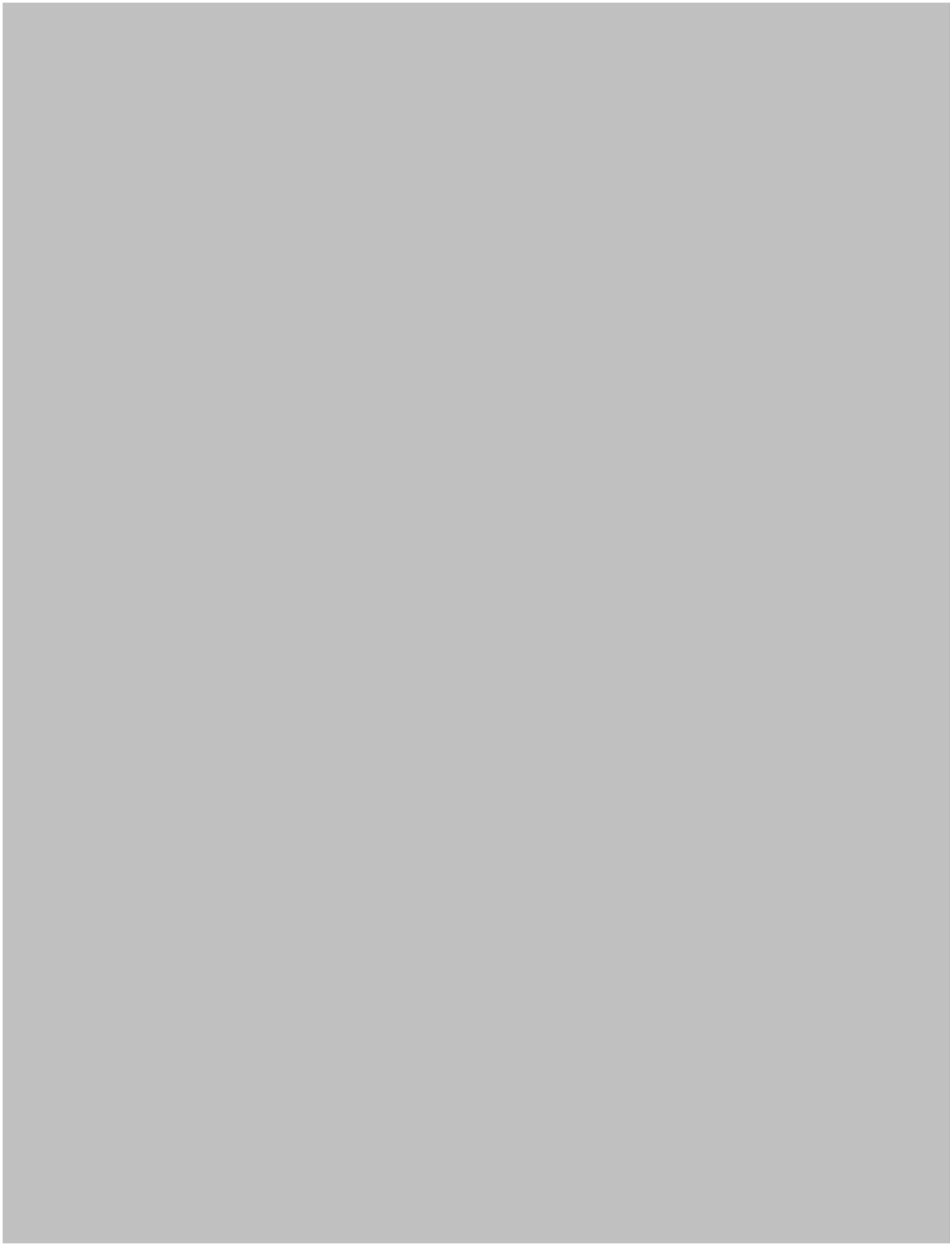
ATAP provides guidelines on assessing the economics of active travel benefits (ATAP – M4).

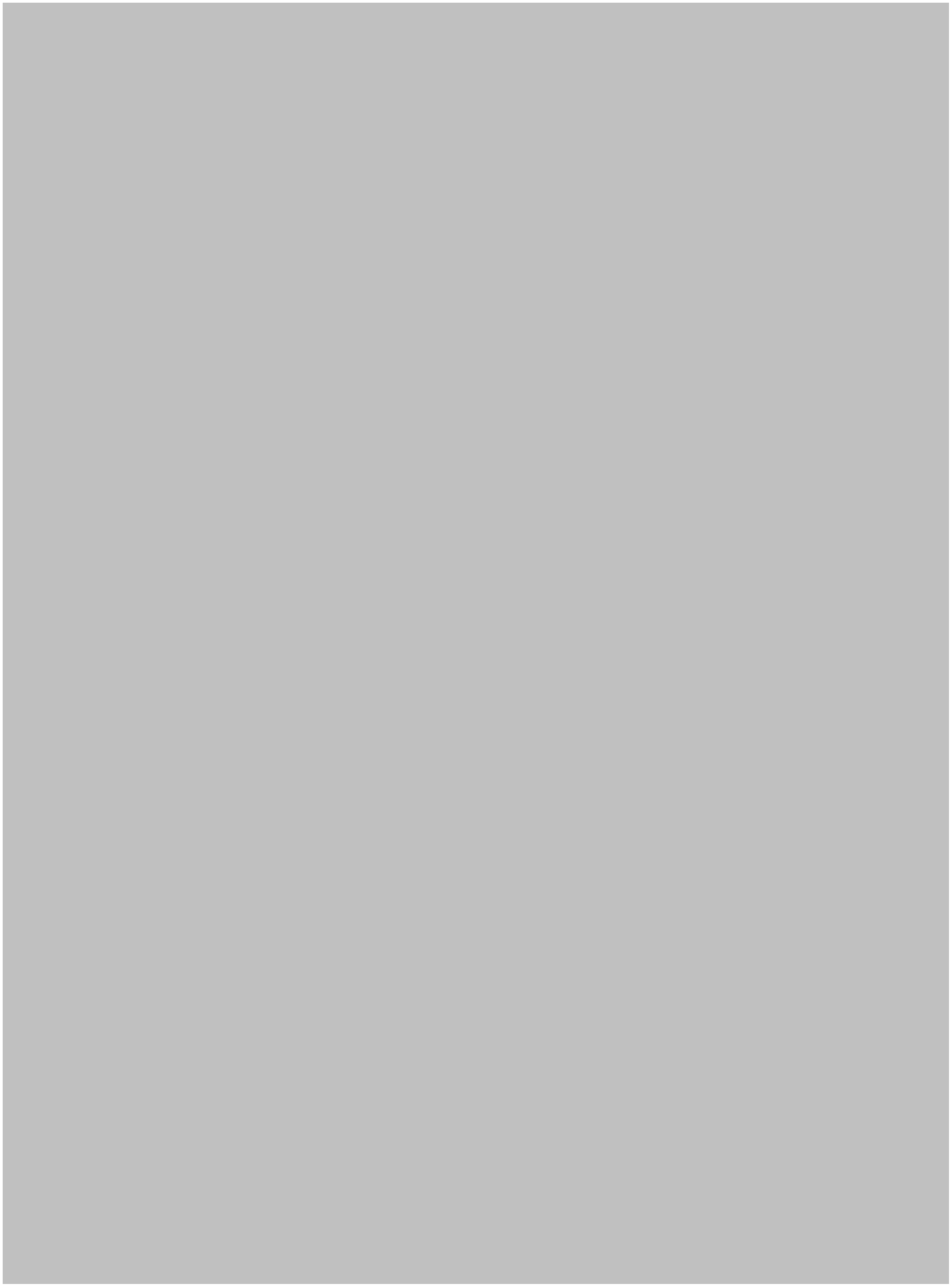
6.3 Qualitative analysis

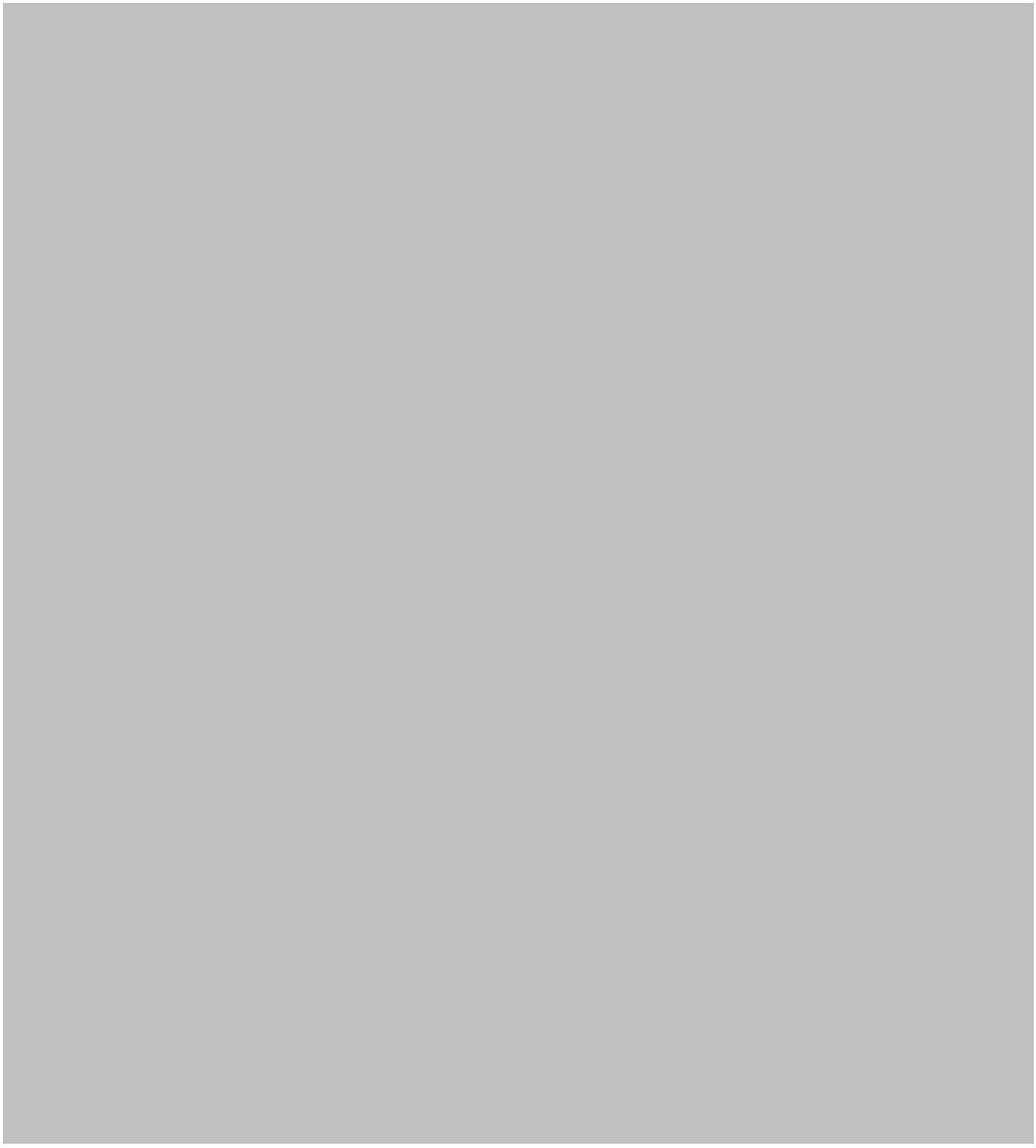


6.5 Summary









[7] Assuming government fuel excise rate is 25%

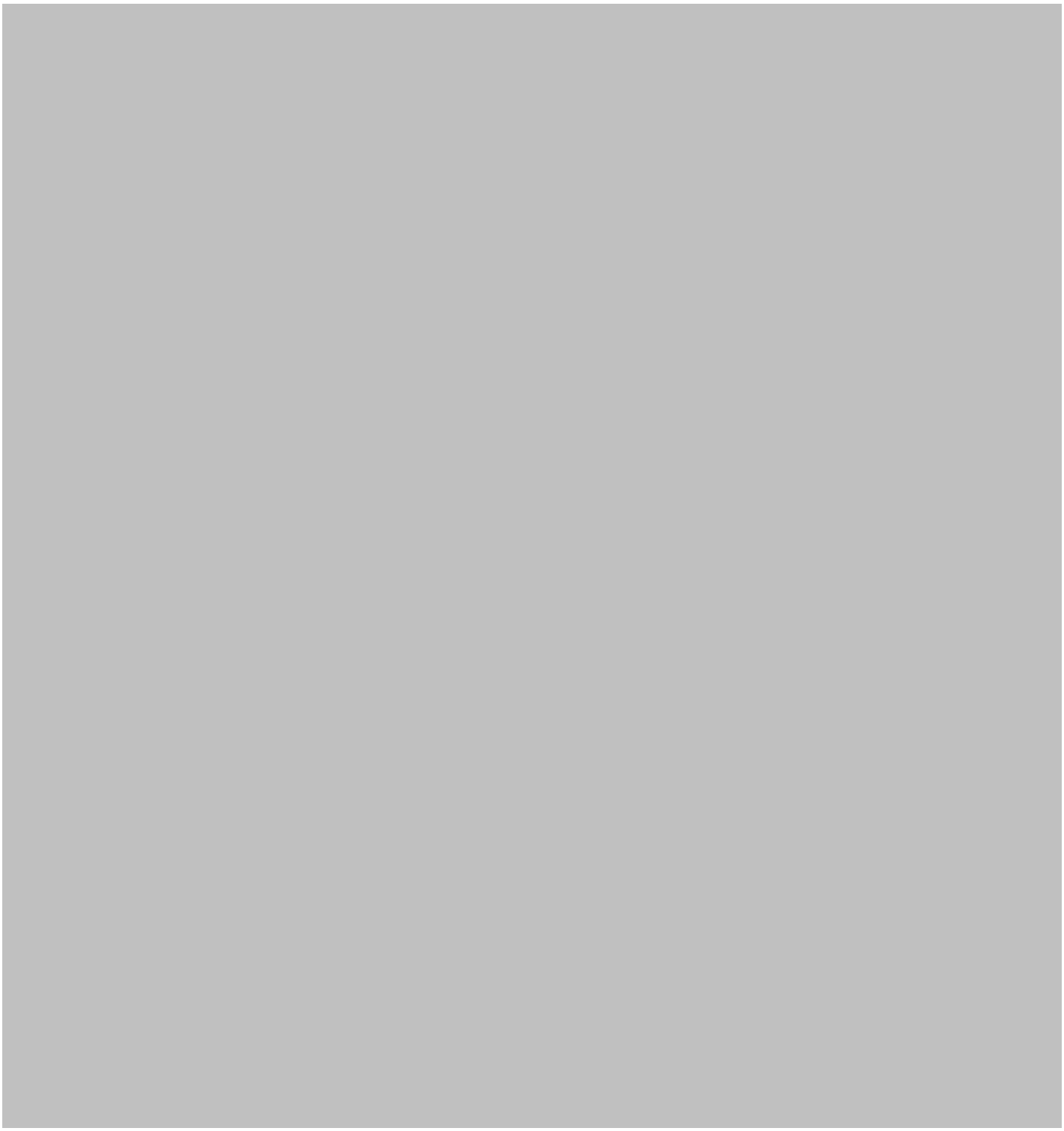
7 SUMMARY AND RECOMMENDED REVIEW ACTIONS

7.1 Strategic interventions

7.2 Demographic and employment projections

7.3 Transport modelling assessment

7.4 Economic assessment



7.5 Recommendation

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APPENDIX A - LEVEL OF REVIEW OF EACH CHAPTER OF THE DBC

Chapter	Full/Partial/None	Chapter	Full/Partial/None
1	Full	16	Partial
2	Full	17	None
3	Full	18	Full
4	Full	19	None
5	Full	Appendix A	Partial
6	None	Appendix B	Partial
7	None	Appendix C	Partial
8	None	Appendix D	Partial
9	None	Appendix E	Full
10	None	Appendix F	Full
11	None	Appendix G	Partial
12	Full	Appendix H	Partial
13	Partial	Appendix I	Partial
14	None	Appendix J	None
15	None	Appendix K	None

APPENDIX B - THE TRANSPORT DEMAND MODELLING PROCEDURE

B.1 Transport modelling procedure

The transport modelling process is central to the estimation of benefits used in the economic assessment. It is therefore important to understand the transport modelling methodology that was applied for this project.

The transport modelling combines both strategic modelling and mesoscopic modelling.

B.1.1 The strategic model

The fundamental inputs to the Zenith model (and all other strategic transport model) are the demography of the modelled area and the transport networks. The demography is used in the estimation of demand for transport, while the transport networks represent the transport supply. In any strategic model, the transport demand and supply are always balanced.

The Zenith series of models aim to reflect the response of transport demand to external changes including factors such as growth of population, employment, travel times, parking charges, fuel prices and public transport fares. Each Zenith model, including the South East Queensland model, follows the same four-step modelling procedure.

These four steps are:

1. Trip Generation (How many people will travel?)
2. Trip Distribution, also called Destination Choice in Zenith (Where will people at each origin travel to?)
3. Mode Choice (What mode will people choose to travel on?)
4. Trip Assignment (What roads and public transport services will people travel on?)

In Zenith, the costs of travel are estimated in the Trip Assignment stage and fed back into Mode Choice stage. This loop is repeated until the changes from one loop to the next are small enough to accept that the model has reached an equilibrium.

The costs of travel by public transport and by car are used to split trips into public transport trips, car trips and active modes trips. In many models, the costs also have a substantial influence on the distribution of trips; destinations with lower costs from an origin typically attract more trips from that origin. In Zenith models, however, the costs determine a single set of destinations, but a loop between assignment and mode choice allow the model to re-estimate mode choice until it reaches equilibrium.

The travel costs are represented by a combination of:

- Fuel price
- Other vehicle costs
- Toll charges
- Travel time
- Parking charge
- Public transport fare
- Access time to station or stop
- Waiting time for service
- In-vehicle travel time.

Costs and times are converted to each other by a value of time.

The costs have a crucial role in the mode choice. Furthermore, for economic assessment of a project, the cost of travelling by public transport and by roads for the Project Case from the trip assignment in the last loop are used are compared to those of the base case to estimate the benefits that a project provides.

The important points to note about the strategic modelling are:

- The trips and costs are provided for three time periods:
  - Morning peak (7am to 9am)
  - Afternoon peak (4pm to 6pm)
  - Off peak (the remainder of the day)
- The public transport network's services are unconstrained. Effectively, this means that public transport has limitless capacity
- The highway network is constrained only by travel time or travel cost. That is, a road link may carry more than its capacity, but the cost of travel along the link will be high
- The mode choice is based on the difference between the cost of travel by public transport and the cost of travel by car.
- No intersection delay or queues are represented in the model
- The highway trip matrix (including cars and commercial vehicles) is passed to the Dynamic traffic model.

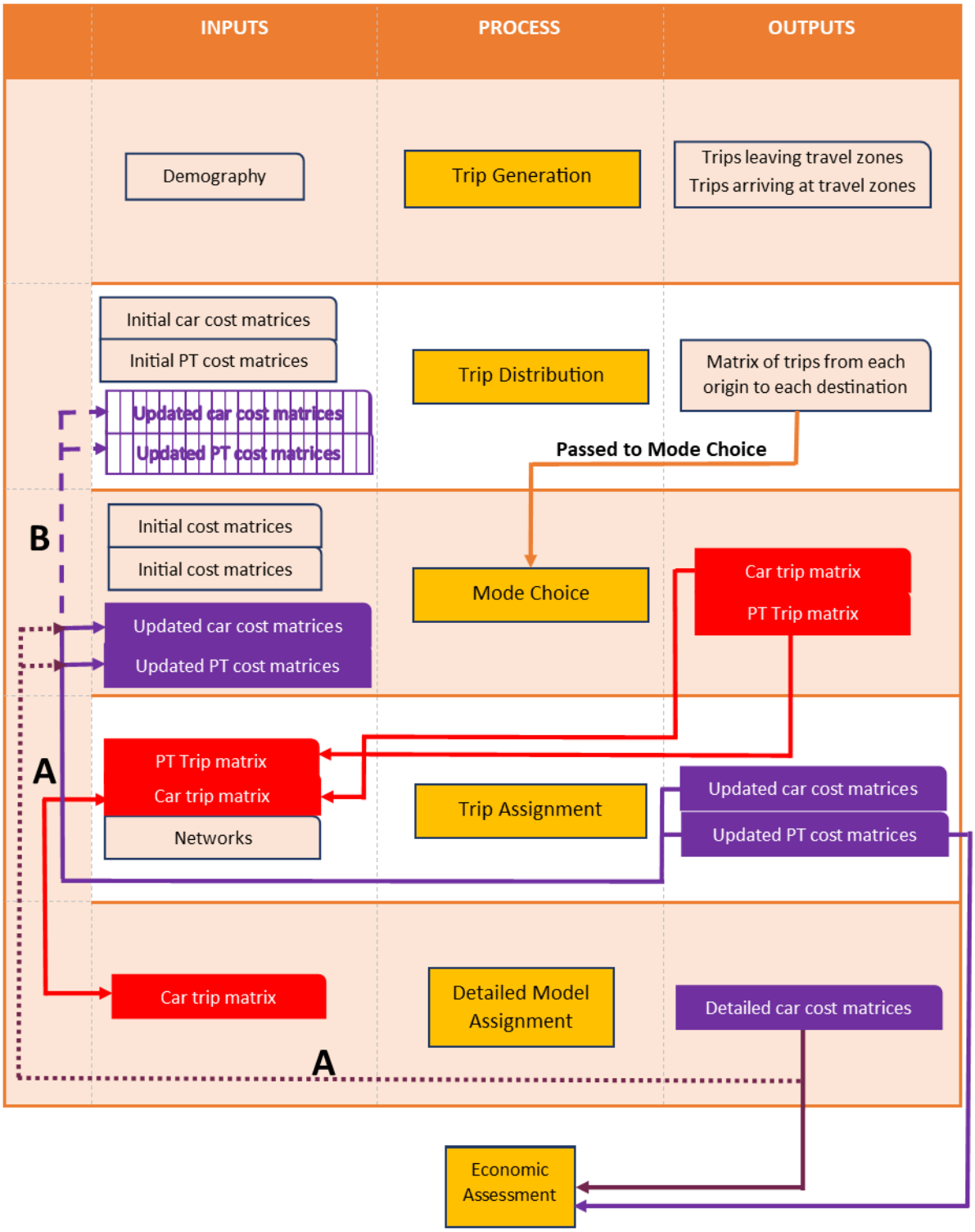

Figure 16 - Figurative representation of the modelling process

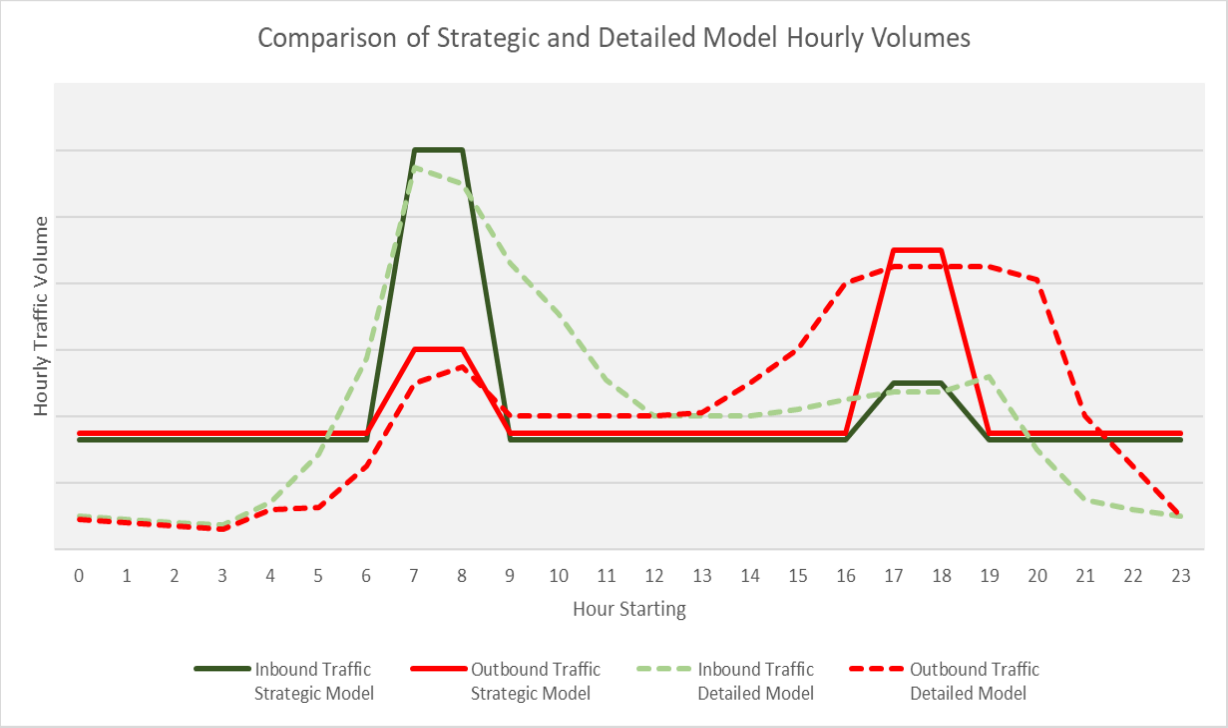

Figure 17 - Example of a typical daily time profile as represented by the Strategic Model and the Dynamic traffic model

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