ATKINS
Member of the SNC-Lavalin Group

Making Connections

Outline Business Case
Appendix B: Appraisal Specification Report

Greater Cambridge Partnership

Date: 22/08/23

Status: Third draft

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Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	Draft with updated modelling spec	EN/SP	SP/EN	AC GH (WSP)	AC	15/02/23
2.0	Draft with updated scenarios and responses to comments	EN/SP	SP/EN	AC GH (WSP)	AC	21/07/23
3.0	Updated draft after further comments	EN/SP	SP/EN	AC GH (WSP)	AC	22/08/23

Client signoff

Client	Greater Cambridge Partnership
Project	Making Connections
Job number	5221788
Document number	
Client signature / date	

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1. Introduction

1.1. Overview

1.1.1.1. This report is the Appraisal Specification Report (ASR) for the Making Connections programme. The Making Connections programme is being developed by the Greater Cambridge Partnership (GCP) as a joint committee of the County Council. GCP has commissioned Atkins, WSP and their subconsultants to prepare this work as part of the Outline Business Case (OBC) development process.

1.1.1.2. This ASR describes the proposed modelling and appraisal methodologies for the preparation of an OBC for the proposed interventions. The methodologies outlined in the ASR are drawn from and intended to be consistent with the DfT's Transport Analysis Guidance (TAG)[1] on the conduct of transport studies.

1.1.1.3. The key purpose of this ASR is to ensure that the assurance body appointed by the GCP agrees with the proposed approach to undertaking the appraisals which will form the basis of the analysis for the OBC. It will be kept as a 'live' document to support and document decision-making during the progression of the OBC towards its expected submission in April 2023.

1.2. The Background of Making Connections Programme

1.2.1.1. The background of the Making Connections programme was introduced in the Option Assessment Report (OAR) and Strategic Outline Case (SOC) completed in 2022. A summary of the background is presented in Appendix A of this report, which covers an introduction of:

- Greater Cambridge
- The Cambridge Phenomenon
- The Greater Cambridge City Deal
- The role of GCP
- The role of Making Connections programme

1.3. Objectives

1.4. The GCP's strategic objectives for the Making Connections programme were approved by the GCP Executive Board as part of their review, and subsequent approval of the Strategic Outline Case (SOC) for the Programme. These objectives are set out below[2]:

- To contribute to the GCP target to reduce traffic by 15% from the 2011 baseline, freeing up road space for more public transport services, and other sustainable transport modes.
- To ensure public transport is more affordable, accessible and connects to where people want to travel, both now and in the future.
- To raise the money needed to fund the delivery of transformational bus network changes, fares reductions and improved walking and cycling routes.
- To make it safe and attractive to walk and cycle for everyday journeys.
- To support the decarbonisation of transport and improvements to air quality.
- To make Greater Cambridge a more pleasant place to live, work travel or just be.

1.4.1.1. The specific objectives of the scheme are outlined below:

- To reduce carbon emissions from transport.
- To improve access to jobs and education for people, especially those living in rural areas.
- To improve air quality in the city centre.
- To contribute to the GCP target to reduce traffic by 15% from the 2011 baseline.

[1] https://www.gov.uk/guidance/transport-analysis-guidance-tag

- To reduce congestion in Cambridge.
- To reduce journey times and improve journey reliability.
- To enable the re-allocation of road space to buses, pedestrians, and cyclists.
- To increase the number of trips by bus.
- To increase the number of trips by cycle.
- To increase the number of trips on foot.
- To reduce the number of road accident casualties.
- To raise sufficient net revenue to fund the transformation of the bus network and wider Sustainable Transport Measures.

1.5. Structure of the Appraisal Specification Report

1.5.1.1. Following this introduction, the remainder of this report is structured as follows:

- Chapter 2 outlines option development and assessment undertaken so far and the approach for taking the options further in the OBC.
- Chapter 3 summarises the scope of output and impacts from the proposed interventions, outlines their corresponding analytical requirements, and the implications on the modelling and appraisal activities, before further details are presented in subsequent chapters.
- Chapter 4 provides an overview of the strategic transport modelling methodology.
- Chapter 5 provides an overview of the economic appraisal methodology.
- Chapter 6 provides an overview of the financial impacts assessment.
- Chapter 7 presents a summary of the environmental appraisal methodology.
- Chapter 8 outlines the approach to the social and distributional impact appraisals.

1.5.1.2. Appendix A summarises the background of Making Connections programme. Appendix B provides an Appraisal Specification Summary Table (ASST) – demonstrating how each of the identified impact will be appraised at the OBC stage – identifying where quantitative or qualitative assessments will be undertaken, and clarifying how individual elements feed into the Value for Money (VfM) calculation.

1.5.1.3. Other appendices include:

- **Error! Reference source not found.**: GCP Common Do Something Assumptions.
- **Error! Reference source not found.**: CSRM2 Run T1361 Common Do Something without Making Connections.
- Appendix C: Managing Uncertainties in Economic Appraisals
- Appendix F: Carbon Assessment Methodology

1.6. Change log

1.6.1.1. The table below records changes to this section of the ASR.

Table 1-1 – Introduction change log

Revision no.	Description	Detail of change
0.1	Internal working draft	Approach set out building on that used for SOC
1.0	First draft for review	Approach taking on board the revised modelling specification in Jan 2023
2.0	Second draft	Streamlined the text by moving background to Appendix A, aligned objectives with the latest OAR in 2023 post December 2022 consultation, and updated report structure with new appendices added.
3.0	Refinement of objective text	

2. Option development and assessment

2.1. Evolution of Making Connections

2.1.1.1. Figure 2-1 gives an overview of the evolution of Making Connections up to the start of the OBC development in 2023.

Figure 2-1 - Timeline of consultation and engagement for Making Connections

2.1.1.2. The start of Making Connections dates to the commencement of the GCP in 2015, when it approved the commencement of option exploration to reduce congestion in Cambridge.

2.1.1.3. Since then, a series of technical work and wide-ranging public engagement have taken place between 2016 and 2021, which led to the GCP Executive Board's agreement to develop a final package of options for improving bus services, expanding the cycling-plus network and managing road space in Cambridge.

2.1.1.4. GCP Making Connections public consultation was launched in late 2021. It focused on the central proposition of a transformed bus network and wider sustainable transport measures, funded through

either a Workplace Parking Levy / increased parking charges, a pollution charge or a flexible area charge. These priced demand management options were also the potential mechanisms for reducing traffic, reducing congestion, and creating the space for more walking, cycling and reliable public transport that is necessary if the outcomes are to be achieved.

2.1.1.5. Findings from the 2021 consultation and previous work informed the first iteration of the option assessment completed and documented in 2022 in Version 1 of the OAR, which informed the SOC and the subsequent recommendations to the Greater Cambridge Partnership Joint Assembly held in September 2022. A core option of road user charge of £5 applied 7am-7pm on weekdays was recommended to and accepted by the Joint Assembly and Executive Board in 2022. This is a Sustainable Travel Zone (STZ) comprising network wide public transport improvements, complementary measures and a road user charge, which is based on the STZ charge consulted on in 2021.

2.1.1.6. The chosen STZ option informed the subsequent Making Connections Consultation from October to December 2022.

2.1.1.7. Upon completion of the consultation in December 2022, further refinement of Making Connections options took place in the first half of 2023 taking onboard insights from the consultation and new technical evidence developed from early 2023. Option development in 2023 has refined the core option (road user charge of £5 applied 7am-7pm on weekdays) assessed in the SOC through the consideration of scheme parameters such as values of charge at different times of day and those who may be eligible for exemptions, based on findings from the new consultation and additional assessment undertaken. Once the revised scheme options have been established, qualitative assessments based on an MCA were carried out to assess the extent to which that the updated scheme options can meet the scheme objectives and address potential issues revealed in the consultation.

2.1.1.8. Outcomes from the refinement are three formulated scenarios for Making Connections along with the consultation proposal and Do-Nothing, which will form the basis of further assessment in the development of the OBC. These were documented in the updated OAR (Version 2) and have been taken on board in the update of this report in July 2023.

2.1.1.9. A full record of the option assessment process outlined above can be found in the OAR updated in 2023. The remainder of this chapter summarises the refined options that informed the scope of the updated ASR.

2.2. Options identified for OBC

2.2.1. Charging scheme

2.2.1.1. As set out above, the SOC was focussed on the £5 all day charge, with no exemptions and with supporting public transport improvements and complementary measures for active modes.

2.2.1.2. This demonstrated a strong performance against the objectives identified at the SOC, and forecasts indicated that revenue generation would be sufficient to cover the costs of the other measures. Findings from the SOC lay a solid foundation for further refinement of the options after the completion of the public consultation in December 2022. As described above, this generated several future scenarios for Making Connections at the OBC stage. These are outlined in Table 2-1 below:

Table 2-1 – Scenarios recommended to take forward for OBC

Scenario	Headline description
Consultation Scheme	7am to 7pm weekdays £5 for cars (per day) AM Peak 2026 All-day scheme from 2027 or 2028
Scenario 1	AM and PM peaks on weekdays £5 for cars (per day) Addenbrooke's/Royal Papworth* visitors and patients free

	Small vans charged the same as cars
Scenario 2	As consultation scheme 180 free days for first two years of STZ 100 free days for 2028 50 free days for 2029
Scenario 3	AM and PM peaks on weekdays £3 for cars (per day) Addenbrooke's/Royal Papworth* visitors and patients free 100 free days 2027 and 2028
Do Minimum	Reference case without Making Connections to compare the performance of the above four against

** As part of the OBC development, consideration would be given to if there are other locations that should be included in any such discount scheme*

2.2.1.3. In each of the above scenarios, with the exception of Do Minimum, the specifications also include a £10 charge for LGVs and £50 for HGVs (per day). These are the same as the proposal consulted in December 2022.

2.2.1.4. Information in Table 2-1 is called scenarios instead of options as they are not fully developed at this stage but are intended to set out a range of possible options to incorporate insights gained from the 2022 consultation. By considering the consultation scheme and the option of Do Minimum in the mix, this provides the widest range of options.

2.2.1.5. These broad scenarios will be taken forward for further consideration as part of the development of the OBC. It is acknowledged that there may be further refinement or alternatives to the parameters considered in the scenarios outlined in Table 2-1, such as variations to the ramp-up period during implementation, the distinctions in charges between different vehicle types (higher charges for LGVs and OGVs as an example) or other parameters. Whilst there is initial consideration of Discounts, Exemptions and Reimbursements (DERs) in the scenarios tabulated, these will continue to be refined and developed as part of the OBC development and beyond as details are finalised for the Full Business Case (FBC).

2.2.1.6. It is noted that the consideration of some of the variations or parameters as described above may be captured through preparation of additional scenarios using the transport model, while others will be considered through analysis outside of the model. Focus has been placed on impacts during the modelled AM peak, Interpeak and PM peak periods on weekdays. It is not proposed to develop additional modelling of off peak or weekend periods, but a qualitative review may be undertaken about the implications of the scheme on these time periods and potential measures that may be considered.

2.2.2. Provision for public transport

2.2.2.1. Public transport improvements have focussed around the following areas building on the work in the SOC and OAR:

- Improved services to planned growth and development areas on radial routes into the city.
- Faster and more frequent rural services to villages and market towns.
- Longer operating hours, including evening services.
- Reductions in fare prices to set a flat £1 fare for all trips within Cambridge or £2 for all trips within Cambridgeshire.

2.2.2.2. These measures are aimed at enabling sustainable development while minimising emissions related to car use.

2.2.2.3. Three primary public transport scenarios will be modelled using Cambridge Sub-Regional Model[3] (CSRM2), including the full 'Making Connections' service specification including reduced fare and two reduced specifications (for Scenarios 1 and 3 in Table 2-1 which are expected to provide lower levels of improvement commensurate with the lower net revenue expected).

2.2.2.4. The full service specification is based on a consultation version of the bus network which sees the frequency of a number of bus services increased and some new services introduced. It reflects the Cambridge Orbit services proposed at the autumn 2022 consultation. It assumes that the three BRT schemes being promoted by GCP (CSETS, Waterbeach Busway and Cambourne to Cambridge) are delivered as part of the 'Do Minimum', along with services to the South West Travel Hub. The reduced funding scenarios reduce the scope of the bus service upgrade, both in terms of the extent of the upgraded and the number of services which are upgraded. In all scenarios, bus service enhancements are distributed across the Making Connections area.

2.2.2.5. Further details of the services included in the CSRM2 modelling can be found in the Making Connections CSRM2 Runs modelling report.

2.2.3. Provision for active modes

2.2.3.1. As CSRM2 captures only the demand side of active mode travel, without any representation of the supply side, the treatment of provision of measures for active modes must be considered largely qualitatively or based on simplified modelling prepared externally to the strategic model.

2.2.3.2. Active mode measures, such as reallocation of road space for active travel, away from car where demand no longer requires existing levels of capacity, will aim to make best use of existing infrastructure, and so deliver benefits while minimising costs. Such measures may be used to complement public transport upgrades and provide more attractive and accessible access/egress between services and key destinations in the city.

2.2.4. Other complementary measures

2.2.4.1. In addition to transport interventions the release of highway space for other purposes and generation of revenue for reinvestment will enable a wider range of measures to be pursued. These may include liveable neighbourhoods, future transport measures such as mobility hubs, e-scooters, e-cargo bikes, freight consolidation, and micro-consolidation.

2.2.4.2. Such measures are not suited to representation within CSRM2 and so will be considered qualitatively.

[3] CSRM2 is CCC's multi-modal transport model, created with a 2015 base year, a 2019 Present Year Validation (PYV) and forecast years of 2026, 2031, 2036 and 2041. It captures the supply of bus, guided bus, park and ride (P&R) and rail services, along with the highway, walk and cycle networks, and associated costs (e.g., parking charges and public transport fares) and the demand for travel in the area. Its study area is the Cambridge Sub-Region (Cambridge City, South Cambridgeshire, Huntingdonshire and East Cambridgeshire) and is therefore strategic in nature.

2.3. Change log

2.3.1.1. The table below records changes to this section of the ASR.

Table 2-2 - Option development and assessment change log

Revision no.	Description	Detail of change
0.1	Internal working draft	Approach set out building on that used for SOC
1.0	First draft for review	Approach taking on board the revised modelling specification in Jan 2023
2.0	Second draft	Updated Evolution of the Making Connections to include development post Dec 2022 consultation (2.1 updated with extracts from 2.2.1). Streamlined the text to focus on the latest scenarios to consider in the OBC (2.2.2 removed; 2.3 removed). Further details on how model runs correspond with Making Connection scenarios were moved to the next chapter (2.4.5 moved; 2.4 changed to 2.2)

3. Scope of impacts and implications on modelling and appraisal

3.1. Introduction

3.1.1.1. This chapter gives an overview of the scope of output and impacts expected from the proposed interventions in the Making Connections programme, setting out the corresponding analytical requirements, and implications on the modelling and appraisal activities.

3.1.1.2. More details about the methodology for each area of appraisal are presented in subsequent sections of this document after this chapter.

3.2. Scope of output and impacts

3.2.1.1. Different components of the Making Connections programme are outlined in Sections 2.2.1 through to 2.2.4, which fall into the following four categories:

- Charging scheme
- Provision for public transport
- Provision for active modes
- Other complementary measures.

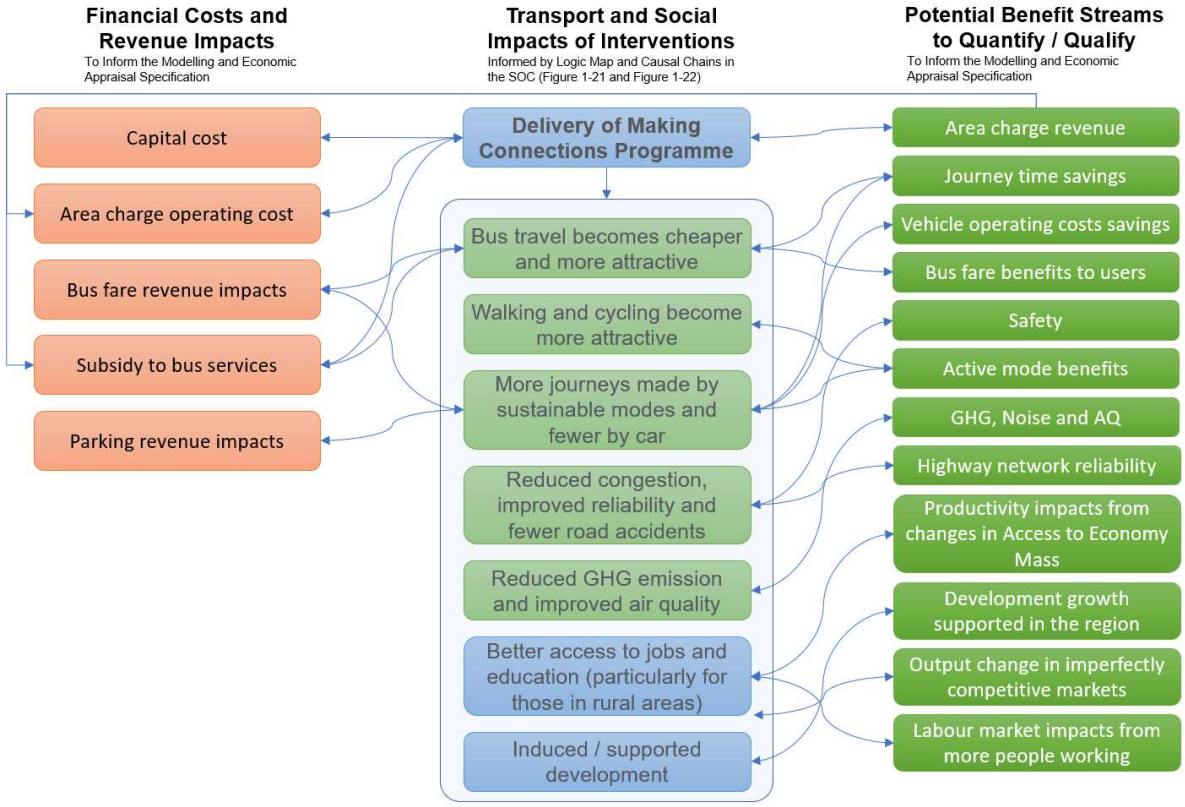
3.2.1.2. The scope of output and impacts from the Making Connections Programme are informed by the findings from the Strategic Case in the SOC, taking on board the strengths and limitations of the economic appraisal that has already taken place. This ensures the continuity from the SOC to the OBC, as well as a common thread between the strategic narrative for the programme and the range of technical evidence that will be prepared in the OBC development.

3.2.1.3. A full range of outcomes and impacts from the Making Connections programme have been outlined in the middle column of Figure 3-1. These expected impacts reflect the Logic Map and Causal Chains established in the completed SOC (Figure 1-21 and Figure 1-22 of the SOC, respectively).

3.2.1.4. The cost and revenue impacts from the delivery of Making Connections programme and its subsequent impacts are listed in the left column of Figure 3-1, whilst the potential benefit streams are outlined to the right.

3.2.1.5. Collectively, the range of impacts in the left-hand and right-hand side of Figure 3-1 determined the analytical requirements of the transport modelling and economic appraisal activities proposed for the development of the OBC. They shaped these requirements by influencing the scope of technical activities, key assumptions in the process, the fitness-for-purpose of techniques and tools employed in order to ensure the robustness of the findings.

Figure 3-1 – The Scope of output and impacts from Making Connections



3.3. Analytical requirements

3.3.1.1. Through understanding of relevant TAG guidance and the scope of output and impacts illustrated in Figure 3-1, some key analytical requirements for the OBC are identified in this subsection. The completed SOC already includes an evidence-driven articulation of the strategic fit, economic and financial impacts, and the collation of evidence under the five-case model, based on information and tools available at the time. Therefore, the analytical requirements set out below for the OBC takes onboard the strengths and limitations of the work undertaken in the SOC:

- Overall, the modelling and appraisal should meet requirements for OBCs outlined in DfT's Transport business case guidance and be undertaken in accordance with TAG appraisal units A1-A5 and modelling units M1-M5.
- The scope of options to be appraised should consider a holistic range of interventions including public transport, active modes and an area charging scheme to manage highway demand which tackles identified transport issues and delivers better travel choices for most people.
- Appraisal of the proposed interventions needs to reflect the scope of impacts set out in the SOC, as summarised in Figure 3-1 above.
- Strategic modelling is to be undertaken using the CSRM2[4] model suite. The specification of strategic modelling and transport forecasts needs to be suitable for generating evidence to support the scope of options summarised in Section 2 and the scope of impacts set out in Figure 3-1.
- Two forecast years have been modelled including the proposed scheme opening year of 2026 with a future forecast year of 2031 at the SOC stage. For the OBC, the second forecast year will be

[4] Cambridge Sub-Regional Model 2 (CSRM2) is is Cambridgeshire County Council's multi-modal transport model, created with a 2015 base year, a 2019 Present Year Validation (PYV) and forecast years of 2026, 2031, 2036 and 2041 (though other years can also be created). It captures the supply of bus, guided bus, park and ride (P&R) and rail services, along with the highway, walk and cycle networks, and associated costs (e.g. parking charges and public transport fares) and the demand for travel in
the area.

moved to 2041 in order to capture the forecast impacts of the proposed interventions over a longer term.

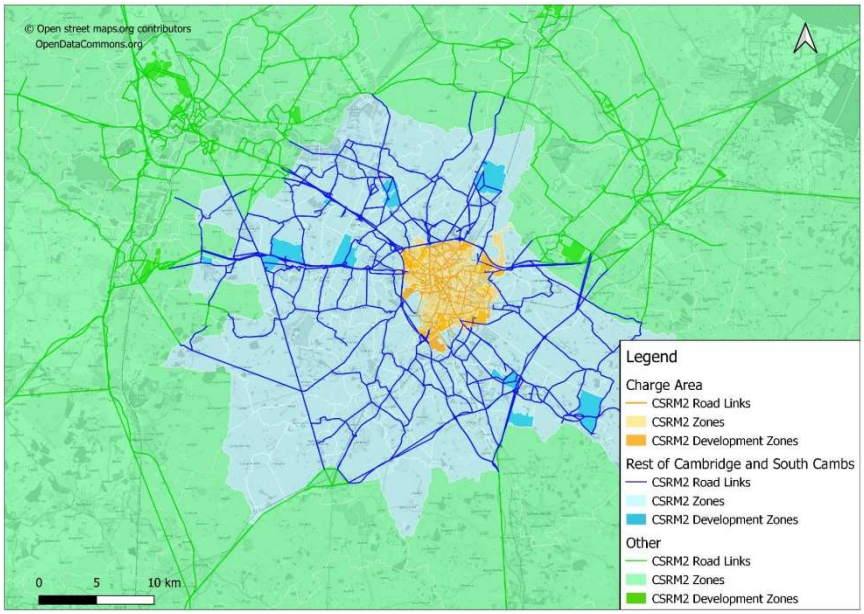
- In addition to a Core Scenario, application of sensitivity tests both quantitatively and qualitatively to considers a range of short term and long-term uncertainties as described in subsequent sections of the document and as defined in TAG unit M4 and the Uncertainty Toolkit.

3.4. Implications on strategic modelling

3.4.1. Geographic scope of analysis

3.4.1.1. The scope of the analysis for the OBC will be focussed on Cambridge and South Cambridgeshire, which is part of the core study area of CSRM2. The area of analysis for the forecast strategic impacts is broadly split into three parts, i.e., the charge area, the rest of Cambridge and South Cambridgeshire, and other area modelled in CSRM2. This structure reflects the likely area of impact from the proposed interventions.

Figure 3-2 – Sectors of analysis in the study area



3.4.2. Forecast years

3.4.2.1. The overall approach to forecasting is set out in Section 4.3. Currently it is proposed that in addition to an opening year (2026), an additional forecast year (2041) is also modelled. This moves the second forecast year further into the future compared with what was modelled at the SOC stage (2031), in order to capture the impact from the proposed interventions in the long term.

3.4.3. Demand forecasts

3.4.3.1. From a strategic modelling perspective, determining the appropriate level of travel demand both locally and nationally is a key consideration in producing robust evidence to inform the economic appraisal and Value for Money assessment.

3.4.3.2. To develop an appropriate set of modelling scenarios for demand forecasts, one factor to consider is whether the appraisal needs to consider land value uplifts from Dependent Development, following the approach set out in Section 3 of TAG Unit A2.2[5] - which requires a specific set of model scenarios with and without the travel demand from any development that is deemed dependent.

[5] TAG UNIT A2.2 Appraisal of Induced Investment Impacts (publishing.service.gov.uk)

3.4.3.3. A dependent development is a case of induced investment, defined in TAG as one stream of wider economic impacts which are in addition to the conventional transport user impacts. Several factors have been considered in the decision-making process, which include:

- The key features of dependent development are as follows: (1) there is a clear intention to develop a specific site; and (2) the existing transport network cannot reasonably accommodate the additional traffic associated with the development, hence the need for a transport investment.
- TAG suggests that it is not appropriate to use the dependent development method (as defined in TAG) for very large, individual and programmatic schemes that aim to have significant structural impacts on multiple, geographically dispersed, unidentified sites. An assessment of induced investment impacts for these schemes would require supplementary economic modelling.
- Transport interventions' usual routes to unlock development include: (1) directly addressing viability and / or access barriers to particular sites; and (2) increasing the capacity of the wider transport network to accommodate development growth. The Making Connections programme mostly falls under the latter of the two routes. Although a level of dependency is expected from the perspective of making space for accommodating further growth, the exact level of dependency from individual sites is hard to evidence as other transport and non-transport interventions are also required to unlock these developments.

3.4.3.4. In light of the consideration above, it is proposed not to quantify the economic impacts from dependent development for the OBC following the approach in TAG Unit A2.2, and therefore, the modelling scenarios associated with dependent development (such as the PQRS scenarios[6]) are not required. It is however acknowledged that supporting development growth in the region is clearly recognised in the scope of economic impacts from the Making Connections programme, as illustrated in Figure 3-1. Therefore, a qualitative assessment around this will be included in the Value for Money assessment in the OBC.

3.4.3.5. Other key factors pertaining to travel demand forecasts are also identified. These issues will influence the robustness and certainty of the demand forecasts, which will not only support the analysis of the traffic, economic and financial impacts of Making Connections in the OBC, but also be used to assess to what extent the proposed interventions will achieve their objectives. A list of these issues is outlined below, with more details on the proposed approaches to address them given in Section 4 of this report.

- Weekend and off-peak demand forecast – traffic impacts during the non-charging period (as a result of the charge scheme during the weekday) need to be analysed to understand the demand responses including potential displacement to assess the achievement of scheme objectives.
- Goods vehicles – the highway model includes goods vehicle flows to capture their impact on congestion and the proposed charge scheme, but it should be noted that these vehicles are not part of the demand model and so their responses in the model are more limited than those of the other modes of travel. The implications of this approach on the forecast economic impacts and revenue need to be explored further in the OBC.
- COVID recovery – CSRM2 has a pre-COVID base year so the decline in travel demand during the pandemic has not been explicitly captured in the transport model. Initial assessment of the recovery of travel demand post the pandemic has found that car travel demand after the pandemic is approximately 10% lower than the 2019 level. More details on the findings from the initial investigation and how relevant impacts will be managed in the economic appraisal during OBC development are presented in Appendix C of this report.
- Uncertainty to inform scenario setting – consideration of the DfT's latest Uncertainty Toolkit and the implications from the proposed approach on the Value for Money assessment. This is discussed in more detail in sub section 3.5.

3.4.4. Modelling Reference Case / Do Minimum

3.4.4.1. Similar to the approach undertaken at the SOC stage, a Do Minimum (DM) scenario will be used as a baseline for transport provision, against which the Making Connections programme will be assessed. The DM scenario was specified as including Cambridge South Station in addition to a range of GCP's proposed public transport corridor schemes, details of which are set out in the CSRM2 F-

[6] Table 1, Page 10, TAG unit 2.2 - appraisal of induced investment impacts (publishing.service.gov.uk)

Series Forecasting Report[7]. This is a model scenario that has been updated from that used in the SOC. More details of the DM scenario and its associated documentation are presented in Section 4.3 of this report.

3.4.4.2. The Do Something scenarios will include proposed changes as outlined in Section 2.

3.4.5. Modelling Do Something

3.4.5.1. Definition of the Do-Something (DS) modelling scenarios is an iterative process. Six model runs (DS1 to DS6) were proposed in version 1 of the ASR in February 2023. As more insights from the December 2022 Consultation became available and fed into the updated Option Assessment Report, options to consider in the OBC evolved and new model runs were proposed (DS1 to DS8). These model runs will be used in the OBC for different purposes as explained in the remainder of this subsection.

3.4.5.2. Several model runs were mapped against the consultation scheme and three broad scenarios formulated in the latest OAR, as presented in Section 2.2 and Table 2-1 of this report. These include DM, DS1, DS6, DS7 and DS8 as shown in Table 3-1.

Table 3-1 – Summary of OBC model runs aligned with scenarios from the OAR

Spec \ Scenario		No Scheme	Consultation Scheme	Scenario 1	Scenario 2	Scenario 3
		DM	DS1	DS6/7	DS1*	DS8
		Ref Case	All day £5	AM and PM peaks £5	All day £5 with free days	AM and PM peaks £3
Model Years	2026	Y	Y	Y	Y	Y
	2041	Y	Y	Y	Y	Y
Charge period	All Day		Y		Y	
	AM & PM			Y		Y
Charge value**	£5		Y	Y	Y	
	£3					Y
PT Fare	Full	Y				
	Reduced		Y	Y	Y	Y
PT Upgrade	None	Y				
	Reduced			Y (DS6)		
	Reduced v2			Y (DS7)		
	Reduced v3					Y
	Full		Y		Y	

** Additional adjustment to DS1 results is required outside the transport model to take onboard impacts from free days*

*** In each of the above scenarios, except for Do Minimum, the specifications also include a £10 charge for LGVs and £50 for OGVs (per day)*

3.4.5.3. Each column in Table 3-1 represents a single scenario with defined assumptions, the rows at the top of each column indicate which forecast years that scenario would be modelled for. As the Making Connections programme is likely to have long term implications for travel in and around Cambridge modelling will be extended from 2026 and 2031 forecast years (previously used for SOC) to 2026 and 2041. It is noted that 2041 is latest possible forecast year in CSRM, although a new model is being developed which may have later forecast years and so provide an opportunity to extend the forecast further into the future. It is also acknowledged that the further into the future the less certainty about

[7] Forecasting Report: "CSRM2 F-Series Forecasting Report v5.0.pdf", dated January 2022

modelling assumptions on land use and demand changes so 2041 is deemed a reasonable balance between a long timeline and certainty of modelling assumptions.

3.4.5.4. It is noted that all model runs proposed in Table 3-1 aim to represent the permanent state of the proposed interventions as closely as possible, so any interim schemes for early years (2026, 2027 or 2028) that may be required are not captured by model runs presented in this table. These interim schemes may be approximated by other model runs or adjustment outside of the transport model that will be introduced subsequently.

3.4.5.5. Similarly, certain difference between the broad options presented in Table 3-1 may not be realistically captured by the transport model, such as some discrepancies in Discounts, Exemptions and Reimbursement (DER). Therefore, these will have to be accounted for outside of the transport model. One example is that both Scenario 2 and Consultation Scheme in Table 3-1 are represented by DS1, but off-model adjustment will be carried out to the former to account for the free days proposed in Scenario 2.

3.4.5.6. Two model runs (DS6 and DS7) were defined for Scenario 1 in Table 3-1. DS6 is the first run with an approximated public transport specification whilst DS7 is the updated run with a refined public transport specification that is deemed more in line with the likely scale of revenue that can be generated by the charging scheme. Therefore, the assessment of scenario 1 in the completed OBC will be based on DS7 when its output becomes available (but DS6 may be used in working draft to gain insights on the performance of the proposed scenario).

In addition to the model runs representing the scenarios from the OAR as outlined in Table 3-1, other model runs are also available to inform the OBC development where necessary. These include model runs that were previously carried out during the preparation of the OAR or SOC and models runs commissioned at the early stage of appraisal specification development (as reported in version 1 of the ASR in February 2023).
Collectively these model runs provide further information and insights that enable the assessment of different variants of the broad scenarios in Table 2-1 and Table 3-1 and / or sensitivity tests. These additional runs are outlined in Table 3-2 and

3.4.5.7. Table 3-3, with their application in the economic appraisal illustrated in the next sub-section.

3.4.5.8. Table 3-2 summarises model runs carried out prior to the start of OBC development. These have informed assessment documented in the OAR and SOC. Model runs in this list were all based on earlier forecast scenario of CSRM2 (as opposed to the latest F-series[7] used for the OBC) so they carry less analytical robustness compared with the latest version. For this reason, they are not intended for directly informing the economic appraisal in the OBC but may offer some value for the purpose of gaining insights on the relative performance of certain options that are not covered in the scope of modelling proposed for the OBC.

Table 3-2 – Summary of old model runs prior to OBC

Charge Type	Charge Period	Charge Value	PT Fares	PT service upgrade	Exemptions
Area Charge	AM	£5	Full	Full	None
Area Charge	All Day	£5	Full	Full	None
Area Charge	AM	£10	Full	Full	None
Area Charge	All Day	£10	Full	Full	None
Area Charge	AM	£5	Reduced	Interim (2026), Full (2031)	None
Area Charge	AM	£5	Full	None	None
Area Charge	AM	£10	Full	None	None
Area Charge	All Day	£5	Full	None	None
Area Charge	All Day	£10	Full	None	None
Parking Charge	All Day	£10	Full	Full	None
Parking Charge	All Day	£10	Full	None	None
Area Charge	AM	£5	Full	Full	ZEV
Area Charge	All Day	£5	Full	Full	ZEV
Area Charge	AM	£10	Full	Full	ZEV
Area Charge	All Day	£10	Full	Full	ZEV
Parking Charge	All Day	£10	Full	None	ZEV

3.4.5.9. Table 3-3 outlines other model runs commissioned as part of the OBC development, which were scoped at the early stage of modelling specification development. Although they do not directly reflect the scenarios that came out of the updated option assessment process, these model runs may provide useful insight in assessing potential variants of the defined options, potential interim option during early years, or informing sensitivity or stress test, as they were prepared using the same CSRM2 forecasting model series as those outlined in Table 3-1.

These additional runs in

3.4.5.10. Table 3-3 feature a £3 all day test (DS2) which provides a low-charge alternative to the £5 scenario in Table 3-1. About higher charge test, findings from the SOC indicated that a £10 charge would generate higher revenue than £5, but with a disproportionate impact on user disbenefits. Therefore, a lower high charge test of £8 per day was proposed (DS3). Collectively they provide a range from £3 to £8 and may help to understand the potentially non-linear range of impacts as the charge varies and the balance between revenue income (financial implications) and transport user impacts (socio-economic implications).

3.4.5.11. In addition to these, AM only charge scenarios (DS4 and DS5) were also developed and assumed to bring a reduced level of bus improvements due to the lower revenue income anticipated. These scenarios would require less initial investment on public transport improvement provisions, as well as much reduced operating costs for additional buses.

3.4.5.12. As explained at the start of this subsection, the model runs outlined in these three tables will be used in the OBC for different purposes. This next subsection describes how they may be considered in the Value for Money assessment.

Table 3-3 – Summary of other OBC model runs

Spec \ Scenario		DS2	DS3	DS4	DS5
		All day with low charge	All day with high charge	AM only £5	AM only with low charge
Model Years	2026	Y	Y	Y	Y
	2041	Y	Y	Y	Y
Charge period	All Day	Y	Y		
	AM only			Y	Y
Charge value*	£5			Y	
	£3	Y			Y
	£8		Y		
PT Fare	Full				
	Reduced	Y	Y	Y	Y
PT Upgrade	Reduced			Y	Y
	Full	Y	Y		

** In each of the above scenarios the specifications also include a £10 charge for LGVs and £50 for OGVs (per day)*

3.5. Implications on economic appraisal

3.5.1.1. The appraisal of individual options or scenarios in the OBC will reflect the scope of impacts illustrated in Figure 3-1. This is a well-defined scope and further details on the approach for individual (dis)benefit streams are given in Section 5.

3.5.1.2. Determining an appropriate range of options or scenarios to consider needs more attention for a complex scheme like Making Connections. Although broad scenarios have been identified in the latest OAR (as listed in Table 3-1 of this report), further development of the proposed interventions in the business case before their implementation is expected as the proposed interventions involve a significant amount of details related to different parameters and rules of the charging system plus indefinite number of permutations for a potential interim scheme during the ramp-up period (if required). One requirement to the development of the OBC is therefore a rational and manageable approach to explore these uncertainties within a reasonable timeframe. The proposed approach for managing this in the economic appraisal is illustrated in Figure 3-3, which covers the following four steps:

- Step 1 – this involves appraising the consultation scheme and three broad scenarios (1, 2 and 3 in Table 3-1) against the DM scenario in accordance with the scope of impacts outlined in Figure 3-1. Standard tools such as TUBA, COBALT, WITA, AMAT and methodology for reliability assessment (TAG Unit A1.3) will be employed. Output from transport model runs in Table 3-1 will be used to inform this step.

Step 2 – this explores different variants of the scenarios above using output from either model runs in

- Table 3-3 or adjustment outside of transport model. Variation to the scenarios in Step 1 could include (but are not limited to) some of the following cases as the OBC progresses:

Interim schemes for early years of implementation such as AM only charge (DS4 and DS5 in

1. Table 3-3 cover £5 and £3 charge)
2. Varying mix of different DER measures (mostly covered by adjustment outside transport models in line with findings from the analysis in the financial models)

Changes to some charging scheme parameters such as £3 all day, which is not included in scenarios in step 1 (DS2 in

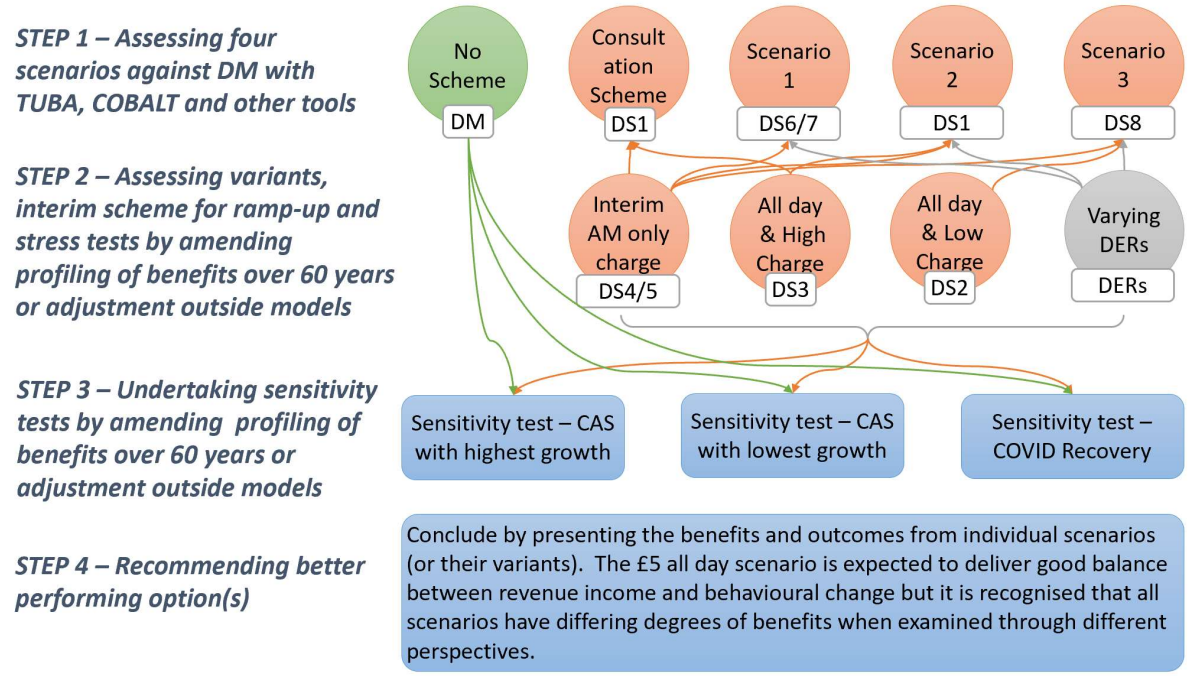
3. Table 3-3 provides a proxy for this)

High charge test to provide insights on the balance between financial implications and social-economic impacts (DS3 in

4. Table 3-3 provides a proxy for this)

- Step 3 – Managing analytical risks and uncertainties is a key element of the appraisal. Some factors associated with these risks and uncertainties have already been identified under Section 3.4.3, with more long-term uncertainties covered in DfT's TAG Uncertainty Toolkit[8]. Building on the scenarios covered in the first two steps, uncertainty analysis will be prepared (quantitatively or qualitatively) to better understand the range of potential outcomes, drawing on the Common Analytical Scenarios (CASs) defined in the TAG Uncertainty Toolkit. The approach for exploring the impacts of several recognised uncertainties on economic appraisal is described in Appendix C of this report, which covers all CASs, COVID impact and other considerations.
- Step 4 – This step concludes the VfM assessment by presenting the benefits and outcomes from individual scenarios (or their variants) considered, along with the scale of associated risks. Although the £5 all day scenario is expected to deliver a better balance between revenue income and behavioural changes, it is recognised that all scenarios have differing degrees of benefits when examined through different perspectives. It is also recognised that the decision makers may wish to 'blend' or phase schemes, so there could be a need to undertake further work to refine or update[9] the business case.

Figure 3-3 – Use of Defined Model Runs in the Economic Appraisal



3.6. Implications on financial analysis

3.6.1.1. Financial appraisal of the Making Connections programme will focus on the affordability of the proposed area charge scheme by analysing its estimated costs, revenues, and risks. The appraisal will focus on:

- Demonstrating that the proposed bus improvement measures and sustainable transport measures can ultimately be funded from a combination of the GCP City Deal funding (net of Charging Scheme expenditure) and the net financial proceeds of the Charging Scheme.

[8] TAG uncertainty toolkit - GOV.UK (www.gov.uk)
[9] Phasing to one of the main options is less likely to need update of the OBC but more significant changes to parameters or changes to DERs are likely to require the OBC to be updated with new technical evidence.

- Showing how the proposed Charging Scheme generates adequate funding for bus improvement measures and sustainable transport measures, whilst balancing the affordability challenges of road users, particularly during the early (implementation) years of the scheme.

3.6.1.2. The cost and revenue forecast for the proposed charge scheme is covered in the scope of impacts illustrated in Figure 3-1. It is directly informed by the scope of strategic modelling, and it is also impacted by some of its associated challenges. Some of these challenges have been identified in the ASR as outlined below. All of these identified challenges need to be addressed in the OBC through analysis inside and / or outside of modelling along with a set of carefully considered scenarios, assumptions and sensitivity tests. Further details of the financial appraisal approach to tackle these challenges are set out in Section 6.

- Demand and revenue forecast for an area-based congestion charging scheme is challenging given that the introduction of charging for road space is a locally novel intervention, and the behavioural response is uncertain both initially and over time.
- Forecasts from the traffic model need to be interpreted with an understanding of the strengths and limitations of the approach for modelling the charge, so implications from any assumptions or simplifications in the modelling process are understood and reflected in the financial appraisal.
- Recent changes around the world, such as the Covid-19 pandemic, the effects of conflict, and the acceleration of home working, will impact demand for travel and travel behaviour, which may add further uncertainty and challenges to the cost and revenue forecasts.

3.7. Implications on environmental impact appraisal

3.7.1.1. Environmental impacts were only considered at a high level at the SOC stage as part of the non-monetised impacts. Noise and air quality impacts were qualitatively considered to be moderately beneficial, whilst other impacts (landscape, townscape, historic environment, biodiversity, and water environment) were deemed neutral. Impacts on greenhouse gas emission were assessed using the TAG Greenhouse Gases workbook informed by forecasts from the traffic model.

3.7.1.2. Environmental impacts assessment in the OBC will cover the same impacts, namely noise, air quality, greenhouse gases, landscape, townscape, historic environment, biodiversity, and water environment, based on evidence with a higher level of detail and robustness.

3.7.1.3. The appraisal will be aligned with the guidance in TAG Unit A3, where necessary quantitative assessments will be undertaken, depending on the scope of options to be analysed and the nature of impacts under investigation. For appraisals which are dependent on traffic modelling (such as noise, air quality and greenhouse gases), it is expected that the quantitative analysis will be undertaken with relevant impacts measured and valued. Completion of these quantitative assessments may be delivered incrementally as and when relevant model output is made available.

3.7.1.4. Further details of the environmental appraisal approach are set out in Section 7.

3.8. Implications on social and distributional impacts appraisal

3.8.1.1. Social and Distributional Impacts (SDI) were assessed quantitatively (where data was available) and qualitatively at the SOC stage, supplemented by socio-demographic analysis, to consider the extent to which the Making Connections programme would impact sensitive groups. Sensitive groups considered include vulnerable and disadvantaged groups, in particular people with reduced mobility, older people, and people experiencing higher levels of deprivation.

3.8.1.2. The social impacts assessment at the SOC stage considered the effects of the scheme on a range of topics and found the Making Connection programme to be largely beneficial on physical activity, security, journey quality, accessibility and non-use values aspects. The accidents aspect was deemed moderately beneficial, with severance scores slightly beneficial and neutral for personal affordability.

3.8.1.3. The distributional impacts assessment at the SOC stage considered the effects of the scheme across different social groups and found the Making Connection programme to be largely beneficial on the air quality aspect (based on a qualitative assessment). Accessibility was deemed moderately beneficial, with user benefits and security scored slightly beneficial. Noise, accidents, and severance were scored neutral.

3.8.1.4. The SDI Appraisal for the OBC will still be undertaken in accordance with requirements set out in TAG unit A4-1 and A4-2. The proposed methodology for each impact category is outlined in Section 8. Where possible, a quantitative analysis will be undertaken in accordance with the guidance.

3.9. Change log

3.9.1.1. The table below records changes to this section of the ASR.

Table 3-4 – Scope of impacts and implications on modelling and appraisal change log

Revision no.	Description	Detail of change
0.1	Internal working draft	Approach set out building on that used for SOC
1.0	First draft for review	Approach taking on board the revised modelling specification in Jan 2023
2.0	Second draft	Added reference to the new Appendix E about managing uncertainties in appraisal including CAS scenarios, COVID recovery impact and other factors. Significant update to 3.4.4 and 3.4.5 to explain different groups of model runs available and how they correspond to the main scenarios carried forward from the updated OAR. Significant update to 3.5 to explain how different model runs may be used in different steps of the VfM assessment (new Figure 3.3) All details about CAS and managing uncertainties updated and moved to the new Appendix E
3.0	Third draft	Minor text update

4. Strategic transport modelling

4.1. Context

4.1.1.1. This section provides an overview of the Cambridge Sub-Regional Model 2 (CSRM2) strategic model, the appropriateness of this model for use in the appraisal of the Making Connections Programme and the approach by which the model will be used.

4.1.1.2. CSRM2 is a well-established model which has been used for representation and assessment of a range of transport schemes in the Cambridgeshire area. It is supported by extensive documentation, such as the latest Local Model Validation Report and Forecasting Report setting out full details of the model, assumptions used within it and internal operations. This ASR has therefore not repeated these details, other than to give a broad overview, unless specifically relevant to the appraisal under consideration. For additional information on the modelling, if this should be required, please see the links to modelling documents provided at relevant points.

4.2. Approach for SOC

4.2.1. Scope of strategic model

4.2.1.1. Strategic modelling developed to inform the Making Connections study, including the SOC, has used the CSRM2. This is Cambridgeshire County Council's multi-modal transport model, created with a 2015 base year, a 2019 Present Year Validation (PYV) and forecast years of 2026, 2031, 2036 and 2041 (though other years can also be created). It captures the supply of bus, guided bus, park and ride (P&R) and rail services, along with the highway, walk and cycle networks, and associated costs (e.g. parking charges and public transport fares) and the demand for travel in the area. Its study area

is the Cambridge Sub-Region (Cambridge City, South Cambridgeshire, Huntingdonshire and East Cambridgeshire) and is therefore strategic in nature. Further detail on the latest version of the model is available in a suite of technical reports:

- the Local Model Validation Report (LMVR)[10],
- the Model Development and Validation Report (MDVR)[11] and
- the Forecasting Report[12].

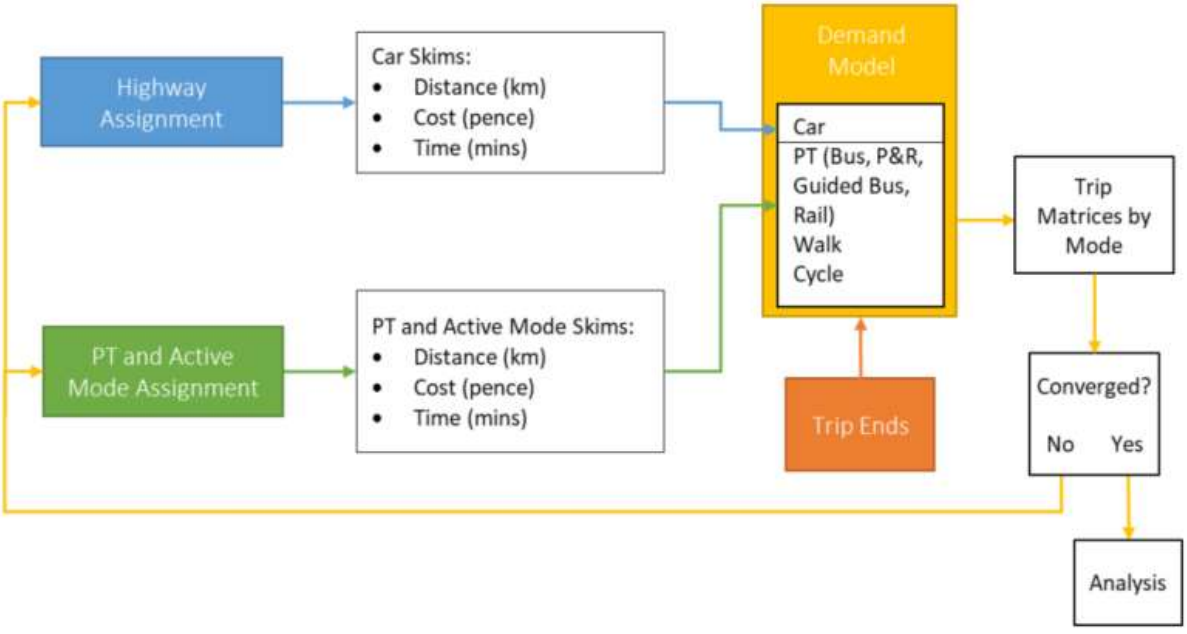
4.2.1.2. Details of particular relevance to the appraisal of the Making Connections Programme are described below. For any further information on the modelling, the reports above should be referred to.

4.2.2. Structure of strategic model

4.2.2.1. CSRM2 comprises three major components: the highway assignment model (implemented using the SATURN software), the public transport and active modes assignment model (implemented using MEPLAN) and the transport demand model (also implemented using MEPLAN). The highway model includes goods vehicle flows to capture their impact on congestion, but it should be noted that goods vehicles are not part of the demand model and so their responses in the model are more limited than those of the other modes of travel.

4.2.2.2. The costs of travel by each mode (in terms of distance, monetary cost and time) are skimmed from the assignment models and passed into the demand model to enable travellers to decide which mode to use, where to go and when to travel. Schemes that are implemented in the assignment models (such as highway improvements, new cycle connectivity, better bus journey times, road pricing, etc.) influence these travel costs and hence the demand model produces different numbers and patterns of trips by mode. The assignment and demand models iterate, feeding information back and forth until they are converged (i.e. until the results of two consecutive iterations are sufficiently similar). Figure 4-1 shows the flow of demand (trip matrices) and cost skims between the different components of the model.

Figure 4-1 - CSRM2 Operational Flow Chart



4.2.2.3. The model is segmented into many categories of supply and demand, which allows the results to be reported at different levels including:

[10] LMVR, version 5.1, issued on 24 May 2022
[11] MDVR, version 5.2, issued on 24 May 2022
[12] Forecasting Report, version 5.1, issued on 13 April 2022

- Time periods: weekday AM peak (07:00-10:00), inter peak (IP) (10:00-16:00) and PM peak (16:00-19:00).
- Modes of travel: private car, bus, guided (or high-quality) bus, rail, P&R and active modes.
- Purposes of travel: commuting, education, business and discretionary.
- Location of origins and destinations of trips.
- Network-level statistics such as traffic on links or passengers on bus services, etc.

4.2.2.4. Note that the highway assignment model covers single peak hours within the three time periods listed above: these are AM peak (08:00-09:00), inter peak (an average of 10:00-16:00) and PM peak (17:00-18:00).

4.2.2.5. The model also includes income group segmentation, which is of particular relevance to the Making Connections Programme for determination variations in transport users' responses to the introduction of an area charge and alternative options of improved public transport with reduced fares being made available. This segmentation has been applied in line with the bands set out in TAG Databook sheet M2.1, using income ranges of:

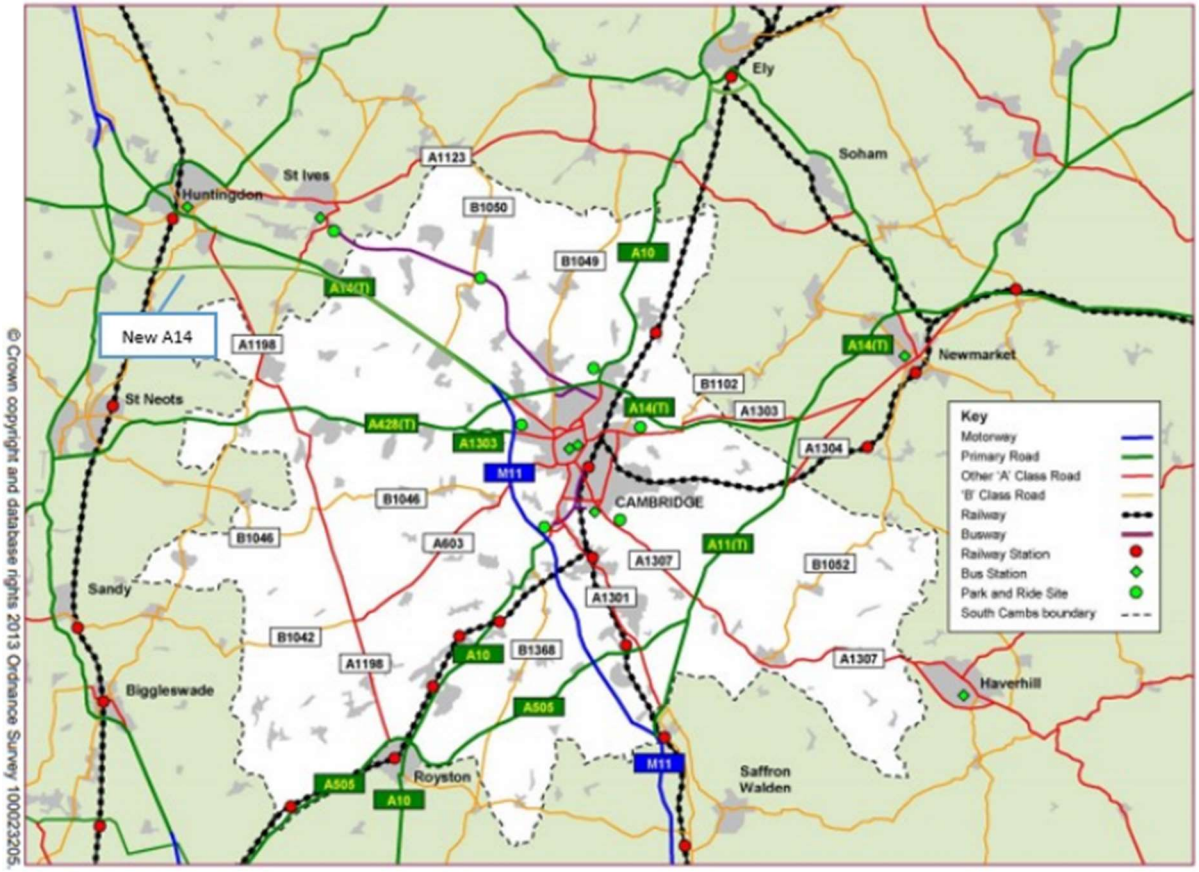
- <£20,000
- £20,000 to £40,000
- >£40,000

4.2.2.6. This income segmentation is applied at the sub-mode choice and assignment stages of the model. For equity reasons the economic appraisal cannot assign different values of time to the income bands and they are therefore not disaggregated for use in the assessment of user benefits.

4.2.3. Spatial coverage

4.2.3.1. The Making Connections programme covers Greater Cambridge, which comprises the two local authority districts of Cambridge City and South Cambridgeshire as shown in Figure 4-2.

Figure 4-2 – CSRM2 Study area



4.2.4. Forecast model

4.2.4.1. CSRM2 has been developed and updated over a period of years. The current version (CSRM2_F-series) was updated in 2022 to reflect latest development assumptions and baseline public transport services. Details about the development of the F-series forecast model can be found in the Forecasting Report mentioned in Sub Section 4.2.1. The latest F-series forecast model was used to prepare different model scenarios as described in the next sub section.

4.2.5. Other details

4.2.5.1. Further details about the model zoning system, highway network modelled, base travel demand development, calibration and validation can be found in the aforementioned LMVR.

4.3. OBC stage strategic modelling

4.3.1. Overview of the approach

4.3.1.1. The strategic modelling which will inform the OBC will be based on the same model as for the SOC, with new model runs developed to suit the range of scenarios described in Sub Sections 3.4 and 3.5.

4.3.1.2. Details on strategic model convergence, variable demand modelling, land use and transport supply assumptions can be found in the completed LMVR, MDVR, Forecasting Report and SOC.

4.3.1.3. The Reference Case for the OBC is a model scenario that has been updated from that used in the SOC, in particular in terms of public transport service specifications to include latest assumptions of the most likely set of services to be in place in the absence of the Making Connections Programme. Details on the preparation and assurance of the reference case scenario can be found in a technical note about GCP Common Do Something Assumptions, and another note about CSRM2 model run

T1361QA – evidence and model outputs. These two notes are enclosed in **Error! Reference source not found.** and **Error! Reference source not found.**, respectively.

Preparation of the Do Something scenarios will follow the scope set out in Table 2-1, along with Table 3-1 and

4.3.1.4. Table 3-3. Modelling report for the preparation of all relevant scenarios will be produced during the development of the business case.

4.3.1.5. The remainder of this subsection outlines land use and transport supply assumptions in modelling as well as the proposed approaches to manage uncertainties in the forecast, many of which have already introduced in Appendix C.

- Weekend and off-peak demand forecast
- Goods vehicle
- COVID recovery
- Uncertainty to inform scenario setting

4.3.2. Land use and transport supply assumptions

4.3.2.1. As noted in the previous sub section, the Reference Case for the OBC was prepared based on the GCP Common Do Something scenario documented in **Error! Reference source not found.**. The Common Do Something scenario covers a range of changes as follows:

- changes to connectivity due to transport infrastructure projects
- changes in public transport service provision
- changes in travel costs (monetary) and the way these are perceived
- changes in land use – new developments, changes in population profiles and household structures

4.3.2.2. Making Connections programme was removed from the Common Do Something to prepare a Reference Case for the purpose of economic appraisal in the OBC. This process is reported in **Error! Reference source not found.**.

4.3.2.3. The land use assumptions in the adopted model scenario follow the Core scenario in CSRM2, which is detailed in Section 2 of the technical note in **Error! Reference source not found.**. The transport supply assumptions are documented in Section 3 of the same appendix, except that the coding of Making Connection programme was removed to prepare a Reference Case as described above.

4.3.3. Weekend and off-peak periods

4.3.3.1. Assessment of the non-charging periods would help to understand traffic impacts in such periods as a result of the charge scheme during the weekday. These periods have not been included in the existing CSRM2.

4.3.3.2. It is acknowledged that the omission of non-charging periods in the model will bring uncertainty in understanding the demand responses during these periods as there is no definitive evidence to suggest whether the forecast changes in the charge period will also occur in the non-charge periods. In fact, the reverse may happen because of potential displacement of demand.

4.3.3.3. On the other hand, the opposite may also be true as the forecast significant modal shift to sustainable modes (as found in the SOC), supported by the proposed improvements on bus provisions, may lead to a reduction in car ownership, which subsequently reduce the weekend or off-peak journeys.

4.3.3.4. The patterns / distribution of car journeys may also change as the uncertainties above may impact different types of journeys (intra-city and to/from city) differently. The potential displacement of demand to non-charging periods will also vary by time period and journey purpose, as mentioned in Section C.3 of Appendix C. For time periods where congestion charge is proposed in all options (such as AM and PM peak periods), the scope for displacement is very limited as the majority of journeys are for commuting, business or education purposes, which are less flexible than other purposes.

4.3.3.5. It is recognised that the Making Connections programme would bring significant transport, social and behavioural impacts to the local area, many of which are not able to be captured fully or definitively in a transport modelling tool. Such impacts will have to be identified and reviewed in the medium term once the behavioural and other changes settle in. These include not only impacts from the changes in the non-charging periods, but also other matters that are discussed in the remainder of this subsection or Appendix C. It is therefore proposed in this ASR to focus on developing a clear narrative to acknowledge such uncertainties, their likely implications on the business case and the VfM findings, and formulate a high-level narrative to inform the interpretation of the forecasts and VfM assessment, in order to manage uncertainties identified and enhance the robustness of the findings. The

uncertainties recognised at this stage will also inform the scoping of the Monitoring & Evaluation of the proposed interventions so the promoting and delivering bodies are better prepared to review, understand and evidence what the actual impacts may be after implementation.

4.3.4. Goods vehicle

4.3.4.1. The highway model includes goods vehicle flows to capture their impact on congestion and the proposed charge scheme, but these vehicles are not part of the demand model. Therefore, demand responses from goods vehicles in the model are more limited than those of the other modes / purposes of travel. The implication from this approach is that the forecast demand in the charge scheme and its revenue may be more optimistic than what it is.

4.3.4.2. Due to this constraint of the CSRM2 model, the area charge has been applied as a fixed rate across all trips, but since freight trips are assumed to have fixed demand, this doesn't affect forecast travel. A correction from the fixed charge to £10 for LGVs and £50 for HGVs will be applied to user charge and revenue impacts in the economic appraisal outside the transport model.

4.3.4.3. In reality, if there is a demand response to the proposed interventions for freight traffic, the actual travel demand may be lower than what the model forecasts suggest. This would mean a potentially stronger behavioural change in terms of modal shift and reducing highway traffic and less disbenefits (due to the cost of charge) to business users. Therefore any economic appraisal based on the model forecast can be deemed more conservative from the Value for Money perspective as the actual decongestion impacts may be stronger and the user costs may be lower than what the model may suggest.

4.3.4.4. On the other hand, the forecast revenue income from the proposed interventions may be more optimistic, which is a risk that needs to be managed from the financial viability perspective. This risk will be managed by a range of ‘stress tests’ to be undertaken in the financial analysis. The purpose of these tests is to explore the certainty of the proposed programme to generate a positive and ongoing net revenue in light of risks identified. Details of these tests will be reported in the Financial Dimension of the OBC.

4.3.5. Covid recovery

4.3.5.1. As CSRM2 has a pre-COVID base year, the decline in travel demand during the pandemic has not been explicitly captured in the transport model. In a similar way to the aforementioned topics, this creates uncertainty in the forecast demand revenue so is another factor to be incorporated in the sensitivity test.

4.3.5.2. This matter is explicitly explored in Section C.3 of Appendix C, with a summary of recent investigation on the recovery of local travel demand and a proposed approach to manage the potential risk through profiling at the economic appraisal stage, instead of undertaking additional transport modelling.

4.3.6. Uncertainty toolkit

4.3.6.1. Notwithstanding the factors discussed above, there is still considerable uncertainty about how the transport system will evolve in the future, particularly with the potential for emerging trends in behaviour and technology to drive significant change over time. To ensure decision making is resilient to future uncertainty, there is a need to understand how the outcomes of scheme proposals may differ under varying assumptions about the future.

4.3.6.2. The DfT Uncertainty Toolkit (published May 2021) states that analysis should not focus exclusively on a “Core Scenario” and the consideration of wider “what if” scenarios should be undertaken. It introduces the six Common Analytical Scenarios (CAS) – which are central to how the DfT intends to approach uncertainty in transport analysis. This includes:

- High Economy
- Low Economy
- Regional
- Behavioural Change
- Technology

- Decarbonisation

4.3.6.3. The proposed approach to each scenario of the Uncertainty Toolkit is presented in Section C.2 of Appendix C.

4.4. Suitability of Strategic Model

4.4.1.1. This chapter provides an overview of the strengths and limitations of the strategic model for use in the appraisal of the Making Connections Programme. While there are certain aspects of the model which will not be able to fully capture the effects on transport users, methods have been set out to overcome these limitations. The key advantages of the model, in being able to provide a strong representation of forecast user behaviour in response to a range of components of the proposed Making Connections Package include the high level of detail considered with both the demand and assignment modelling, with a structure set out to represent a wide range of socio-economic user groups.

4.4.1.2. The area of coverage is also ideally suited to the programme. It covers a wide enough area to represent changing behaviours of users who may adjust their choice of travel, in terms of route, mode, destination or whether to travel at all, while enabling a high level of detail to be represented in the city of Cambridge.

4.4.1.3. The use of peak hours within the assignment model allows impacts of delays during the busiest times of day to be well represented, while inclusion of interpeak modelling allows for analysis to be undertaken to best represent benefits during shoulder peak hours drawing on elements of different time periods, while ensuring a conservative approach is followed.

4.4.1.4. A key component within the model is the inclusion of users in different income bands, allowing for different demand responses and different choices of route for transport users who are more or less able to afford different transport options.

4.4.1.5. A range of scenario testing within the model, as set out above, will enable it to be used to provide uncertainty analysis, in addition to central forecasts of the scheme impacts.

4.5. Change log

4.5.1.1. The table below records changes to this section of the ASR.

Table 4-1 - Strategic transport modelling change log

Revision no.	Description	Detail of change
0.1	Internal working draft	Approach set out building on that used for SOC
1.0	First draft for review	Approach taking on board the revised modelling specification in Jan 2023
2.0	Second draft	Minor update to section 4.3 to align with changes made elsewhere

5. Economic appraisal

5.1. Overview

5.1.1.1. The approach to the economic appraisal and calculation of the scheme's Value for Money (VfM) for the OBC will follow the VfM framework[13] as well as TAG guidance (Units A1 and A2), which provide information on the role of transport modelling and economic appraisal.

5.1.1.2. Appraisal will be undertaken using TAG data book v1.20.2 published in January 2023. A 60-year appraisal period will be considered to capture a wide scope of benefits and costs, which includes an assumed opening year of 2026 and a second forecast year of 2041. Alternative assumptions such as

[13] Value for money framework (publishing.service.gov.uk)

a 30-year appraisal period has been considered. It is expected to have similar impacts on forecast user benefits, disbenefits, scheme operational costs and revenue (i.e. they are all expected to reduce as the appraisal period is shortened) and therefore has not been taken forward as it does not bring significant additional insights.

5.1.1.3. Table 5-1 summarises the overall approach to the economic appraisal. Further details of the approach for each appraisal element are provided in subsequent sub-sections of this chapter as signposted below. The range of economic impacts considered is informed by the scope of anticipated output and impacts from Making Connections programme as illustrated in Figure 3-1

Table 5-1 - Overview of economic appraisal

Impact	Approach Overview	ASR Sub-Section
Level 1[14] impacts included in Initial Benefit Cost Ratio (BCR)		
Present Value Cost (PVC)	Calculation of PVC based on the Options cost estimates covering the relevant appraisal period.	Section 5.2
Transport User Impacts	TUBA assessments of Transport Economic Efficiency (TEE) in line with TAG Unit A1-3, including highway decongestion benefits, public transport time savings, revenues related to charges and fares and indirect tax revenues.	Section 5.3
Impacts during construction	Consideration of transport impacts during the implementation period.	Section 5.3
Environmental impacts	Monetised impacts for greenhouse gases. Air quality and noise impacts assessed qualitatively.	Section 5.4 / 7
Safety Impacts	COBA-LT assessment of variations in road traffic accidents in line with TAG Unit A4-1.	Section 5.5
Active mode impacts	Appraisal of journey quality, health and absenteeism impacts due to provision of improved cycling and walking facilities using the Active Modes Appraisal Tool (AMAT).	Section 5.6
Level 2 impacts included in Adjusted Benefit Cost Ratio (BCR)		
Reliability Impacts	Assessment of highway and public transport reliability impacts in line with TAG A1-3.	Section 5.7
Wider Economic Impacts	WITA v2.2 in line with TAG Unit A2 series	Section 5.9

5.2. Scheme costs

5.2.1. Implementation costs

5.2.1.1. For the appraisal, in order to estimate the likely outturn costs at the time of construction expenditure, adjustments for real price inflation will be based on the Retail Price Index (RPI) extracted from the TAG Databook. As expenditure will be primarily on equipment, rather than construction works, RPI provides the best representation of likely cost increases in the future.

5.2.1.2. Following the consideration of real cost changes over time, all future year scheme costs will be rebased to 2010 prices using the GDP deflator. These values will then be adjusted from factor costs to market prices and discounted to 2010 Present Value Costs (PVC), in line with TAG A1-2 guidance.

[14] Different levels of economic impacts in this table are aligned with the definition in the VfM Framework.

5.2.1.3. In addition to the cost adjustments to convert to present values, as outlined above, this appraisal will include optimism bias for the Area Charging capital costs. An optimism bias of 46% was used at the SOC stage, which is the recommended value for schemes that fall under the Roads category in Table 8 of TAG Unit A1-2. The default recommendation in TAG to consider for the next stage (OBC) under the same category of schemes is 23%.

5.2.1.4. Due to the limited infrastructure requirement of the Making Connections programme, the evidence which informed the recommended optimism bias uplift rates for road schemes provided in TAG may not be directly comparable to this investment. A review has been undertaken during the OBC development to identify any more representative sources for optimism bias uplift. This review included a more detailed analysis of the findings from a study which informed TAG's recommendations of application of optimism bias[15] to establish whether any comparable schemes had been included. However, this was found not to provide any more relevant information and relevant evidence from elsewhere could not be established with similar schemes elsewhere being few in number. The TAG recommended optimism bias has therefore been retained.

5.2.1.5. Another way to explore the appropriateness of the optimism bias assumed is to compare it against the contingency from a Quantified Risk Assessment (QRA). Guidance in Section 4 of TAG A1-2 will be used to interpret and reconcile the divergence between QRA and optimism bias estimates. The higher value from the optimism bias and the P(mean) from the QRA will be applied as an uplift to the base cost forecast in the OBC. The optimism bias and QRA estimate will not be used cumulatively in the VfM assessment.

5.2.1.6. The increased fleet requirements for added services will be captured within operational costs payable to the bus operator, rather than requiring an initial investment and subsequent renewals.

5.2.1.7. Complementary measures which will be funded by income from the area charge will also require capital cost contributions which will be included in this appraisal.

5.2.2. Whole life costs

5.2.2.1. Following initial implementation of the area charge scheme, regular maintenance and renewal cost will be captured on a regular cycle. Renewal of assets will also be captured, aligned to the operational lifespan of those assets. There may also be maintenance savings as a result of reduced vehicle*km in the highway network, which can be assessed with the Marginal External Cost (MEC) rates from DfT's latest TAG Databook.

5.2.3. Operating costs

5.2.3.1. Operating costs for the area charge equipment and services will be forecast on an annual basis, reflecting changes in numbers of trips by vehicle type which will be subject to the charge and changing methods of payment as users become more accustomed to the systems. These costs will be forecast from the opening date up to 2035 and assumed to remain stable thereafter, varying only in line with inflation.

5.2.3.2. Bus operating costs will reflect the change in services specified, and ongoing costs for maintenance of bus shelters and operation of CCTV will also be captured.

5.2.3.3. As for capital costs, operating costs will be inflated in real terms, converted to 2010 prices, discounted to 2010 and then converted to market prices.

5.2.3.4. There are no recommended specific optimism bias uplifts for operating costs in TAG due to insufficient evidence. However, the study which informed DfT's optimism bias guidance in TAG A1.2 did assess variations in operating costs from those forecast and the outcome of this study has been used to apply an uplift to the area charge operating and maintenance costs. Optimism bias has not been applied to costs for increased bus services or investment in complementary measures because, over the long-term, the investment in these areas will be determined by the value of revenue generated, rather than being a fixed commitment which could lead to over-spend if unit prices vary. The sensitivity of the VfM findings to changes in operating costs will be considered. This will be explored in the form of sensitivity tests.

[15] Updating the evidence behind the optimism bias uplifts for transport appraisals (publishing.service.gov.uk)

5.2.4. Bus operator subsidy

5.2.4.1. It will be assumed for the purpose of economic appraisal that the bus operator would experience no positive or negative net impact on operating margins as a result of this scheme.

5.2.4.2. At this stage of business case development, a number of procurement models are under consideration and the exact method by which costs and revenues of operating bus services may affect the public and private sector and any subsidies to operators affected which may become payable will need to be established at FBC.

5.2.4.3. Given this uncertainty both revenues and operating costs generated by the improved bus services have been assumed to affect the public sector. In practical terms this has no impact on the NPV, since transfer payments would affect PVB and PVC equally. The BCR would be affected, but since scenarios are expected to be financially positive the economic performance will be judged on the NPVs rather than BCRs.

5.2.4.4. Over the length of the appraisal period, commercial contracts will be renegotiated to adjust for changing revenues and costs. Subsidies may therefore become necessary to offset the difference between bus operating costs and bus revenues depending on the operating structure put in place.

5.2.4.5. Such a subsidy would be payable by the Greater Cambridge Partnership (GCP) and / or Cambridgeshire & Peterborough Combined Authority (CPCA) and so appear as a cost in the Public Accounts, adding to the total Present Value of Cost (PVC).

5.3. User benefits and revenues

5.3.1. Overview

5.3.1.1. A detailed assessment of monetised transport user benefits will be undertaken using DfT's TUBA v1.9.17 in accordance with TAG Unit A1-3. This assessment will be used to capture journey time savings, vehicle operating costs, user charge impacts from the area charge, parking charges and bus fares, revenues related to the same charges and indirect taxes.

5.3.1.2. While TUBA generates a forecast of greenhouse gas emissions (GHGs), this will be excluded from reported results as a more accurate approach to assessment of GHGs will be followed as described in chapter 7.

5.3.1.3. Scheme costs will also be captured externally to TUBA, using a spreadsheet-based method, to enable increased flexibility and precision.

5.3.2. TUBA methodology

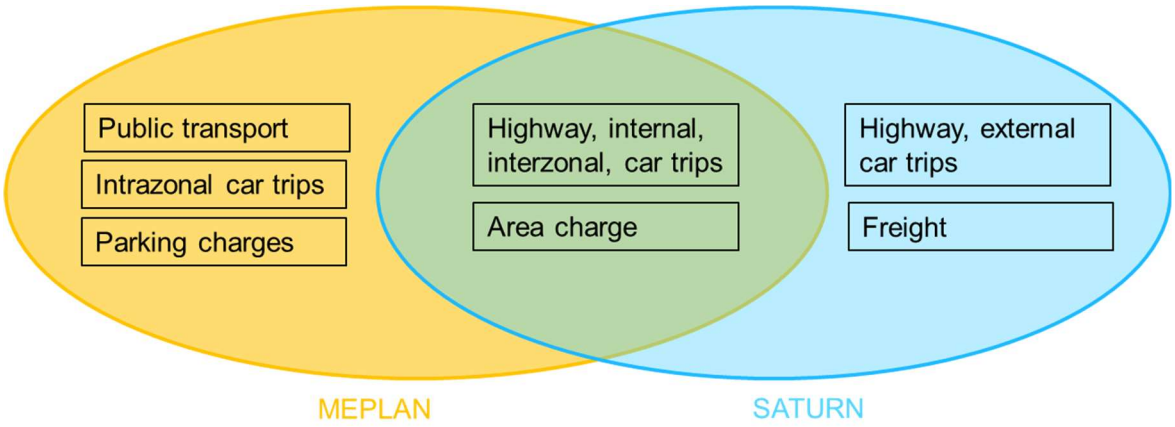
5.3.2.1. Owing to the structure of the CSRM2 transport model, including a SATURN model for highway assignment and an MEPLAN model used for demand modelling and public transport assignment, a bespoke approach has been developed to fully capture transport impacts as represented by TUBA while avoiding double counting. Details of this approach are set below.

Structure of Assessment

5.3.2.2. A detailed structure has been required for the TUBA assessment. This is in part down to the structure of the transport model and part because of the range of impacts being assessed.

5.3.2.3. Two separate but interactive models have been used to provide the best representation of the transport network and how the Making Connections scheme will affect users. The MEPLAN (demand and public transport (PT) assignment) and SATURN (highway assignment) models have both been used to inform the economic assessment but have slightly different scope as illustrated in Figure 5-1.

Figure 5-1 - Overlap of MEPLAN and SATURN



5.3.2.4. As shown in Figure 5-1, neither model in isolation can fully inform the appraisal, but using the two models in parallel and combining the outputs would result in double counting of benefits and revenues.

5.3.2.5. To eliminate the double counting, filtering has been applied. To help simplify the process and ensure that outputs can be easily understood, each pair of DM and DS scenarios[16] modelled through TUBA has been captured through the use of 6 different TUBA assessments.

Table 5-2 - TUBA Run Specifications

Test Name	Model Platform	Mode	Charges Used
A	MEPLAN	Car (External) and Freight	Area Charge
B	SATURN	Car (Internal)	Area Charge + Parking
C	MEPLAN	Public Transport (Excluding P&R)	PT Fares + Parking
D	MEPLAN	Park & Ride	PT Fares + Parking
E	MEPLAN	Park & Active	None
F	MEPLAN	Walk and Cycle	None

5.3.2.6. Fares represented in SATURN include only the Area Charge, while those in MEPLAN include both Area Charge and parking charges for highway trips, but these are represented as a single combined charge in MEPLAN. In order to distinguish between the two, matrices entered to TUBA Tests A and B have been manipulated prior to the TUBA runs to separate out the two elements overlap between SATURN and MEPLAN.

5.3.2.7. Demand matrices for Test A have been edited to remove all car trips which are not made between two external zones, while those for Test B retain only trips made to, from or within the internal area of the model.

5.3.2.8. As MEPLAN is only able to output the area charge and parking charges as a single matrix, these matrices have been edited externally to subtract the value of the area charge, as output by SATURN, so as to isolate the two charge components for use in TUBA.

5.3.2.9. Finally, matrices have been reviewed to identify cells which could lead to a perceived “new mode” or “large cost change” warning, which could relate to a distortion in the calculated benefits. As a number of entirely new bus services are introduced in the DS scenario there are a number of trips which will use these buses but will have no viable bus option in the DM scenario which can lead to warnings of this type. Measures have been taken to minimise such events, by producing TUBA outputs for several of the modelled public transport services as an aggregated sub mode, but this has not been sufficient to capture all cases.

5.3.2.10. Where such instances occurred, with demand values of zero in the DM scenario but non-zero in the DS scenario, journey cost matrices in the DM scenario have been capped to ensure that benefits

[16] The same DM scenario is used in all cases

reflect the value of having a new service available, but do not produce excessive benefits. This capping has employed a limit such that DM time may be no more than the DS time for the same movement and may also be no more than 4 hours. This approach has been followed as an alternative to the "Intermediate Point" modelling solution recommended in the TUBA manual, due to the widespread nature of the affected movements and resultant impracticality of applying that guidance.

5.3.2.11. Outputs of TUBA runs A to F are simply summed together to give the total benefits. However, certain adjustments have also been required to compensate for inflation.

Price base and growth

5.3.2.12. The CSRM2 has been developed with a 2015 base year. For this reason, all unit costs within the model are in 2015 real prices. To ensure that financial costs in the model, such as the proposed area charges and parking charges, have the correct impact in the demand and assignment modelling, these charges have been factored down to 2015 prices. This means that the area charge, of £5 in 2026 current prices, is represented in CSRM2 as £3.93 in 2015 prices. No real-terms growth in the area charge has been assumed in the model up to 2041. Similarly, parking charges have been identified in current 2022 prices and factored down to 2015 prices for use in CSRM2.

5.3.2.13. However, since development of the model inflation assumptions have been reviewed and it has been determined that real terms inflation of 0.7%[17] p.a. should be applied beyond 2026 up until 2041.

5.3.2.14. Unlike other charges in CSRM2 bus fares have been modelled to include inflation at a rate of RPI+2% p.a. through until 2041. No additional growth has therefore been required.

5.3.2.15. The TUBA assessment has applied factoring to all charge matrices to convert these from 2015 prices into 2010 real prices, consistent with all other parameters used in TUBA.

5.3.2.16. While TUBA includes functions to represent real-terms growth in values of time and vehicle operating costs over the appraisal period, it does not enable similar growth to be applied to charges. The TUBA outputs of user charge disbenefits and revenues have therefore been factored up externally to reflect the real growth assumptions described above, to build in this additional growth over time to the values generated for each year.

5.3.2.17. No additional growth in demand following the final forecast year of 2041 has been assumed.

User Charge of Freight Trips

5.3.2.18. CSRM2 is only able to represent the area charge based on a single value and is not able to apply the different charges to freight trips which form part of the scenario specifications. As freight trip demand does not respond to changes in cost in the model, this omission does not affect the model forecast, but it has been necessary to adapt TUBA outputs so that revenue and user charge disbenefits for LGVs and HGVs reflect the higher charges which apply to these modes.

5.3.2.19. Factors appropriate to each scenario have therefore been applied to these outputs to correctly capture the benefit and revenue impacts.

5.3.3. Sectoring and geographic scope of analysis

5.3.3.1. The sectoring system adopted is shown in Table 5-3. This system will be reviewed prior to commencing appraisal for OBC to ensure it will meet the needs of the appraisal. This will include consideration of merging some smaller sectors and dis-aggregating some larger sectors to best reflect the particular scheme options being considered.

5.3.3.2. A review undertaken at SOC suggested no masking benefits was necessary as the levels of model noise outside of the study area was limited. Checks will be performed to confirm whether or not this is still the case and masking will be applied if considered appropriate.

Table 5-3 - Making Connections Sectors

Sector	Area	Sector	Area
1	Cambridge	10	Newham

[17] This rate of growth has been identified based on TAG A5.3 recommendations for growth which would otherwise have relied on RPI, which is to be discontinued.

2	South Cambridgeshire (North)	11	Taunton Deane
3	South Cambridgeshire (South)	12	Chorley
4	South Cambridgeshire (East)	13	Suffolk Coastal
5	South Cambridgeshire (West)	14	Mole Valley
6	East Cambridgeshire	15	Kettering
7	Huntingdonshire	16	Chelmsford
8	Chatteris	17	East Hertfordshire
9	Colchester	18	South Norfolk

5.3.4. Annualisation factors – weekdays

5.3.4.1. Annualisation factors are used to convert from peak hour (SATURN) or peak period (MEPLAN) to annual values. These annualisation factors have been derived from the CSRM2 Technical Assurance Note and are set out in Table 2. As MEPLAN covers peak periods rather than peak hours these conversion factors are only required for highway trip data from SATURN.

Table 5-4 - Annualisation factors applied to SATURN outputs

Purpose	AM Factor	IP Factor	PM Factor
Commuting	2.506	6	2.348
Education	1.691	6	2.721
Business	2.964	6	2.883
Other	3.695	6	2.946

5.3.4.2. Having adjusted impacts calculated using SATURN from hourly to daily values, both SATURN and MEPLAN outputs are factored from daily to annual values using a factor of 253, representing the number of weekdays in the year excluding bank holidays.

5.3.5. Impacts during off peak and weekends

5.3.5.1. Up to this point in the Making Connections analysis no quantification has been applied to benefits or revenues generated during off peak and weekend periods as the CSRM2 model does not explicitly represent them. However, it is recognised that travel behaviour outside of peak times will be affected in a number of ways by the introduction of the Making Connections Programme. For instance:

- People may choose to make more journeys during off peak that they would otherwise have made during the peak, to avoid the charge.
- Enabling people to make commuting and school run journeys by bus may lead to a reduction in car ownership, which would affect off peak/weekend car journeys.
- More familiarity with using buses from use during peak times will generate greater willingness to use bus even outside of charging periods. The same will apply to active mode travel.
- Patterns of trips will also be affected, as all the elements above will vary between trips within the city and trips into the city from elsewhere.

5.3.5.2. As a result of this diverse range of factors contributing to variations in travel behaviour. A single forecast of off peak and weekend impacts is not considered appropriate.

5.3.5.3. In the absence of off peak and weekend modelling, an interpeak model supplemented by a review of traffic flows to identify periods which are suitably comparable is often used. However, this is not considered likely to be as reliable a method in this case due to the interaction between charging and non-charging periods at different times.

5.3.5.4. Consideration will therefore be given to impacts during this period, but is likely to be qualitative rather than quantitative and any quantified assessment will be treated as sensitivity testing rather than contributing to the core BCR.

5.3.6. Impacts during construction and maintenance

5.3.6.1. Overall, the impacts during construction and maintenance are expected to be small. Works required to implement the area charging element of the Making Connections programme will be generally off-line and should have limited impact on existing travel. The core component of the Area Charge scheme is the installation of ANPR cameras in the proposed charging zone. Installation may have some short-term adverse impact on existing travel. Any work to the bus fleet or stops (such as maintenance) can be carried out while vehicles are not in operation or when there are relatively low levels of demand at stops.

5.3.6.2. Some traffic management will likely be required while implementing any reallocation of road space for buses and to support the proposed sustainable transport interventions.

5.3.6.3. There will be limited impacts on embodied carbon with the low levels of construction works required.

5.3.6.4. In light of the above, no quantitative assessment is proposed to measure the impacts during construction and maintenance.

5.4. Environmental impacts

5.4.1.1. Monetised appraisals will be undertaken for air quality and greenhouse gas impacts (following the more detailed modelling approach from DEFRA). Consideration will also be given to monetising noise and landscape impacts in accordance with TAG. (Refer to Chapter 7 for further information).

5.4.1.2. Other environmental impacts will be assessed qualitatively as detailed in the relevant sub-sections in Chapter 7.

5.5. Safety impacts

5.5.1.1. DfT's COBALT v2.3 will be used to measure the impacts of road safety based on outputs from the transport model. This assessment will not assume any specific road safety measures are applied as part of the scheme, it will simply consider the reduction in road traffic resulting from the area charge and the increased attractiveness of public transport and any variations to network specifications resulting from reallocation of road space.

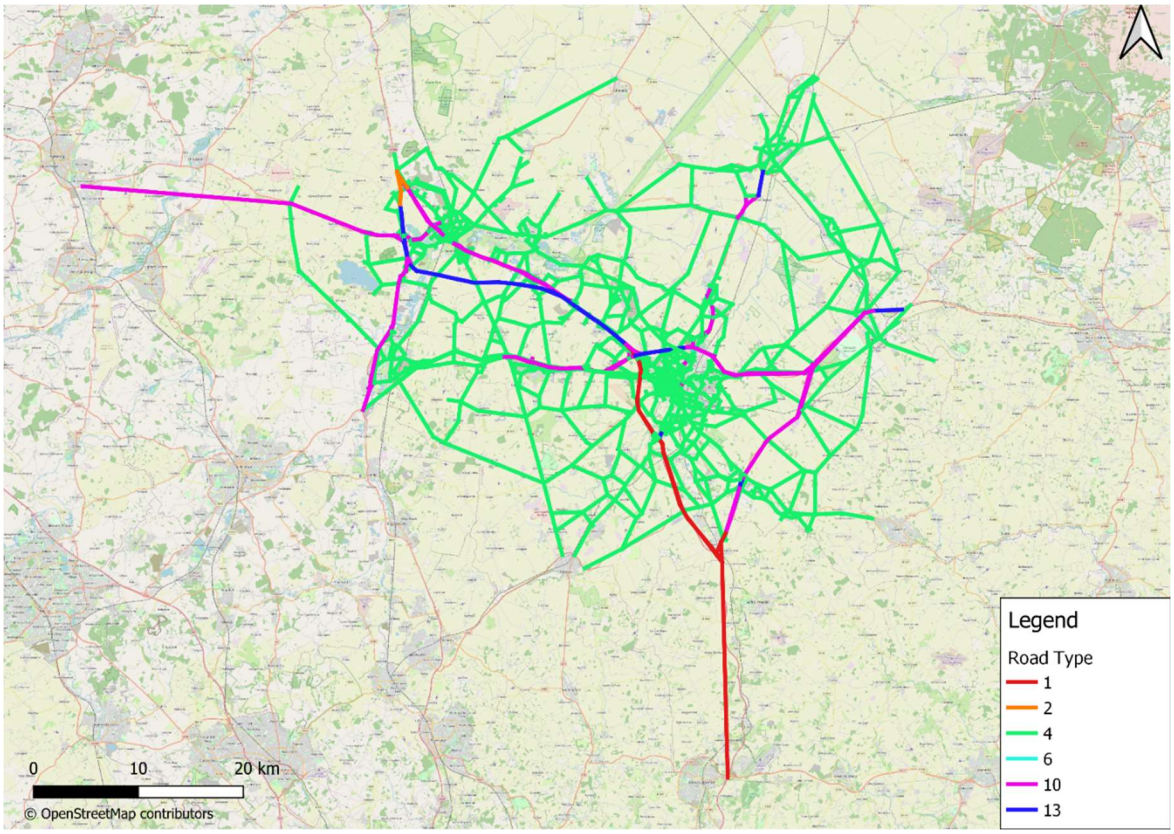
5.5.1.2. In practice any such variations would be required to conform with modern design standards, which in some areas is likely to result in improvements to safety standards. However, this level of detail in design is not currently available, so the conservative assumption will be taken that no change to safety related to design will occur.

5.5.1.3. Based on network characteristics, the change in vehicle kilometres on each modelled link will be translated into a forecast change in Personal Injury Accidents (PIAs) and damage only accidents. The assessment will follow the approach of link and junction combined accident rates since no changes to either links or junctions has been assumed.

5.5.1.4. Local accident rates will be reviewed to identify network sections where such data is considered sufficient to be reliable. Where links have low traffic flows any recorded accidents (or record of no accidents) are unlikely to provide a good representation of the long-term trend on that link. In such cases the default accident rates for each type of link, as defined within COBALT, will be applied.

5.5.1.5. The COBALT analysis will cover the area within the Cambridgeshire District boundary, but it will not consider the full model due to lack of detail in the outer sections of the modelled network. The assessment will focus on the area illustrated in Figure 5-2, which indicates COBALT link types defined according to a cross-reference with link specifications extracted from the SATURN model.

Figure 5-2 - COBA-LT study area



5.6. Active mode impacts

5.6.1.1. DfT's Active Mode Appraisal Toolkit (AMAT) will be used to assess the impacts of mode shift towards active travel on pedestrians and cyclists[18]. This provides a wider range of impacts for active mode users, such as health benefits and reduced absenteeism.

5.6.1.2. An appraisal period of 60 years will be adopted within the AMAT assessment. The choice of appraisal period is based on consideration that the potential behavioural change as a result of the proposed changes can be significant and also significant operating costs have been considered for 60 years after scheme opening. This ensures that the forecast costs and (dis)benefits are appraised consistently.

5.6.1.3. The scale of mode shift to active modes will be informed by the forecasts from the CSRM2 scenarios. Changes to facilities for either pedestrians or cyclists will not be included in the CSRM2 scenarios as specific details of these interventions were not available at the time of commissioning the model runs. This limitation is likely to lead to a conservative estimate of benefits from mode shift.

5.6.1.4. AMAT includes a calculation of decongestion benefits to remaining car users and to wider society, generated by the forecast number of trips mode shifting from car to active modes. These forecasts will be excluded to avoid double-counting as they were captured elsewhere in more detail. Only the benefits of health improvements (physical activity and reduced absenteeism) to those users who do choose to transfer to active modes will be claimed. This includes reduced risk of premature death and the saving in lost output for employers resulting from reduced absenteeism.

5.7. Place-Based impacts

5.7.1.1. A place-based impact assessment will be undertaken to consider what impact the Making Connections Programme will have within its surrounding area. This assessment will build upon the

[18] This will not account for impacts of sustainable transport measures, which have not been modelled.

findings of the Social and Distributional Impact (SDI) assessment to take a spatial view of potential impacts and using mapping tools to identify and highlight key findings. Details on the methodology for the SDI assessment are presented in Section 8 of this report.

5.7.1.2. Impacts on communities around Cambridge will be examined, taking into account areas which will experience a step change in public transport provision and areas which will experience changes in accessibility and attractiveness due to alterations in road use. This will also consider impacts on areas which may benefits less from the proposed public transport upgrades and therefore could experience adverse financial impacts as a result of the area charge.

5.7.1.3. This analysis will follow the guidance in TAG Unit A4-3. It will draw on findings of the Social and Distributional Impact Assessment and will be informed by outputs from other elements of assessment, including TUBA, COBALT, WITA and Environmental appraisal.

5.7.1.4. In general, the following steps are planned:

- Establishing that the geographical areas in scope align with the SDIA
- Aligning place-based analysis with the established scheme objectives
- Undertaking place-based analysis for the selected option(s)

5.7.1.5. The place-based analysis will primarily focus on the following impacts which will also inform the SDIA:

- User benefits – transport economic efficiency impacts for highway and public transport users
- Social impacts – quantified safety impacts
- Environmental impacts – quantified air quality (where available) and carbon assessment output

5.8. Level 2 – Reliability

5.8.1.1. Two components of reliability will be considered. Highway journey time reliability will assess according to TAG's Urban Roads approach which applies a derived relationship between changes in journey times and distances and journey time reliability. The second element relates to the reduction in the lateness of public transport services, measured based on current levels of reliability and how these will be expected to change as a result of the Making Connections Programme.

5.8.1.2. Benefits associated with highway journey time reliability will be quantified following the formulae below (Section 6.3, TAG Unit A1-3) and included in the adjusted BCR along with Level 2 wider economic impacts. Reliability impacts associated with public transport services will only be qualitatively assessed.

$$Highway\ Reliability\ Benefit = -\frac{1}{2}\sum_{ij} \Delta\sigma_{ij} * \left(T_{ij}^{0} + T_{ij}^{1}\right) * VOR$$

$$\Delta\sigma_{ij} = 0.0018\left(t_{ij2}^{2.02} - t_{ij}^{2.02}\right)d_{ij}^{-1.41}$$

where:

$\Delta\sigma_{ij}$	is the change in standard deviation of journey time from i to j (seconds)
t_{ij1} and t_{ij2}	are the journey times, before and after the change, from i to j (seconds)
d_{ij}	is the journey distance from i to j (km)
VOR	value of reliability (VOR) is obtained by multiplying the value of time by the reliability ratio (0.4)
T_{ij}^{0} and T_{ij}^{1}	are number of trips before and after the change

5.9. Level 2 – Wider economic impacts

5.9.1.1. In addition to reliability, Level 2 impacts cover a range of wider economic impacts as follows:

- Productivity gains from enhanced agglomeration (i.e. better access to economic mass) as individuals and firms derive productivity benefits from locating in close proximity to other individuals and firms.

- Labour supply impacts due to individuals moving into the labour market from economic inactivity and the tax wedge from these impacts.
- Output change in imperfectly competitive markets – changes in the level of output as a result of a transport investment are not unique to imperfectly competitive markets, but the presence of market failures in such markets means that there are additional sources of welfare which should be captured (i.e. the value of the output is greater than the costs of production).

5.9.1.2. All these have been identified in the scope of potential economic impacts from the Making Connections programme, as illustrated in Figure 3-1. Productivity uplift usually arise from improved labour market interactions, knowledge spill-overs and linkages between intermediate and final suppliers. For a place of significant economic mass like Cambridge, these may occur within an industry (localisation economies) and across industries (urbanisation economies) when significant changes in transport connectivity (to economic mass and opportunities) occur. Findings from the SOC suggest that the Making Connection programme is expected to bring significant changes in the transport network and travel demand / behaviours, with material changes to the cost of travel in different modes and significant modal shift expected. Significant improvement in the public transport connectivity and reduction in fare is expected, along with decongestion in the highway network as a result of modal shift. These will greatly enhance the access to economic mass through the local transport network. On the other hand, application of an area charge will also increase the cost of travel by private vehicles. Therefore, an increase in travel cost (i.e. reduced access by car) is expected as a result of the charge. Furthermore, the pattern of travel / distribution of journeys will also change the impacts of the aforementioned changes will influence different types of journeys / activities in different ways. The collective and net impact of these potential impacts on the access to economic mass (i.e. a key measure of agglomeration) has not been quantified so far, and therefore will be assessed in the OBC.

5.9.1.3. Labour supply impacts at Level 2 mainly capture the labour supply side response from the Making Connection programme. This will be based on the assumptions that the programme may bring material impacts to the following outcomes:

- Better job matching as travel to work areas expand
- Potential changes to the number of working hours
- Reduction in labour inactivity as more people enter the labour market

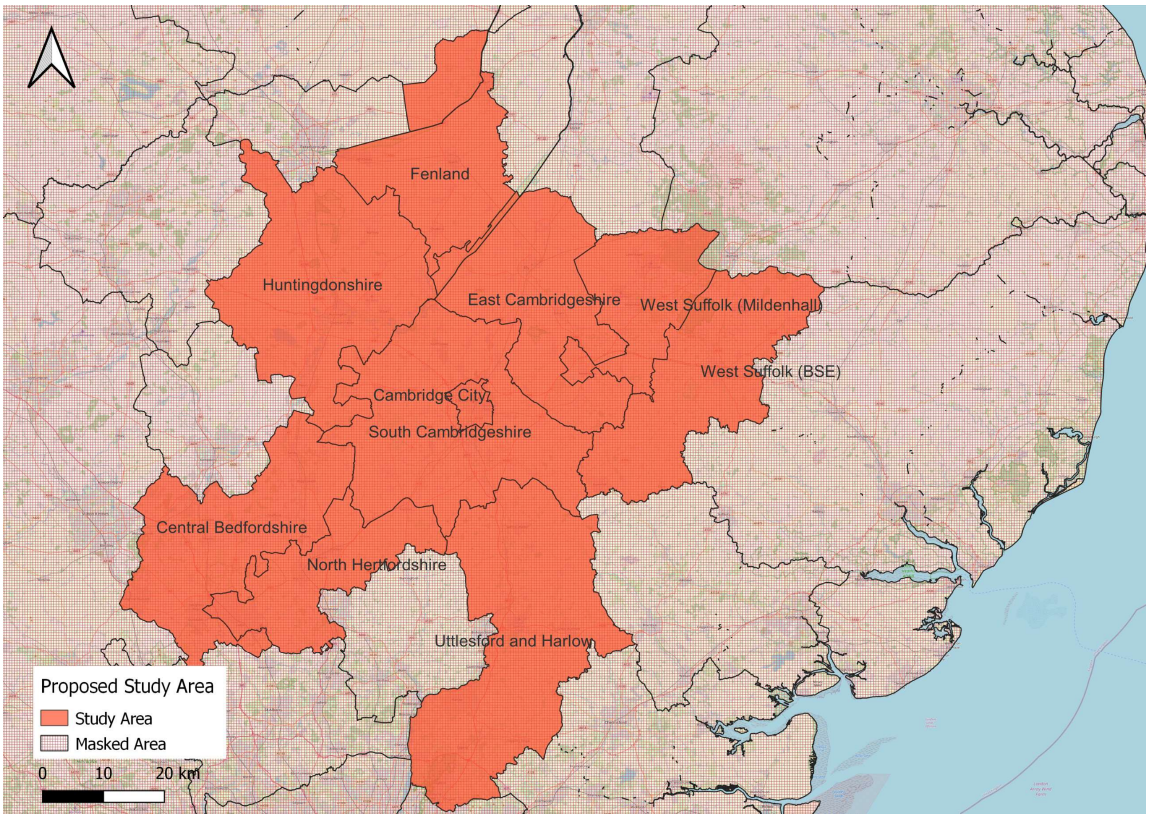
5.9.1.4. These changes have been captured in the scope of economic impacts identified in Figure 3-1. The discussion above about the connectivity impacts from the Making Connection programme also applies to commuting to work. The proposed programme will significantly improve and expand the travel to work areas, particularly for the public transport and some rural settlements in the region, along with clear decongestion in the highway. The proposed area charge on the other hand will increase the cost of travel to work by car to or from the city. The collective impacts of these different changes along with their welfare effects (i.e. tax wedge) will be captured in the OBC.

5.9.1.5. Both the productivity uplift (from changes in urban agglomeration) and labour supply impacts will be assessed in the OBC with WITA[19] v2.2, which is a standard tool for this purpose as recommended by DfT. This assessment will be undertaken strictly in line with the guidance in TAG with travel demand and cost data covering the entire country. Masking of benefits will be applied to focus on the study area illustrated in Figure 5-3 to improve the robustness of the forecast impacts.

5.9.1.6. The potential for output change in imperfectly competitive markets is informed by the evidence showing that transport acts as a barrier to investment. It is well narrated in the SOC and also touched on in this report that the Making Connections programme will contribute to unlocking development by providing capacity in the network to accommodate growth. This benefit stream can be estimated with a proxy that is equivalent to 10% of the business user transport economic efficiency impact in accordance with the guidance in TAG.

[19] The WITA software undertakes the appraisal of wider impacts appraisals in accordance with the Department for Transport's TAG Unit A.2 Wider Economic Impacts. The Department's TAG methods (and hence WITA) seeks only to capture the welfare impacts of employment, investment and productivity effects that are not already included in the conventional user benefit calculations for transport schemes (as undertaken by TUBA).

Figure 5-3 – WITA study area



5.10. Value for Money assessment

5.10.1.1. VfM assessment will be undertaken in accordance with the DfT Value for Money Framework. It will include consideration of all monetised and non-monetised impacts, and sensitivity analyses to determine the level of confidence in the core assessment, plus highlight any important areas of uncertainty that could affect the VfM categorisation.

5.10.1.2. The VfM categories and their relationship with benefit-cost ratios (BCRs), generated through cost-benefit analysis are presented in Table 5-5.

Table 5-5 - Value for Money categories

Value for Money category	Implies
Very high	BCR greater than or equal to 4
High	BCR between 2 and 4
Medium	BCR between 1.5 and 2
Low	BCR between 1 and 1.5
Poor	BCR between 0 and 1
Very poor	BCR less than or equal to 0

5.10.1.3. As has been identified in development of the SOC, depending on the specifications of the scheme it is possible that options considered may return negative costs and/or benefits. This is a result of the area charging element of the scheme which generates large amounts of revenue which can offset the relatively low implementation and operating cost. Depending on which elements of benefits are monetised the impact of the area charge on users can also offset decongestion benefits.

5.10.1.4. It is therefore also necessary to consider the value for money categories which may occur when revenues exceed costs, as set out in the VfM Framework and as illustrated in Figure 5-4.

Figure 5-4 - Value for Money when cost savings are generated

Very High (and Financially Positive)	Proposal generates benefits to wider society and 'pays for itself' in the long-run since outlays are less than revenues and cost-savings combined.
Economically Efficient Cost Savings	Cost savings outweigh benefit losses and thus overall public value is increased, implying value for money.
Potentially Efficient Cost Savings	Benefit losses outweigh cost savings, but only to a limited extent. As a result, if the money returned to the budget were spent on proposals representing at least Medium value for money, public value would increase overall. The ultimate outcome is therefore likely to represent value for money.
Poor (but Financially Positive)	Proposal results in benefit losses that outweigh cost savings to a greater extent. In these cases, even if the money returned was spent on a Medium value for money proposal, it would not lead to an overall increase in public value. Whilst there may be strong strategic, financial, management or commercial reasons for proceeding with these proposals, they are not considered to have a strong economic case.

5.10.1.5. These scenarios can result in negative BCRs if one or other of the cost and benefit is negative, or a positive BCR if both are negative. In this latter case careful interpretation is needed because the relationship between the BCR and Value for Money becomes inverted.

5.10.1.6. As has been highlighted above Value for Money is not represented only by the monetised elements which contribute to the BCRs, but will also consider qualitative elements of the assessment and the levels of uncertainty which can be reflected, which are discussed below.

5.11. Sensitivity tests

5.11.1.1. As set out in Section 3.5, Section 4.3 and Appendix C, consideration will be given in the OBC to a range of topics that reflect the uncertainties in the future. These cover uncertainties associated with the proposed programme as well as long-term uncertainties set out in the Common Analytical Scenarios (CAS) set out in the TAG Uncertainty Toolkit. The proposed approach for dealing with these uncertainties with a range of sensitivity test is illustrated in Figure 3-3 and detailed in Appendix C.

5.11.1.2. Following the approach articulated above, a range of other economic uncertainty analysis may also be considered in the sensitivity tests, which will include:

- Low/high values of time, reflecting uncertainty in the central forecasts as set out in TAG A1.3.
- Low/high costs, based on assumed changes to the operating costs.
- Low/high carbon values, based on TAG unit values.

5.11.1.3. These variants to core assumptions will be of relevance both in the short and long term.

5.11.1.4. Based on the findings of this analysis, capturing both the monetised and the qualitative elements, a cumulative uncertainty forecast will be developed to indicate the overall range of uncertainty within the results and the likelihood of this impacting on the central value for money category of the scheme.

Switching values will also be presented to indicate the scale of variation in either costs or benefits which would be required to result in a change of value for money category.

5.12. Change log

5.12.1.1. The table below records changes to this section of the ASR.

Table 5-6 - Economic appraisal change log

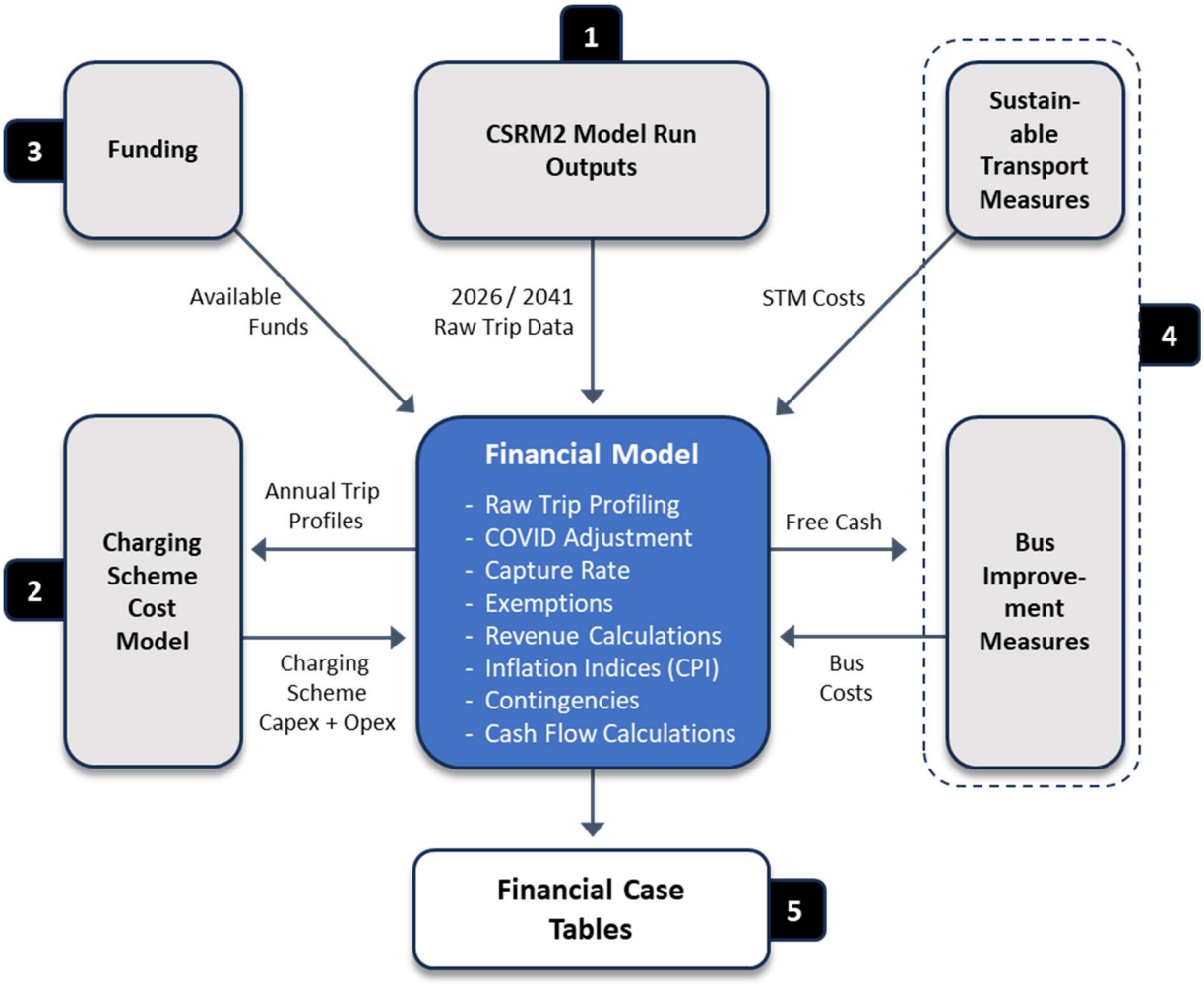
Revision no.	Description	Detail of change
0.1	Internal working draft	Approach set out building on that used for SOC
1.0	First draft for review	Approach taking on board the revised modelling specification in Jan 2023
2.0	Second draft	Updated 5.3.1 to take onboard evolution in TUBA assessment Added details on WITA analysis in 5.9 Updated 5.11 to align with the approach for managing uncertainties as set out in Appendix E
3.0	Third draft	Clarification of appraisal period assumptions including the use of 60-year appraisal for AMAT and identification of air quality and noise assessments as qualitative rather than quantitative.

6. Financial impact appraisal

6.1. Introduction

6.1.1.1. The Financial Model has a number of functions as summarised in the text and illustration below:

- It consolidates a range of data inputs, including costs.
- It carries out a number of calculations in order to produce annual net cash flow positions in real and nominal terms.
- It populates the key tables used in the Financial Case.



6.2. Trip data from CSRM2

6.2.1.1. Raw trip data will be taken from the CSRM2 model run outputs. These outputs show daily trip volumes in 2026 and 2041 and are received net of any same-day duplicate trips (as the charge will be applied per vehicle per day rather than per entry of the charge zone).

6.2.1.2. The Financial Model creates annualised trip profiles by multiplying the daily trip volumes by 252 days (on the basis of a Monday to Friday charge) and interpolating, on a straight-line basis, between the forecast 2026 and 2041 values.

6.2.1.3. Annual trip volumes will then be adjusted in the Financial Model for three elements: (1) COVID impacts – currently a 10% reduction[20], (2) trip capture rates – currently a 5% reduction and (3) charging exemptions/discounts (but not including free days) – currently a 20% reduction.

6.3. Charging scheme costs

6.3.1.1. Adjusted annual trip volumes are provided to the Charging Scheme Cost Model. In turn, the Charging Scheme Cost Model calculates the Charging Scheme capital and operating expenditure in 2022 terms. The Charging Scheme Cost Model also calculates the estimated impact on total trips of any free days taking into account assumptions contained therein in respect of account take-up and the number of trips per account. These outputs are provided to the Financial Model.

6.4. Charging Scheme Revenues and Funding

6.4.1.1. The Financial Model estimates annual revenues based upon the annual trip volumes adjusted for potential COVID impacts, the estimated impact of any free days and several other DERs for the scenarios where relevant impacts apply. Table 6-1 summarises these assumptions that will be adopted in the analysis. Please note that individual adjustments will only be applied to the scenarios where they apply. Full details of application will be reported in the OBC.

Table 6-1 – Revenue assumptions related to COVID impacts and DERs considered

Trip and revenue assumptions	Details
COVID Trip Adjustment	All daily trips are reduced by 10% to reflect post-COVID trip reductions
License Plate Read Charge Exemption	5% of all trips are assumed to be exempt from the charge due to a failure to accurately record the licence plate
Global Exemption (proxy for discounts, exemptions and reimbursements)	20% of all trips are assumed to be exempt from the charge
Hospital Parking Exemption (patients, visitors and staff parking – cars only)	2,750 car trips per day (693,000 per year) are assumed to be exempt from the charge
Free Days Exemption (applies only to car trips that are attached to an account)	The number of free days applied varies by individual scenarios proposed. Details are to be reported in the OBC.

6.4.1.2. Estimated revenues are combined with other funding sources, such as City Deal Funds, to generate a total annual estimate for Charging Scheme funds.

[20] This adjustment is independent of the COVID recovery related sensitivity test in the VfM assessment, which only informs the Economic Case.

6.5. Charging Scheme Free Cash Flows

6.5.1.1. The Financial Model makes two further adjustments before calculating free cash flows:

- Contingencies are applied to Charging Scheme revenues (currently a 20% reduction) and the Charging Scheme capital costs (currently a 40% increase) and operating costs (currently a 10% increase).
- Inflation is applied to Charging Scheme revenues and costs. CPI estimates from the Office for Budget Responsibility (OBR) are used in all cases. Costs are inflated every year from the designated base date for the estimates. Revenues are inflated every three years with an assumed 2027 base date.

6.5.1.2. Given the limited examples of city-wide charging in cities similar to Cambridge there is a degree of uncertainty around how car drivers may respond to a charge for driving. In addition to the uncertainty surrounding demand recovery or behavioural changes post Covid, there could further external factors, such as fuel price increases, that could change the relative cost of motoring to other forms of transport. For this reason, a 20% revenue contingency has been proposed in the financial model to ensure some headroom, should there be fluctuations in the scale of vehicles paying the charge.

6.5.1.3. Emerging results suggest that even in the lowest revenue generating option, the 20% revenue contingency is almost at the same level of magnitude as the annual operating costs. This demonstrates a resilience in the analysis to reduced revenue or increased operating costs.

6.5.1.4. 40% contingency was proposed to CAPEX given relatively early stage of design. This is deemed conservative as most of infrastructure (cameras and road side equipment) involved are from mature market place.

6.5.1.5. In addition to revenue and CAPEX contingency, 10% contingency on operating costs has been proposed. A relatively lower value has been chosen as the scheme operation will be adaptable in terms of fine tuning the staff resources to scale against the steady state. There are also options for further automation of services. All contingency assumptions made will be compared with the findings from the QRA.

6.5.1.6. Finally, the Charging Scheme free cash flow is calculated taking into account the funding, revenue and cost estimates described above.

6.6. Bus Improvement Measures and Sustainable Transport Measures

6.6.1.1. Expenditures on Bus Improvement Measures and Sustainable Transport Measures are calculated based upon the available free cash calculated in the Financial Model.

6.6.1.2. These costs are then returned to the Financial Model in order to generate summary tables required for the Financial Case

6.7. Sensitivity Analysis

6.7.1.1. Key inputs will be subject to sensitivity analysis. The final sensitivity analysis will depend upon the chosen scenarios but will likely include alternative inputs in respect of:

- Traffic volumes / profiles.
- Discounts and exemptions.
- Inflation indices.
- Scheme size.
- Account take-up and use of contact channels.
- Call centre location.
- Approach to back-office transaction processing

6.8. Change log

6.8.1.1. The table below records changes to this section of the ASR.

Table 6-2 – Financial appraisal change log

Revision no.	Description	Detail of change
0.1	Internal working draft	Approach set out building on that used for SOC
2.0	Second draft	Incorporated methodology for financial modelling
3.0	Third draft	Minor update on revenue contingency assumption (18% changed to 20%) with more narrative on the choices made Assumptions for revenue adjustments for COVID and DERs are presented.

7. Environmental appraisal

7.1. Input from the environmental appraisal team

The methodology proposed for each topic is presented in the following sub-sections:

- Noise – Section 7.2
- Air quality – Section 7.3
- Greenhouse gases – Section 7.4
- Landscape – Section 7.5
- Townscape – Section 7.6
- Historic environment – Section 7.7
- Biodiversity – Section 7.8
- Water environment – Section 7.9.

7.2. Noise

7.2.1.1. A reduction in car travel will reduce noise from traffic, particularly when those trips are instead made by active modes. The reduced noise impact will be assessed following the guidance in the Design Manual for Roads and Bridges (DMRB) LA111 Noise and Vibration. The investigation will focus on the difference or change in noise level as a result of different scheme scenarios. It will be used as the primary differentiator to determine the relative performance of individual scenarios from an acoustics perspective.

7.2.1.2. In order to determine the change in road traffic noise levels along each road link, firstly an 18-hour Basic Noise Level (BNL)[21] will be calculated for each road link in accordance with the Calculation of Road Traffic Noise (CRTN)[22] and based on the CSRM2 2026 forecast traffic flows. The change in noise level will then be calculated by comparing each of the proposed scenario against the DM, to predict the change in noise level as a result of each scheme option.

7.2.1.3. The DMRB criteria for assessing the magnitude of the predicted change in road traffic noise are set out in Table 7-1 below.

Table 7-1 – DMRB Criteria for Assessing the Magnitude of Changes in Road Traffic Noise

Magnitude	Noise level change, dB $L_{A10, 1h}$	Significance
Major beneficial	<= -5.0	Likely to be significant (beneficial)
Moderate beneficial	-4.9 to -3.0	
Minor beneficial	-2.9 to -1.0	Unlikely to be significant
Negligible	-0.9 to 0.9	
Minor adverse	1.0 to 2.9	
Moderate adverse	3.0 to 4.9	Likely to be significant (adverse)
Major adverse	>= 5	

[21] The Basic Noise Level (BNL) is described in the Calculation of Road Traffic Noise (CRTN). It does not relate to any specific receptor, but rather is a measure of source noise, at a reference distance of 10 m from the nearside carriageway edge of a specific length of highway. It is determined by obtaining the estimated noise level from the 18-hour traffic flow and then applying corrections for vehicle speed and percentage of heavy vehicles as described in CRTN.
[22] Department of Transport, (1988); Calculation of Road Traffic Noise. HMSO

7.3. Air quality

7.3.1.1. This section summarises the scheme air quality assessment carried out in 2022 (termed Phase 3B work) in parallel to the development of the SOC and what will be undertaken (termed Phase 4 work) to inform the OBC.

Phase 3B

7.3.1.2. The Making Connections Project proposes the introduction of a Sustainable Travel Zone (STZ) within Cambridge (as illustrated in Figure 3-2) with the aim to *'significantly improve the bus network, walking and cycling, as well as, reducing congestion and pollution'.*

7.3.1.3. The Phase 3B works (completed in 2022) considered the potential impacts of a number of STZ options, the following scenarios were included:

- 2019 baseline and model verification
- 2026 future baseline
- 2026 £5 all day charge
- 2026 £5 AM charge
- 2031 future baseline
- 2031 baseline with all electric buses
- 2031 £5 all day charge
- 2031 £5 all day charge with all electric buses

7.3.1.4. To assess the changes, i.e., impacts, in local air quality due to the introduction of the options in 2026 and 2031, detailed dispersion modelling was undertaken for nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$). At the request of Cambridge City Council, the modelling and analysis was undertaken by Cambridge Environmental Research Consultants (CERC). The detailed modelling methodology and analysis of the assessment findings can be found in their report[23].

7.3.1.5. The potential impacts of the modelled scenarios in 2026 and 2031 were determined using the descriptors published in the joint Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM) guidance[24].

7.3.1.6. Modelling of the 2026 and 2031 scenarios showed that the introduction of the £5 All Day Charge would result in the greatest widespread air quality improvements due to the predicted reduction in traffic flows. A summary of the key findings in relation to the £5 All Day Charge only is outlined below[25].

7.3.1.7. All day charging is predicted to lead to a reduction, i.e., an improvement, in NO_2 concentrations across Cambridge with the greatest decreases on major roads; however, there are a small number of roads where the modelling predicted small increases in NO_2 concentrations (i.e., a worsening in air quality) including:

- Some of the roads just outside the STZ, where traffic is predicted to increase, such as the road from Hauxton to Shelford
- Roads such as Regent Street and Station Road and those inside the Biomedical Campus, where there would be a significant increase in the number of buses
- Some roads close to the Park and Ride sites, such as Newmarket Road

7.3.1.8. The modelled changes in PM_{10} and $PM_{2.5}$ concentrations are smaller than for NO_2 and are restricted to along the major roads, including those within the STZ. Increases in concentrations were predicted along roads outside the charge area where traffic flows are predicted to increase, and along some central roads where there will be large increases in bus numbers.

7.3.1.9. The modelling also showed increases in concentrations along some roads in Newmarket, where an increase in buses is planned.

[23] CERC (2022) Air Quality Modelling for Greater Cambridge Partnership Making Connections Project.
[24] Environmental Protection UK and Institute of Air Quality Management (2017) Land Use Planning & Development Control: Planning for Air Quality (version 1.2) [online]. Available at: https://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf [Accessed July 2023].
[25] Discussion of the other modelled scenarios is included with the CERC modelling report.

7.3.1.10. The impacts due to the introduction of the £5 All Day Charge in 2026 are classed as slight beneficial for the major roads in the STZ, including Mill Road, Parker Street, Emmanuel Street, Magdalene Street and Victoria Road. Beneficial impacts were also seen at some busy junctions such as Lensfield Road/Fen Causeway, Mitcham's Corner and the Elizabeth Way/Chesterton Road roundabout.

7.3.1.11. The introduction of the charge in 2031 has a slight beneficial impact on small areas on Mill Road and at Mitcham's Corner.

7.3.1.12. All changes outside the STZ, including in Newmarket, were negligible.

Phase 4

7.3.1.13. Since the completion of the Phase 3B assessment (outlined above) in 2022, updated traffic model runs have been undertaken for all scenarios taken forward from the new OAR (as given in Table 3-1 of this report) for 2026 and 2041 forecast years.

7.3.1.14. The outputs of the previous air quality assessment will be reviewed to identify those areas that experienced the greatest changes (both decreases and increases) in pollutant concentrations in each of the scenarios assessed, including the 'hot spots' identified in paragraph 7.3.1.7 where air quality was predicted to worsen.

7.3.1.15. The revised traffic data will be reviewed and the change in total vehicle flows for each of the revised scenarios, when compared to the relevant baseline year, will be calculated. Using the CERC modelling as a base, a comparison will then be made between the traffic data provided for 2022 Phase 3B modelling against the revised traffic data that will be made available in 2023.

7.3.1.16. A qualitative, high-level assessment will be undertaken to determine:

- Where traffic increases and decreases will be the greatest, and therefore lead to disbenefits and benefits, respectively, in terms of local air quality
- The relevant public exposure on routes with major changes and areas of social deprivation

7.3.1.17. The analysis will be used to identify areas of concern and which of the proposed charging scenarios is most favourable, drawing on the conclusions of the Phase 3B modelling.

7.4. Greenhouse Gases

7.4.1.1. This impact will be assessed in line with the latest guidance from DfT in TAG Unit A3.

7.4.1.2. In accordance with the latest guidance from DfT in TAG Unit A3, this assessment of Greenhouse Gases will seek to consider carbon emissions over the whole lifecycle of the proposed interventions, including user carbon (emissions associated with scheme users, such as changes in emissions due to modal-shift), capital carbon (emissions associated with scheme construction) and operational carbon (emissions associated with scheme operation and maintenance).

7.4.1.3. The quantification of carbon impacts will predominantly use appraisal, modelling and cost estimation outputs. It will apply industry standard methodologies to calculate carbon impacts. Several tools bespoke to different impacts will be used in these carbon calculations, but the workings and results will be collated within WSP's Carbon Zero Appraisal Framework for the purpose of bringing individual calculations and the supporting qualitative assessment together in a consistent, transparent format

7.5. Other Environmental Impacts

7.5.1.1. Based on initial findings from the SOC, the proposed interventions were not found to have significant impacts on other aspects of the environmental assessment such as landscape, townscape, historic environment, biodiversity and water environment. Therefore, these will be assessed qualitatively in the OBC.

7.6. Change log

7.6.1.1. The table below records changes to this section of the ASR.

Table 7-2 – Environmental appraisal change log

Revision no.	Description	Detail of change
0.1	Internal working draft	Approach set out building on that used for SOC
2.0	Second draft	Incorporated methodology for AQ and GHG
3.0	Third draft	Refinement of assessment methodology for some environmental impacts

8. SDI and EqIA Assessments

8.1. Social impacts

8.1.1. Introduction

8.1.1.1. Social impacts cover the human experience of the transport system and its impact on social factors not considered as part of economic or environmental impacts. These impacts may positively or negatively influence the preferences, well-being, behaviour or perception of residents and other social groups. The purpose of the Social Impact Appraisal is to evaluate, and where appropriate quantify, these impacts in order that they can be considered relative to other outcomes and where possible mitigated. The SIA forms part of the options appraisal process and will feed into the Appraisal Summary Table. The SIA will be undertaken in accordance with TAG Unit A4.1.

8.1.2. Approach for SOC

8.1.2.1. At SOC stage, the Social Impact Assessment was undertaken using information available for the scheme. The assessment was undertaken in line with TAG Unit A4.1 and a full assessment for the consultation option was undertaken. The Social Impact Assessment informed the Economic Case within the SOC.

8.1.3. Approach for OBC

8.1.3.1. As part of the update to the OAR and OBC development, further illustrative scenarios of Making Connections programme were identified alongside the consultation option. This SDIA will be updated from the SOC to include a full assessment of the best performing option in the OBC along with a high-level qualitative assessment comparing results from the selected option to other options taken forward in the OAR.

8.1.4. Safety

8.1.4.1. The proposed scheme could result in changes to the volume of traffic across the road network and could therefore impact on the number and type of accidents. The assessment will be based on a comparison of accidents ‘with-scheme’ and ‘without-scheme’ forecasts, using a 7-point scale.

8.1.5. Physical activity

8.1.5.1. The proposed scheme that are being assessed may cause an impact to the amount of daily physical activity that people undertake. This could result from any complementary walking and cycling measures being delivered as well as from a modal shift to public transport as more people would likely be walking or cycling to bus stops. To assess the changes in physical activity, the estimated net change in car, active travel, and public transport trips will be assessed.

8.1.6. Security

8.1.6.1. As part of the proposed scheme being put forward, there are several complementary measures being proposed including bus network improvements. The assessment of security will largely relate to any changes in public transport waiting or interchange facilities, changes to pedestrian access, changes to visibility or natural surveillance etc. The assessment of security impacts will be based on a series of security indicators set out in TAG Unit A4.1 including site perimeters, entrances and exits, formal surveillance, informal surveillance, landscaping, lighting and visibility and emergency calls. Each of these indicators will be assigned a relative importance (low, medium, or high) and a qualitative assessment (using the 7-point scale) will be made on the impact of the proposals both with and without scheme.

8.1.7. Severance

8.1.7.0. TAG Unit A4.1 requires the assessment of individuals whose access to community facilities would be impacted by the programme. The assessment is largely concerned with non-road users i.e.,

pedestrians. It takes into consideration any physical and perceived barriers (e.g., route diversions resulting in increased journey times) for people to access facilities. The assessment will be focused on any physical barriers created by the proposed illustrative scenarios or if traffic changes resulting from the programme remove or create barriers for local people.

8.1.7.1. The assessment will focus on areas where there will be an increase or decrease in traffic flow of 10% and identification of key routes where journeys would be impacted. A map of key routes will be created to aid in the assessment of severance impacts. Severance would have an impact if local residents were unable to access community facilities. As such, we will identify any facilities located within an 800m buffer boundary of areas where there are significant changes in traffic flow. This will be undertaken in line with Design Manual for Roads and Bridges (DMRB) guidance as outlined within TAG Unit A4.1.

8.1.7.2. The impact of severance will be assessed with and without scheme and may be classified according to the following four broad levels: None, Slight, Moderate and Severe. An overall assessment will then be made in line with Table 5.1 within TAG Unit A4.1.

8.1.8. Journey quality

8.1.8.1. As outlined within TAG unit A4.1, journey quality refers to a measure of the real and perceived physical and social environment experienced while travelling. Factors affecting journey quality include public information provision, perceptions of safety, provisions for accessibility, physical crowding on public transport services etc.

8.1.8.2. Journey quality will be identified across three main categories as follows:

- Traveller care
- Traveller views
- Traveller stress

8.1.8.3. An initial qualitative assessment will be undertaken to assess the difference in journey quality in a ‘with scheme’ and ‘without scheme’ scenario, using a 7-point scale.

8.1.9. Option and non-use values

8.1.9.1. The requirement to assess option and non-use values arises when there is a change in the availability of transport services and includes the introduction of local bus services. The assessment will consider the number of households impacted by any proposals. A qualitative score will be assigned as follows:

- >1,000 households: Large impact
- 250-999 households: Moderate impact
- 1-249 households: Slight impact
- 0 households: Neutral impact

8.1.9.2. The values are assessed as beneficial when a service is introduced and as adverse when a service is removed.

8.1.10. Accessibility

8.1.10.1. TAG Unit A4.1 identifies five key barriers that impact upon accessibility, as follows:

- The availability and physical accessibility of transport: For some people in isolated urban and rural areas there are limited or no public transport services or the services are unreliable, or do not go to the right places or at the right times.
- Cost of transport: Some people find the costs of personal or public transport very high or unaffordable.
- Services and activities located in inaccessible places: Developments including housing, hospitals, business and retail are often located in areas not easily accessible to people without a car.
- Safety and security: Some people will not use public transport or walk to key services because of the fear of crime or anti-social behaviour.

- Travel horizons: Some people are unwilling to travel long journey times or distances or may not know about or trust transport services.

8.1.10.2. A qualitative assessment will be undertaken for each of the barriers listed above and will inform a more detailed analysis of accessibility within the Distributional Impacts Assessment (DIA).

8.1.11. Personal affordability

8.1.11.1. The introduction of road user charging will have a direct and tangible impact on the affordability of travel by car for some users. Measures to reduce bus fares will also impact on personal affordability of public transport. A full assessment of personal affordability will be undertaken within the DIA.

8.2. Distributional impacts

8.2.1. Introduction

8.2.1.1. Distributional impacts (DI) relate to the extent to which there are differences in the way impacts affect different groups in society. For example, the noise impacts of an intervention will affect different groups of households, with some experiencing increases, and others decreases. DIA is required within the options appraisal process and feeds into the Appraisal Summary Table produced for the Making Connections Programme. Both beneficial and/or adverse distributional impacts of the proposed interventions have been considered along with the identification of the different social groups that are likely to be affected. The assessment will be carried out in line with TAG Unit A4.2.

8.2.2. Approach for SOC

8.2.2.1. A Distributional Impact Assessment (DIA) was undertaken in accordance with TAG Unit A4.2 for the consultation and its outputs informed the Economic Case. The assessment for the DIA was structured around each topic which was scoped into the assessment through a screening exercise. Where sufficient data was available, the assessment of impacts was carried out qualitatively. Where limited information was available and high-level indication of assessment was carried out using a 3-point scale compared to the detailed 7-point scale.

8.2.3. Approach for OBC

8.2.3.1. A key step in the DIA is undertaking a **screening exercise**. The topics that are included within this stage are those that are outlined within TAG Unit A4.2. The screening exercise has established what topics will be scoped into the assessment. The scoping of topics is based on the relevance of these topics to the illustrative scenarios being considered and the data availability to undertake the analysis.

Table 8-1 – DIA screening findings

Indicator	Appraisal Output Criteria	Potential Impact (Yes/ No/ Positive/ Negative) if known	Inclusion within DIA (Yes/No)
User benefits	In the absence of the TUBA user benefit analysis software a high-level qualitative assessment has been used in the appraisal.	Yes – Positive overall (subject to further work)	Yes
Noise	Any change in alignment of transport corridor or any links with significant changes (>25% or <-20%) in vehicle flow, speed or %HDV content. Also note comment in TAG Unit A3.	Yes – Positive (subject to further work)	Yes
Air quality	Any change in alignment of transport corridor or any links with significant changes in vehicle flow, speed or %HDV (Heavy-Duty Vehicles) content: • Change in 24-hour AADT of 1,000 vehicles or more • Change in 24-hour AADT of HDV of 200 HDV vehicles or more • Change in daily average speed of 10kph or	Yes – Positive (subject to further work)	Yes

	more • Change in peak hour speed of 20kph or more • Change in road alignment of 5m or more		
Accidents	Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts, or any links with significant changes in vehicle flow, speed, %HGV content or any significant change (>10%) in the number of pedestrians, cyclists or motorcyclists using road network.	Yes- (subject to further work)	Yes
Security	Any change in public transport waiting/interchange facilities including pedestrian access expected to affect user perceptions of personal security.	Yes	Yes
Severance	Introduction or removal of barriers to pedestrian movement, either through changes to road crossing provision, or through introduction of new public transport or road corridors. Any areas with significant changes (>10%) in vehicle flow, speed, %HGV content.	No- (subject to further work)	Yes
Accessibility	Changes in routings or timings of current public transport services, any changes to public transport provision, including routing, frequencies, waiting facilities (bus stops / rail stations) and rolling stock, or any indirect impacts on accessibility to services (e.g., demolition & re-location of a school).	Yes – Positive	No
Affordability	The Making Connections programme will significantly improve public and active travel which will include a reduction in fares on the bus network and will encourage a mode shift to using public transport and active travel. These modes are a lower cost option compared to driving due to the wider costs associated with car ownership and offer a lower cost option for travel especially for those in the least deprived quintile. A discount for lower income households is being considered as part of the proposals for individuals who are unable to complete trips by public transport or active travel.	Yes – Slight beneficial (subject to further work)	Yes

8.2.4. User Benefits

8.2.4.1. The assessment of user benefits within the DIA focuses on analysing the spatial distribution of user benefits against the distribution of income. To understand these benefits, the outcomes from the Department for Transport's programme of Transport Users Benefit Appraisal (TUBA) are used to ascertain user benefits. The user benefits reflect the change in the cost of travel, which considers travel time costs, fuel and non-operating costs as well as user charges. This applies to business, commuter, and other transport users. Any increases in travel costs would lead to user disbenefits and any decreases in travel costs would lead to user benefits.

8.2.4.2. The user benefits for each zone which fall within the defined study area will be analysed, with the assessment of user benefits only considering non-business journeys. It is deemed inappropriate to conduct a DIA for business journeys as any benefits or disbenefits are experienced by businesses rather than individuals. The assessment of user benefits within the DIA will be calculated for the AM

peak, inter peak and PM peak periods. User benefits are reported at discounted present values in 2010 prices and are calculated over a 60-year appraisal period.

8.2.4.3. The distribution of these user benefits will then be mapped against the Index of Multiple Deprivation, specifically the Income Domain, grouped into quintiles, across the Lower Super Output Areas (LSOAs) within the defined study area.

8.2.5. Accidents

8.2.5.1. Should the Proposed Scheme result in a change of more than 10% on the various routes being considered for the following variables: vehicle flow, speed, heavy duty vehicles or pedestrians for road user charging then accident analysis will be required.

8.2.5.2. An analysis of STATS19 data will be undertaken to identify casualties by vulnerable group for the study area. The casualty data will then be analysed against the following vulnerable groups:

- Pedestrians
- Children as pedestrians
- Older people as pedestrians
- Children excluding pedestrians.
- Older people excluding pedestrians.
- Young male drivers
- Cyclists

8.2.5.3. The accidents by vulnerable groups will be mapped to identify the cluster of hotspots. In line with TAG, with and without scheme accident analysis will be used to ascertain the total number of accidents and casualties by severity of injury (fatal, serious and slight) within the impact appraisal. The forecast change in accidents will be analysed against vulnerable user groups to assess whether there are any distributional impacts.

8.2.6. Noise

8.2.6.1. The DIA assesses noise impacts resulting from the proposals against the distribution of income as well as vulnerable groups, particularly children aged 0-15 years and older people aged 65 and over.

8.2.6.2. The assessment will draw on the predicted changes to noise levels resulting from changes to traffic levels because of the programme. The assessment will consist of mapping affected locations including residential and non-residential locations (non-residential locations will focus on places where people may gather) to LSOAs particularly looking at income and vulnerable groups. This will enable us to ascertain where people in each group experience adverse changes (forecasted increases in noise), beneficial changes (forecast decrease in noise) or no-change in noise levels.

8.2.7. Air Quality

8.2.7.1. The DIA assesses air quality impacts resulting from the proposals against the distribution of income as well as vulnerable groups, particularly children aged 0-15 years. The air quality modelling outputs are unavailable for this issue of the report and will be assessed in further stages of the programme.

8.2.7.2. The assessment will draw on the predicted changes to air quality resulting from changes to traffic levels because of the programme. The assessment has consisted of mapping affected locations including residential and non-residential locations (where non-residential locations are places where people may gather) to LSOAs, particularly looking at income and vulnerable groups. This has enabled us to ascertain the proportion of the population in each group that could experience adverse changes (forecasted increases in air pollutants), beneficial changes (forecast decrease in air pollutants), and no-change in air pollutants.

8.2.8. Security

8.2.8.1. The DIA builds on the assessment outcomes of the SIA. Using the assessment outcomes, the vulnerable groups who have concerns about their personal security especially regarding journeys completed on public transport will be mapped. Vulnerable groups include older people, children, women, people with disabilities, ethnic minority groups and those within the LGBTQ+ community.

8.2.8.2. It is hard to quantitatively assess security benefits or disbenefits, therefore a qualitative analysis will be undertaken for a 'with programme and 'without programme scenario. The assessment will be undertaken in line with the framework provided within TAG Unit A4.2.

8.2.9. Accessibility

8.2.9.1. A series of wider public and active travel improvements are proposed as part of the Making Connections programme. The accessibility assessment will take into consideration any changes in routing, frequency or timing of public transport services as well as key destinations that local residents would be travelling to. The exact details of these interventions are unavailable at present and so a high-level qualitative assessment will be made. Changes to public transport journeys will then be considered for vulnerable groups. These groups include:

- Young people
- Older people
- Women
- Individuals with disabilities
- Low-income households

8.2.9.2. This is largely a qualitative assessment and is informed by on-going work from the Bus Strategy team.

8.2.10. Severance

8.2.10.1. Assessment of severance within the DIA is largely related to traffic related severance to understand how changes in traffic may impact journeys of vulnerable groups. It will build on outcomes from the SIA. As defined within TAG Unit A4.2, community severance is related to separation of residents from community facilities and services caused by changes in infrastructure or traffic flow. Severance will be assessed across vulnerable groups, which will include the following:

- Children under 16
- People aged 65 and over
- People with a disability
- People without access to a car

8.2.11. Personal Affordability

8.2.11.1. The assessment of affordability focuses on personal affordability impacts of the proposed illustrative scenarios and is assessed against the distribution of income groups. As the illustrative scenarios propose a form of road user charging, the increased monetary costs of travel can become a barrier for travel for certain groups. A DIA of personal affordability has analysed the IMD Income Domain data within the LSOAs in the study area and has been compared to regional and national comparators to understand whether there is a distributional effect. It is recommended within TAG guidance that the assessment should consider potential TUBA cost changes for non-business users in the assessment of personal affordability. However, changes in vehicle operating costs are already considered in the analysis of user benefits for non-business users, which is appraised as a separate impact category. Therefore, this DIA report does not report a TUBA based personal affordability analysis. Instead, a qualitative analysis of increases and decreases to travel costs against the IMD Income Domain statistics for LSOA's in the study area will be undertaken.

8.3. Equality impact assessment

8.3.1. Introduction

8.3.1.1. An Equality Impact Assessment (EqIA) is an assessment of the likelihood or actual effects of policies or proposals on social groups as defined in the Equality Act 2010. These groups known as Protected Characteristic Groups (PCG) are: Age, Disability, Gender Reassignment, Pregnancy and Maternity, Race, Religion, Sex, Sexual Orientation, Marriage and Civil Partnership.

8.3.1.2. An EqIA is used to inform the Scheme design, so that identified negative impacts can be mitigated as much as possible, and any opportunities for furthering equality aims are taken. As set out in the Equality Act 2010, the public sector equality duty states that a public authority must, in the exercise of its functions, have due regard to the need to:

- Eliminate discrimination, harassment, victimisation and any other conduct that is prohibited by or under this Act.
- Advance equality of opportunity between persons who share a relevant protected characteristic and persons who do not share it.
- Foster good relations between persons who share a relevant protected characteristic and persons who do not share it

8.3.1.3. The EqIA focuses on impacts the Scheme may have on road users, staff, stakeholders and PCGs.

8.3.1.4. The EqIA remains live throughout the Scheme's development and implementation. It is reviewed and updated as the Scheme progresses, in line with any design changes, phases of work and new information relevant to the EqIA, such as any additional consultation if required, to ensure all impacts are captured, mitigated and monitored accordingly.

8.3.2. Approach for OBC

8.3.2.1. During Summer 2022 an EqIA was developed for the SOC. Since then, further consultation on the Scheme has been done and the Scheme details have been developed further. Therefore, the EqIA is now being updated to reflect the changes to date, and to help inform the OBC.

8.3.2.2. Update to the EqIA will involve the following activities:

- Examination of the Scheme changes since the Summer 2022 EqIA update, to incorporate the latest programme for the STZ, bus improvements and sustainable travel improvements.
- An update of the baseline data used to examine the demographics of those living within Cambridgeshire, to ensure the most current data is included in the assessment, such as Census 2021 data.
- An update of socio-demographic maps in order to identify areas within the study area where there are key hotspots of PCGs.
- A series of meetings with equalities representatives within Cambridge City Council, Cambridgeshire County Council and South Cambridgeshire Council, with the aim of ensuring any potential equalities differences across the authorities are considered. This was also an opportunity to review the previous EqIA iteration, in light of the Scheme's development and consultation outcomes, and incorporate additional demographic groups relevant to the Scheme, not captured within the Equality Act 2010 nine PCGs. Including low income, carers, care leavers and armed forces veterans.
- Holding meetings with equalities representatives is also valuable in drawing on local knowledge of the area, including experience working with communities across the study area.
- Examination of the consultation report, summarising the latest public consultation undertaken during November and December 2022, in order to extract information to inform the EqIA.
- Collating all of the gathered data and information into the EqIA report, and assessing the potential impacts of the Scheme features, namely the impact of the STZ charge, and the impact of the bus and sustainable travel improvements, upon the PCGs.
- The EqIA concludes its findings along with recommended mitigations where possible to reduce or eliminate negative impacts. Then EqIA also poses further areas for assessment, to be addressed as the Scheme programme is developed further.

8.4. Change log

8.4.1.1. The table below records changes to this section of the ASR.

Table 8-2 – SDI appraisal change log

Revision no.	Description	Detail of change
0.1	Internal working draft	Approach set out building on that used for SOC
2.0	2nd draft	Included draft methodology for SDI and EqIA assessment

Appendices

Appendix A. The Background of Making Connections Programme

A.1. Greater Cambridge

Greater Cambridge is made up of South Cambridgeshire District and the City of Cambridge, in the county of Cambridgeshire, as highlighted in the map below showing Greater Cambridge and its neighbouring local authorities.

© OpenStreetMap contributors

Greater Cambridge is home to 307,700[26] people. It has a diverse economic base with strengths across a broad base of knowledge intensive sectors: professional, scientific, bio-medical, clean-tech, technology, and advanced manufacturing. It is host to some of the most productive and innovative parts of the UK economy, competing on a global stage, and attracting high-tech investment to the UK. It is considered to be the innovation capital of the country, with more patents per 100,000 population than any other city and twice as many as the next city[27]. Cambridge is home to two universities, Cambridge and Anglia Ruskin, and a world-class hospital[28]. As a historic city, Cambridge has a strong visitor economy.

A.2. The Cambridge Phenomenon

Greater Cambridge's economic success to date is the story of a networked and highly connected city region, characterised by world-leading innovation. The emergence and growth of a cluster of high-technology firms around Cambridge – the "Cambridge Phenomenon[29]" – has been attributed to the following factors:

- a world class university drew talent into the area from across the globe.
- the area's scale and connectedness.
- Cambridge is an attractive place and competes with other world cities as a good place for business leaders and their families to live.

[26] Making Connections (amazonaws.com)
[27] Centre for Cities, Cities Outlook 2017 (2017)

[28] Addenbrooke's hospital
[29] The Cambridge Phenomenon, a term first coined by Peta Levi in a Financial Times article in November 1980, describes the incredible explosion of technology, life sciences and service companies that has occurred in the city since 1960.

The vibrant economy of Greater Cambridge is already leading to strong growth in population and jobs and, consequently, housing need and increased pressure on transport networks. People travel from a wide area to work in and around Cambridge, and many of these journeys are made by car. Cambridge is also indisputably a city with an abundance of cyclists. In fact, it is the only city in the UK where the proportion of people regularly cycling outweighs those who do not – 54 per cent versus 46 per cent[30]. Although few would question that Cambridge is a cycling city, establishing whether or not it is a friendly place for cyclists is another matter. Increasing traffic as a result of its own economic success means that congestion is a major and growing problem, threatening mobility, health and well-being, and detracting from the appeal of Cambridge for residents, employees, businesses and visitors. Congestion therefore impacts the quality of life of existing residents and employees and will constrain further economic growth. Increasing traffic also contributes to poor air quality and high carbon emissions, whilst people without access to a car are held back from accessing opportunities by a lack of viable public transport or limited walking and cycling connections.

In summary, the success of the Cambridge phenomenon has brought a series of transport related challenges, which need to be addressed in order to protect the wellbeing of the local residents and achieve continued growth. These problems are outlined below and are examined in detail in the Case for Change section of the SOC (Section 1.6) completed in August 2022.

- Continued growth of traffic and congestion, as more people live in and travel to the area for work.
- Limited choices for people to travel by public transport with approximately 10%[31] modal share for public transport in all travel to work journeys within, to and from Greater Cambridge.
- Poor air quality with 106 deaths each year in Greater Cambridge attributable to air pollution.
- High levels of carbon emissions due to high levels of car use, contributing to climate change.
- A city environment dominated by the car, which discourages some people from walking and cycling and makes our public spaces less attractive.
- Difficulty in accessing opportunities for those who rely on public transport.

A.3. The Greater Cambridge City Deal

The City Deal (signed on 19 June 2014) is an agreement between central government and the three local authorities[32] to invest in Greater Cambridge to encourage economic growth, benefiting the UK economy and wider society. It aims to enable a new wave of innovation-led growth by investing in infrastructure, housing and skills that will facilitate continued growth. It acknowledges the region's strong record of accomplishment in delivering growth and seeks to support existing and new businesses in achieving their full potential. To achieve this, the City Deal creates:

- A governance arrangement for joint decision making between the local councils.
- An infrastructure investment fund worth up to £1 billion over a 15-year period from 2015/16, including central Government funds of up to £500 million, subject to Gateway Reviews.

The City Deal aims to:

- Accelerate delivery of 33,500 planned homes.
- Enable delivery of 1,000 extra new homes on rural exception sites.
- Create 44,000 new jobs.
- Deliver over 420 new apprenticeships for young people.
- Provide £1bn of local and national public sector investment, enabling an estimated £4bn of private sector investment in the Greater Cambridge area.

[30] Cambridge leads for percentage of population cycling - but Hackney gets more people on bikes | road.cc
[31] Greater Cambridge Local Plan: Existing Transport Conditions Report (Cambridgeshire County Council Transport Infrastructure Policy and Funding Team) November 2020 (greatercambridgeplanning.org)
[32] Cambridgeshire County Council, Cambridge City Council and South Cambridgeshire District Council

A.4. The Role of GCP

The Greater Cambridge Partnership (GCP) is the local delivery body for a City Deal with central Government, bringing powers and investment to vital improvements in infrastructure, supporting and accelerating the creation of jobs and homes. GCP is responsible for developing the Making Connections programme.

A.5. The Role of the Making Connections Programme

As introduced in Section 2 of this report, the Making Connections programme seeks to deliver transformational changes to make public transport in Greater Cambridge more affordable, convenient, reliable, safe, including wider improvements to cycling and walking. It is an integral part of the wider City Access programme[33], and will help to tackle the issues summarised under sub section A.2, delivering better travel choices for people.

To achieve this, reduction in traffic is firstly required to create the space for buses, walking and cycling and provide a source of revenue to fund a transformed bus network and wider programme of sustainable transport measures.

Through reducing traffic, congestion can be tackled, providing more reliable travel for buses and the vehicles that need to travel in the city. This also tackles other traffic related issues by improving air quality and reducing carbon emissions within the city, along with reduced noise and improved perception of safety for walking and cycling.

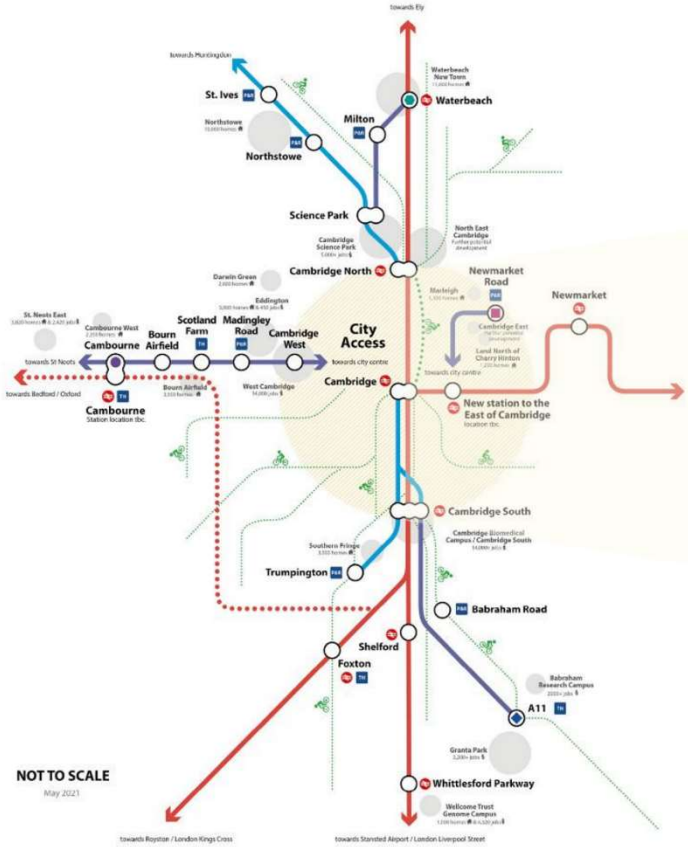
Making Connections provides an opportunity for the Greater Cambridge Partnership and partner authorities to transform travel choices in a way that is aligned with the targets and outcomes sought in the Greater Cambridge City Deal.

The wider investment in sustainable transport, alongside the reduction in congestion that may be brought by Making Connections, will establish Cambridge as a successful example in addressing the complex challenges we face in influencing travel behaviours.

The diagram[34] below illustrates the strong inter-relationship between Making Connections and other elements of the wider GCP City Access programme.

[33] The City Access work encompasses a number of activities to support delivery of the City Deal objectives. Please refer to the following document for detail <Document.ashx (cmis.uk.com)>.
[34] Diagram extracted from Making Connections Strategic Outline Case completed in August 2023

GCP Transport Programme - Future Network



Key

- Railway
- East West Rail – alignment tbc
- Existing Guided Busway
- GCP corridors
- Cambourne to Cambridge
- Cambridge Eastern Access
- Waterbeach to Cambridge
- Cambridge South East Transport
- Interchanges & Stops
- National Rail Station
- Chisholm Trail
- Greenways
- Park & Ride
- Travel Hub (GCP schemes)
- City Access measures
- Growth Area

Illustrative Network
Not all stops shown
Development figures will not all be complete by 2030

Appendix B. Appraisal Specification Summary Table (ASST)

Impact area		Description of anticipated impacts	Anticipated scale of impacts (on 7-point scale)	Details of intended approach to appraisal	Included in economic appraisal?				
					Initial BCR	Adjusted BCR	Quantitative assessment	Qualitative assessment	Distributional impacts
Economy	Business users and transport providers	Journey time savings, VOC savings, user charge disbenefits.	Large adverse to slight beneficial*	Follow guidance in TAG Unit A1.3 using output from TUBA. Impacts calculated for weekdays only over a selection of appraisal periods.	✓	✓	✓		
	Reliability impacts on Business users	Improvement in reliability of highway journey times due to decongestion and to public transport journey time due to decongestion and improved service frequency.	Moderate beneficial	Follow guidance in TAG Unit A1.3 using output from TUBA and urban roads reliability tool, based on TUBA.		✓	✓		
	Wider economic impacts (fixed land use)	Productivity gains, labour supply impacts and output change in imperfectly competitive markets.	Neutral or marginal net impacts*	WITA applied with fixed land use		✓	✓		
Environment	Noise	Largely reduced noise impacts in the city with some increases at limited locations such as at P&R sites.	Slight beneficial	Noise impacts based on changes by source rather than by receptor. Measured quantitatively based on DMRB LA111 at a link level, with overall impacts assessed qualitatively.	✓			✓	✓
	Air Quality	Changes in predicted NO_2, PM_{10} and $PM_{2.5}$ concentrations are anticipated across Cambridge.	Based on the detailed modelling undertaken for Phase 3B, the predicted impacts are anticipated to range from negligible to slight beneficial	Qualitative assessment of the impacts based on the change in total traffic flows for each scenario (when compared to the relevant baseline year) to determine where changes in traffic will be the greatest therefore leading to disbenefits and benefits, respectively, when compared to the Phase 3B assessment. Assessment of relevant exposure on routes with major changes and areas of social deprivation will also be determined.	✓		✓(reference to quantified evidence from the previous stage)	✓	✓
	Greenhouse Gases	Reductions in emissions resulting from reduced traffic	Moderate beneficial	Emissions are assessed in line with TAG A.3 and collated using WSP's Carbon Zero Appraisal Framework.	✓		✓		
	Landscape	No direct impact is expected and so landscape will not be assessed	Neutral					✓	
	Townscape	A high-level qualitative assessment has been considered proportion, since impacts are expected to be very limited	Neutral					✓	
	Historic environment	No direct impact is expected and so historic environment will not be assessed	Neutral					✓	
	Biodiversity	No direct impact is expected and so biodiversity will not be assessed	Neutral					✓	
	Water environment	No direct impact is expected and so water environment will not be assessed	Neutral					✓	
Social	Commuting and other users	Journey time savings, VOC savings	Moderate beneficial	Follow guidance in TAG Unit A1.3 using output from TUBA. Impacts calculated for weekdays only over a selection of appraisal periods.	✓	✓	✓		✓

Impact area		Description of anticipated impacts	Anticipated scale of impacts (on 7-point scale)	Details of intended approach to appraisal	Included in economic appraisal?				
					Initial BCR	Adjusted BCR	Quantitative assessment	Qualitative assessment	Distributional impacts
	Reliability impacts on commuting and other users	Improvement in reliability of highway journey times due to decongestion and to public transport journey time due to decongestion and improved service frequency.	Slight beneficial to moderate beneficial	Follow guidance in TAG Unit A1.3 using output from TUBA and urban roads reliability tool, based on TUBA.		✓	✓		
	Physical activity	The scheme will include measures to improve facilities for active modes generating health and absenteeism benefits.	Moderate beneficial	Monetised appraisal using AMAT. Exclusion of mode shift related benefits which will be captured through external modelling.	✓	✓	✓		
	Journey quality	Improved journey quality for active mode users from complementary measures, for public transport users through facilities at stops and onboard vehicles and for car users from reduced congestion.	Slight beneficial	Details of quantification of these benefits to be identified once options are specified. Qualitative assessment is likely to be proportionate.				✓	
	Safety	All options are expected to reduce the number of collisions due to reductions in vehicle-kms.	Moderate beneficial	Appraisal using COBA-LT based on outputs from CSRM2. Study area and use of observed accident data set out in section 5.5.	✓	✓	✓		✓
	Security	A qualitative assessment, taking into account impacts on users of all modes will be performed.	Slight beneficial					✓	✓
	Access to services	Improvements to public transport and active travel facilities are expected to have beneficial impacts, the scale of which will depend on the level of investment in these areas.	Moderate to large beneficial					✓	✓
	Affordability	Financial impacts on commuting and other users will be assessed through TUBA, capturing user charge impacts and changes to bus fare prices.	Moderate adverse*		✓	✓	✓		✓
	Severance	Improvements to facilities for active mode users and reductions in traffic will reduce severance	Slight beneficial					✓	✓
	Option and non-use values	A step change in provision of public transport will be achieved including provision of services to locations where public transport is not a feasible option.	Moderate beneficial					✓	
Public Accounts	Cost to Broad Transport Budget	Additional capital, renewal and maintenance costs due to increase to fund area charging. Operational costs for bus services and subsidised fares.	Moderate adverse to large beneficial *	Calculate of PVCs in accordance with TAG Unit A1.2 with appropriate inflation and optimism bias uplifts applied.	✓	✓	✓		
	Indirect Tax Revenues	Impact on tax revenues due to changes in vehicle fuel consumption, fuel duty receipts and charges.	Moderate adverse	Assessed through TUBA	✓	✓	✓		

* Some benefit groups have a wide potential range of impacts dependent on how the scheme is specified. High area charges will generate large revenues but also large user disbenefits unless that revenue is efficiently reinvested to generate additional user benefits.

Appendix C. Managing Uncertainties in Economic Appraisals

C.1. Introduction

Although the investment cost for the Making Connections Programme is relatively low, the impact on public finances is much higher through the revenue generated. The level of uncertainty in the forecast scheme impacts and Value for Money findings is also potentially high. This covers both uncertainties to do with certain aspects of the proposed interventions (such as forecast responses and choices of transport users impacted by the scheme) and long-term evolutions in the transport system in the future (such as trends in behaviour, technology and decarbonisation that may drive significant change over time).

Several uncertainties associated with demand forecasting have been mentioned in Section 3.4.3 of the report. DfT's TAG Uncertainty Toolkit also offers defined Common Analytical Scenarios (CAS) that help to capture and rationalise long-term changes introduced above.

This document outlines the proposed approach to explore several well recognised sources of uncertainties quantitatively or qualitatively in the findings from the economic appraisals:

- All CAS recommended in the Uncertainty Toolkit
- Impacts from recovery of travel demand post-COVID

C.2. CAS in Uncertainty Toolkit

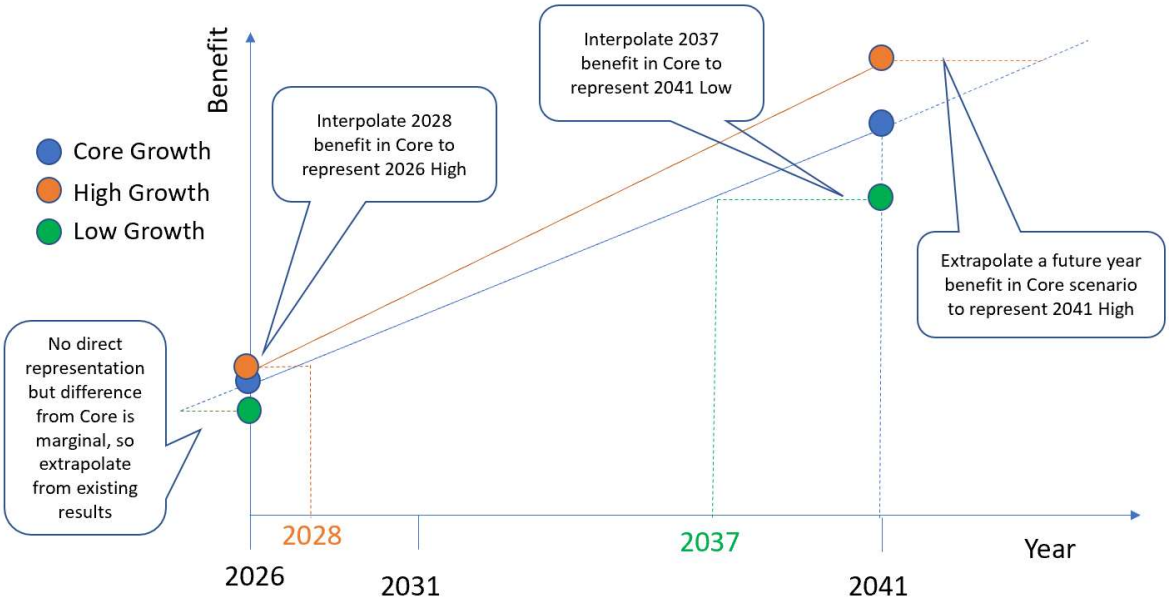
All CASs have been considered individually to identify the level of relevance of each scenario to Making Connections in order to establish an appropriate method of assessment.

High and Low Economy scenarios (CAS1 and CAS2) potentially have large impacts on the economic and financial performance, as these represent different rates of growth in the economy, affecting GDP, population, and employment, which subsequently influence the travel demand, a key driver to the level of congestion and the potential revenue from the proposed interventions. The implication of this is that the Low Economy scenario (CAS2) may result in both reduced revenue and reduced journey time savings, but with lower user charge disbenefits, while the High Economy scenario (CAS1) will have the reverse effect. Both scenarios are considered valuable to inform the longer-term impacts and should ideally be quantified.

Regional (CAS3) refers to varying level of growth (population, households and employment) in different parts of the country so can manifest itself through impacts on travel demand in Cambridge in a similar way to CAS1 and CAS2. For the same reason as above, it is also deemed relevant and quantifiable using the databook[35] from DfT.

For the four CAS scenarios above, modelling the potential changes to demand directly in CSRM2 would involve amendments to both DM and DS scenarios with the adjusted levels of growth, which could imply a large number of additional modelled scenarios. To improve efficiency in this analysis, a simplified approach is proposed to infer the forecast economic impacts under the alternative demand scenarios through interpolating or extrapolating model runs that are already prepared (as outlined in Section 3.4.5 of this report). This approach is illustrated in the figure below using a high growth and low growth example, where high and low growth relate to growth in the economy[36], not growth in traffic.

[35] Common analytical scenarios databook - GOV.UK (www.gov.uk)
[36] This growth in the economy has been informed by relevant data from the CAS databook and pivoted around central growth forecasts from CSRM2



The high economy and low economy scenarios in the example above essentially reflects a speeding up or slowing down of growth relative to central forecasts. It is therefore possible to correlate different points in time between the three growth scenarios (low, central, and high) at which levels of demand for travel will be consistent.

For example, as set out in the figure above (using purely illustrative flow patterns) the level of transport demand and impacts on journey time in 2041 in the low growth scenario may be comparable to that of the central scenario in 2037[37]. While 2037 will not be modelled for the central scenario the impacts can be identified through interpolation (between the modelled 2026 and 2041 central scenarios).

Similarly, the high growth scenario demand and travel times in 2026 may be comparable to those of the central scenario in 2028, which can then be interpolated following a similar method.

It is noted that year 2028 and 2037 in the example above are for illustration purpose only.

This method of representation allows the high growth scenario to be derived from two central scenarios modelled. It is acknowledged that this simplified approach based on interpolation or extrapolation will introduce a degree of approximation, but this approach is not different with what would have occurred by using TUBA to infer benefits between two modelled years so fundamentally has a similar level of robustness.

It is also acknowledged that there is relatively a higher degree of risk associated with extrapolation than interpolation. This limitation needs to be considered when interpreting the output from the economic appraisal for the high growth test. About extrapolation for the 2026 low growth as illustrated in the figure above, this risk is much lower as the scale of change between the low and central scenarios in 2026 will be marginal.

Behavioural Change (CAS4) scenario reflects important behavioural trends because of new ways of working, shopping and travelling in the future. These result in changes in trip rates, vehicle ownership and use of LGVs (less shopping trips but more deliveries due to increased online shopping). Ultimately these changes are also reflected in the changes to travel demand, similar to CAS1/2/3.

A common feature among the four CAS scenarios introduced is that their impacts can all be reflected in changes to travel demand. The current CAS databook provides indices to account for such changes in travel demand driven by factors described above. These factors can be used (as relative changes in % terms) to estimate potential changes in the forecast economic impacts (pivoting off the central forecasts).

[37] The actual years in this process would be determined through analysis of the demand forecasts and assumptions used in the High and Low growth scenarios

However, unlike the CAS1/2/3 the Behavioural Change scenario results in growth in trips not slowing down but becoming negative, with trip numbers continuing to decline into the future. This means that the approach described above would not be appropriate to capture the impacts of this scenario. A qualitative assessment for this scenario has been considered proportionate given that travel behaviour since this scenario was devised has moved in the opposite direction and that the scheme itself is not dependent on long-term performance to offset costs of implementation.

With regard to the **Technology Scenario (CAS5)**, this scenario considers the potential impact on travel behaviour as road travel becomes far more attractive and accessible to road users because of a high take-up of connected autonomous vehicles (CAVs), which enter the fleet in the 2020s and make up to 50% of it by 2047[38]. These could lead to changes in travel demand (such as trip rates and vehicle ownership change) as well as changes in travel behaviours (such as reduction in the perceived Value of Time and car occupancy). The changes in the former (trip rates) are essentially reflected in uplifts in travel demand. These impacts are not dissimilar to what have already been explored in CAS1 to CAS4. Whilst for the travel behaviour related changes, these would primarily be reflected in two areas of travel costs:

- Perceived Value of Time (VoT) - Low VoT savings per hour of travel are associated with CAVs because users will be able to make more effective use of their travel time. Shortening their travel time therefore adds less value than would otherwise be the case. The Making Connections programme will increase the cost of car travel through application of the area charge. Therefore, the reduced VoT is likely to affect demand less than what would be the case for trips where VoT forms a larger proportion of the cost of travel. Modelling will be required in order to robustly capture impacts from this change. However, any tests with changes in VoT are basically varying the proportions of costs attributed to travel time and the proposed charge in the total travel costs. It is argued that similar insights can be gained from tests that are already covered by the range of model runs with £3, £5 and £8 charges, i.e., how transport users would respond if the cost attributed to travel time is a higher or lower proportion of the total generalised travel cost. It is therefore proposed not to model the potential falls in VoT in CAS5 separately at this stage of the business case for the reason of proportionality when similar impacts are already covered in model runs planned.
- Vehicle Operating Costs (VOCs) – The Technology scenario also assumes a much higher take-up of electric vehicles, bringing down VOCs. User benefits derived from VOC savings as a result of decongestion will therefore be reduced. However, the impact of VOCs as a proportion of the scheme impacts is not large enough for modelling to be proportionate. It is therefore considered appropriate to assess the impacts of this scenario qualitatively.

Decarbonisation scenario (CAS6) refers to two plausible futures where there is either vehicle-led or mode-balanced decarbonisation. The difference between these two is mainly whether there will be an unspecified government intervention to equalise electric vehicle costs with costs for petrol and diesel vehicles. Its implication on travel demand forecast is through the PPK (pence per kilometre) parameter in the transport model, which will be reflected in changes in the proportion of vehicle related cost in the total travel cost. For the same reasons as those for CAS5 (that VOCs impacts from the proposed interventions is marginal and there are already a range of tests with varying total travel costs), it is not proposed to model this separately.

The proposed approach for all the six CAS scenarios is outlined in the table below, based on the reasons described above.

CAS Scenarios	To quantify in the OBC?
1 - High Economy	Yes*
2 - Low Economy	Yes*
3 - Regional	Yes*
4 - Behavioural change	Yes*
5 - Technology	No but can be assessed qualitatively

[38] Assumptions in TAG Uncertainty Toolkit

CAS Scenarios	To quantify in the OBC?
6 - Decarbonisation	No but can be assessed qualitatively

** For the reason of proportionality, only the two scenarios (out of CAS1 to 4) which give the highest or lowest impact on travel demand will be quantified.*

C.3. Local Uncertainties

8.4.1.2. In addition to the standard CASs covered in the previous section, there are other potential variations to demand response that have been identified. These will be considered as part of the Value for Money (VfM) assessment either qualitatively or quantitatively. Where quantitative analysis is required, it will be carried out through spreadsheet based on transparent assumptions instead of CSRM2 model runs. These potential uncertainties are listed below, some of which have already been touched on in Section 3.4.3:

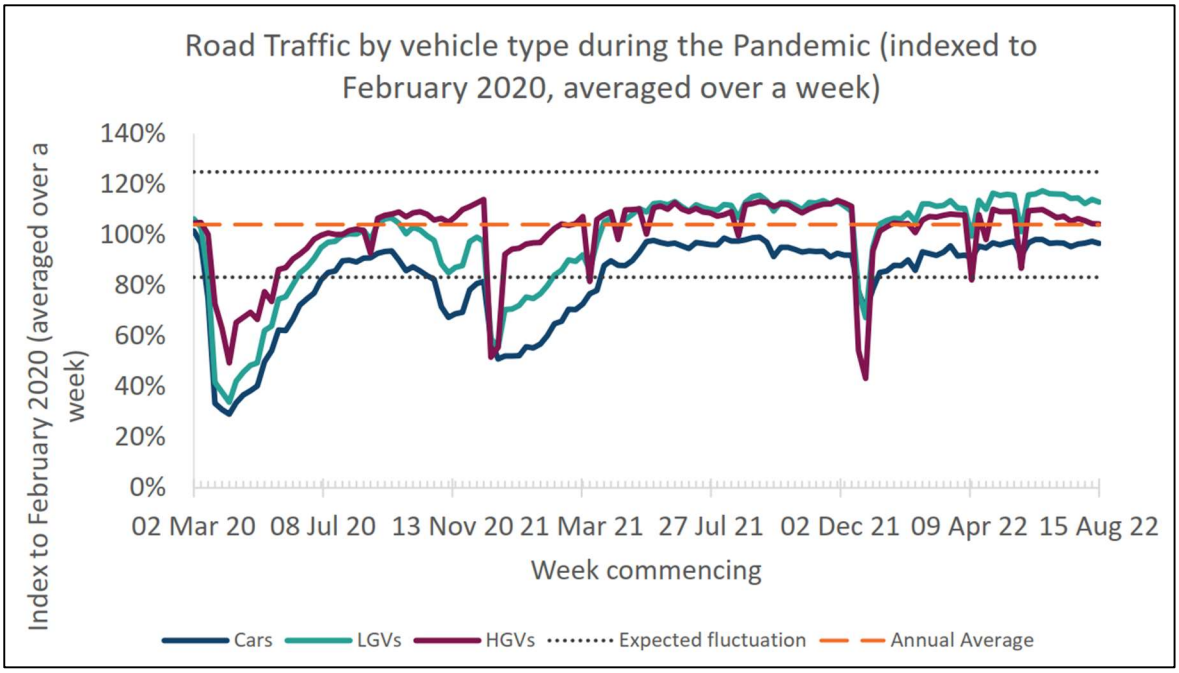
- **Impacts of Working from Home –** it is deemed that this is already covered by the Behavioural Change CAS so no additional assessment is required in addition to what is outlined in the previous section.
- **Seasonality of active modes –** the impact of the Making Connections Programme is in part dependent on the level of mode shift of trips from car to active modes. The extent of this mode shift will be influenced by the varying willingness of people to walk and cycle at different times of year in different weather conditions. These impacts are not well suited to modelling. Overall, the aggregated forecast annual or 60-year impacts are still deemed reasonable to represent the average condition throughout the year. At present, more disaggregated forecasts, such as forecasts for specific months, are not required, which is likely subject to more seasonal variations. No additional assessment is therefore planned.
- **Freight demand/behaviour response** – it is likely that freight companies will seek to minimise their costs by reducing the number of vehicles required to pay the area charge and that the number of vehicles currently moving in and out of the cordon area may over-represent the number which will eventually be charged. Fleets may be redistributed to ensure smaller numbers of vehicles operate within Cambridge, making a larger number of trips each within the city, or alternative vehicle types such as bike couriers may be used for smaller deliveries. Adjustments to address these potential changes are best dealt with in the financial analysis informing the financial case, which will cover the financial viability of the proposed interventions.
- **Weekend and off-peak demand** – traffic impacts during the non-charging period (as a result of the charge scheme during the weekday) will be qualitatively assessed as CSRM2 does not cover weekend or off-peak periods. The potential displacement of demand to non-charging periods will vary by time period and journey purpose. For time periods where congestion charge is proposed in all options (such as AM and PM peak periods), the scope for displacement is limited as the majority of journeys are for commuting, business or education purposes, which are less flexible than other purposes.

The last but also potentially the most significant uncertainty is to do with **recovery of travel demand in the baseline scenario post the COVID pandemic**. CSRM2 has a pre-COVID base year and then the first forecast year is from 2026, so the decline in travel demand during the pandemic has not been explicitly captured in the transport model. Therefore, the risk associated with travel demand recovery post COVID is that the real-world travel demand in the selected forecast years (2026 and 2041) may be materially lower than what was represented in the forecast models. This potential discrepancy would have implications on the forecast behavioural changes and demand (and revenue) related to the proposed STZ.

National Road Traffic Projections 2022[39] (NRTP2022) reported the road traffic level by different vehicle types from the start of the pandemic to August 2022 as seen in the figure below, where car traffic has remained lower than pre-pandemic levels while particularly LGV traffic has overpassed it.

[39] National road traffic projections - GOV.UK (www.gov.uk)

The report mentioned that in February 2022, traffic (not freight traffic) was 8% lower than 2019 level. Since a 3% background growth would have been expected for all vehicle types over two years, then February 2022 traffic was approximately 11% lower than what would have been expected to be without the pandemic.



In addition to the national evidence, local data in Cambridge city has also been assessed using monitored traffic counts on sites within the local road network in 2019, 2020, 2022 and 2023. It is clear from the assessment that local traffic has decreased and that there is clearly 'lost growth' during the pandemic. However, there is no clear pattern of changes by time of day, direction or routes.

Across the sites with observed data, the reduction in car traffic to or from city centre varies between 5% to 9% in the AM and PM periods in October 2022, in comparison with October 2019. The corresponding reduction during the IP period is about 2% to 3%.

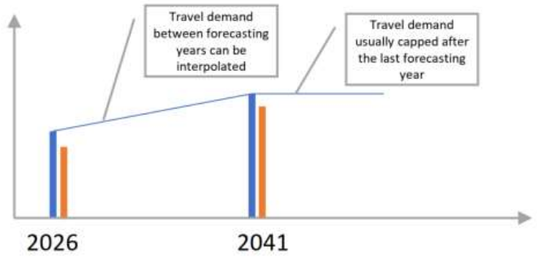
Over the same period of time, the reduction in goods vehicle traffic is over 20% towards the city centre in the PM peak and away from the city centre in the AM peak. The reduction during the IP period is between 4% and 9%.

The findings summarised above are based on limited local data available for comparison of pre and post-pandemic conditions in Cambridge. It is also recognised that information is missing for some key routes and there were also major disruptions or roadworks that might have contributed to the data observed. Overall, an approximate drop of 10% in car traffic seems a reasonable assumption across the city.

A full description of the initial assessment summarised above will be presented in the OBC. The finding from the assessment is that the forecast demand in 2026 and 2041 from CSRM2 is potentially higher than what it may actually be. A sensitivity test is therefore proposed to capture potential impacts from this in the VfM assessment.

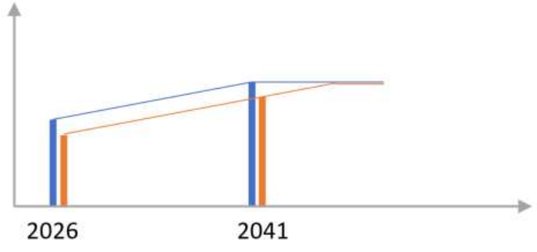
To improve efficiency in this analysis, a simplified approach is proposed to infer the forecast economic impacts with adjustment for COVID impacts through interpolating or extrapolating model runs that are already prepared (i.e., what would have been expected to be without the pandemic). This approach is similar to what was proposed for CAS1 to CAS4 in the previous section. A graphical illustration of the proposed approach can be found overleaf.

Making Connection – Consider COVID Impact by Adjustment to Economic Appraisal at the Profiling Stage with Existing Model Output

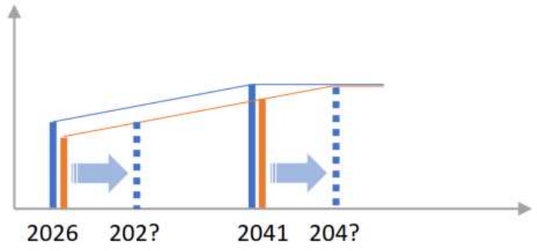


Modelled
Actual

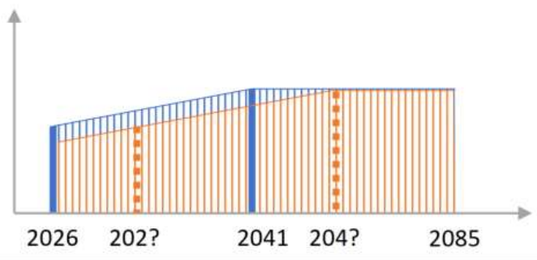
Analysis of observed data suggests current 2023 highway demand is about 10% lower than the 2019 level (assumption to be evidenced)
CSRM2 model has a base year of 2015 and forecasting years of 2026 and 2041.
The traffic model does not understand or include any impacts from the pandemic.
The forecast demand in 2026 and 2041 is therefore very likely to be higher than what it may actually be.



Using the traffic model output following the blue lines is likely to overestimate scheme impacts
Whilst the actual travel demand is more likely to follow the orange line
It will take a few extra years for the actual travel demand to grow to the forecast level



Although the modelled 2026 and 2041 demand is too high for these two modelled years,
They can represent what will occur in the future by shifting the modelled demand (blue lines) several years to the right
We can undertake economic appraisal using the two shifted model scenarios, which provide a more realistic profile over time



The polygon filled with blue bars represent a 60-year appraisal based on 2026 and 2041 model output without COVID adjustment
The polygon filled with orange bars represent a 60-year appraisal based on 202? and 204? model output
(by shifting 2026 and 2041 output to the right) with COVID adjustment
The difference between these two polygons broadly represent the outcome of COVID adjustment, ie reduced scheme impacts