Cambourne to Cambridge Better Bus Journeys

Multiple Criteria Assessment Framework (MCAF): Second High Level Assessment

Greater Cambridge Partnership

30 August 2017

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Executive summary

Skanska and Atkins have been commissioned by the Greater Cambridge Partnership (GCP) to investigate the provision of a high-quality bus link between Cambourne and Cambridge.

In response, a Strategic Outline Business Case (SOBC), detailing six high-level options for bus infrastructure improvements between Cambourne to Cambridge, was submitted to the Greater Cambridge Partnership (GCP) board for approval.

Following a public consultation, Option 1 and Option 3a were identified as preferred options for further development. The Local Liaison Forum (LLF) presented an additional route option, Option 6, which facilitated service from Cambourne to Cambridge utilising a new tidal flow bus lane.

An initial high level comparative assessment relating to Options 1, 3a and 6 has been undertaken. The assessment took the form of an abridged and updated Multi-Criteria Assessment Framework (MCAF) using attributes agreed with LLF.

Whilst the MCAF analysis was carried out using LLF criteria, it was noticed that certain benefits and impacts of the options were not examined reasonably. For this it was agreed that a second, more detailed MCAF is required to provide a comprehensive assessment of the options using the readily available data and evidence.

Atkins developed a second version of the MCAF, which incorporated and expanded certain elements of the previous MCAF, while adding new attributes for assessment.

The outcome of the Second Multiple Criteria Framework Assessment indicated that, out of the three proposed options, Option 3a is the best option. Its high scores for journey experience, technical attributes and future proofing exhibit its advantages over Option 1 and Option 6.

However, there are certain attributes which are qualitative and there is no/little evidence available for the MCAF. Also, Option 1 and Option 3a have been developed to a certain extent for the public consultation last year, but Option 6 does require more investigation so that a fair comparison can be carried out across all three options. Based on these observations, this note recommends that Option 6 should be further developed at an appropriate level for its comparison with Option 1 and Option 3a.

1. Introduction

Skanska and Atkins have been commissioned by the Greater Cambridge Partnership (GCP) to investigate the provision of a high-quality bus link between Cambourne and Cambridge. In response, a Strategic Outline Business Case (SOBC), detailing six high-level options for bus infrastructure improvements between Cambourne to Cambridge, was submitted to the Greater Cambridge Partnership (GCP) board for approval.

During October and November 2015, a public consultation for the Cambourne to Cambridge Better Bus Journeys project was undertaken. The consultation was centred on the six high-level options for bus infrastructure improvements detailed in the SOBC. Following the consultation, Option 1 and Option 3a were identified as preferred options for further development.

In January 2017, the Cambridge Local Liaison Form (LLF) prepared a 'Supplementary Option Assessment Report for Cambourne to Cambridge Better Bus Journeys.' In the document, the LLF presented an additional route option to facilitate a High Quality Public Transport (HQPT) service from Cambourne to Cambridge utilising a new tidal flow bus lane. This new Option 6 was additional to those options presented in the Strategic Outline Business Case (SOBC), and, was included with Option 1 and Options 3a, to be taken forward for further development following publication of the SOBC and 2015 public consultation.

1.1. Option Description

Following the Strategic Outline Business Case and the public consultation, two options were taken forward for further development. These were **Option 1** and **Option 3a**.

Option 1 is an online option that proposes no new infrastructure up to Madingley Mulch Roundabout, after which it provides:

- An Eastbound nearside bus lane along Madingley Road between Madingley Mulch and M11 bridge. Bus gate provided at the bridge, so buses run with general traffic up to High Cross. Existing carriageway retained and bus lane constructed adjacent, apart for a section where the alignment is smoothed to meet standards for ride quality.
- An Eastbound nearside bus lane along Madingley Road between JJ Thompson Avenue and Lady Margaret Road. Bus priority at Grange Road and bus gate at Lady Margaret Road. Narrowing of footway/cycleway in places.
- A Park and Ride site, currently located within the vicinity of Madingley Mulch.
- A stopping pattern of: Grange Road – British Antarctic Survey - Madingley Mulch – Madingley Mulch P&R – Hardwick Roundabout – Bourn Roundabout – Broadway – Cambourne High Street

Option 3a takes the form of an offline Busway between Cambourne and the City Centre. At this stage, it is also assumed to have the same service pattern as Option 1. It includes a Park and Ride site, currently located within the vicinity of Madingley Mulch.

In September 2016, at the Joint Local Liaison Forum (LLF) for the A428 Cambourne to Cambridge Better Bus Journeys scheme, an additional option for an alternative bus link alignment was proposed by LLF members. In order to facilitate a High Quality Public Transport (HQPT) service from Cambourne to Cambridge, the alternative option proposed guided busway provision along the existing A1303 Madingley Road corridor between the Madingley Mulch Roundabout and west Cambridge, utilising an unsegregated tidal bus lane aligned to the centre of the A1303 Madingley Road. Tis additional option was referred to as Option 6.

Option 6 is also an online option. It is an alternative proposal to Option 1 and includes the following aspects:

- The same service pattern as Options 1 and 3a, with stopping and express services;
- A Park and Ride site at Scotland Farm;
- A bus lane on the A428 eastbound off-slip approach to Madingley Mulch roundabout;
- Signals on Madingley Mulch roundabout to give bus priority;
- A central tidal bus lane between Madingley Mulch roundabout and High Cross, which is usable in both directions. However, when one direction uses the bus lane, the opposite direction travels as part of general traffic.

A diagram of Options 1, 6 and 3a can be found in 3.Appendix A.

1.2. Initial High Level Option Assessment

An initial high level comparative assessment relating to Options 1, 3a and 6 has been undertaken. The assessment took the form of an abridged and updated Multi-Criteria Assessment Framework (MCAF), based on that suggested by the LLF. The criteria were set out and agreed with the LLF in a series of meetings, with a view to broadly assess each option against each other with respect to performance, service, cost, risk and impact. Each option was scored by Skanska and Atkins with respect to the criteria being assessed.

In July 2017, LLF undertook a review of the MCAF analysis and provided comments and new scores based on their views of some of the criteria assessed. It was felt that some attributes are generic and don't provide in-depth understanding of the anticipated benefits and impacts of each option. As a result, it was agreed that a second, more detailed MCAF is required to provide a more comprehensive assessment of the options.

2. Second High Level Assessment

Atkins developed a second version of the MCAF, which incorporated and expanded certain elements of the previous MCAF, while adding new sections and attributes for assessment. The MCAF was divided into the following sections:

- public transport (to understand the benefits of each option on public transport network performance)
- road network/cars (to examine the influence of each option on the road network especially with respect to re-routing effects)
- overall network (to investigate the impact of each option on other modes and interactions)
- deliverability (to know about any risks that could affect the deliverability of each option)
- costs (to cover the capital and on-going costs for each option)
- development (to review how each option will help removing barriers to unlock housing and employment development in the area)
- environmental impacts (of each option) and
- public consultation (to capture views presented by stakeholders and the public).

Each option was scored based on the effect it had on the attribute. The score was on a scale between 1 to 5, where:

1 – very poor: implementing the option makes no detectable changes to the attribute or worsens the attribute

2 – poor: implementing the option results in a marginal improvement in the attribute

3 – neutral: implementing the option results in a substantial improvement in the attribute

4 – good: implementing the option results in a large improvement in the attribute, but some factors remain unaddressed

5 – very good: implementing the option results in an undisputable beneficial effect on the attribute.

The MCAF is attached as 3.Appendix AB.

2.1. Detailed Attribute examination

The following section provides a detailed explanation of each attribute featured in the MCAF. This section states the source of the data for the attribute and details the rationale behind the scoring of each option.

2.1.1. High Quality Public Transport

	Option 1	Option 6	Option 3a
High Quality Public Transport	**4**	**4**	**5**

“PROCEED: Guidelines for European High Quality Public Transport in small and medium sized cities” defines High Quality Public Transport (HQPT) as: a quality of Public Transport service that is generally perceived, by local politicians and in the media, to be reliable, frequent, good-value, reasonably comfortable (throughout the journey), reasonably fast, operate at convenient times, and to be suitable for most core journeys between key traffic generators (including residential areas) and the town / city centre.

There are 3 features that distinguish a High Quality Public Transport (HQPT) system from standard transport:

- Infrastructure: HQPT system must offer high quality infrastructure that is strongly branded, publicly supported and integrated with other modes of transport
- Bus fleet: HQPT must offer high quality buses that service the route at high frequency
- Bus stops: HQPT must offer high quality bus stops, which feature easy to understand information about the service and fast ticketing facilities

This attribute favours options, that effectively deliver the above-mentioned HQPT features in an efficient manner.

Option 1 offers the least amount of new infrastructure out of the 3 options. It proposes a number of dedicated eastbound bus lanes between Madingley Mulch and Cambridge City Centre, and no new infrastructure for westbound services. Option 1 bus services are likely to be impacted by general traffic, which will result in reduced quality of the services.

The new infrastructure offered by **Option 6** is more versatile when compared to Option 1. Option 6 proposes a tidal lane between Madingley Mulch Roundabout and High Cross, which can be used by both eastbound and westbound bus services. However, when services going in one direction use the bus lane, services going in the opposite direction must travel as part of general traffic. As a result, Option 6 is likely to offer slightly higher quality bus service to passengers, as, between Madingley Mulch Roundabout and High Cross, bus services will be segregated from traffic in one direction.

Option 3a offers the largest amount of new infrastructure. It proposes an offline track between Cambourne and Cambridge City Centre, which is exclusively dedicated to bus services. Accordingly, Option 3a is likely to provide the highest quality public transport service, as throughout most of the journey the bus service will be segregated from the general traffic. This will allow the bus service to provide tram-like frequency and reliability, while maintaining ride quality.

2.1.2. Journey Ambience

	Option 1	Option 6	Option 3a
Journey Ambience	**3**	**3**	**5**

As specified by WebTAG, Journey Ambience attribute appraises the feelings that passengers experience while travelling on the bus service. The feelings are affected by the following 3 features of the HQPT:

- Traveller care: the feeling of using an enhance transit mode, how easy it is to access and exit the service, customer service provided throughout the journey,
- Traveller views: bus route travelling along scenic locations, exposure of passengers to maintenance and construction work, exposure of passengers to noise and pollution
- Traveller stress factors: presence of other vehicles on the route, exposure to accidents and delays, high speed of bus services

This attribute favours options that maximise features that affect Journey ambience in a positive way, while minimising features that compromise journey ambience.

Option 1 proposes a bus lane between Madingley Mulch Roundabout and Cambridge City Centre. For the rest of the journey, bus services travel as part of general traffic. This causes increased stress for passengers, as they may be worried about arriving late at their destination due to traffic. They may also be concerned of being involved in a traffic accident, as pedestrians and cyclists can easily access the bus route. Option 1 bus services will travel along A428 and A1303, which are both standard motoring landscapes, and will likely provide little comfort for passengers, as they will be exposed to pollution and noise from traffic.

Under **Option 6**, for the section between Madingley Road Roundabout and Cambourne, bus services will still interact with general traffic, exposing passengers to the same journey ambience as Option 1 for that section. Option 6 proposes more versatile infrastructure than Option 1. The gantries, which are necessary to enable the tidal lane, will separate bus services from general traffic and help maintain ride quality between Madingley Road Roundabout and High Cross. However, the gantries will also affect the appearance of A1303, turning it into a more urbanised setting. This will negatively impact its current country road appearance.

Option 3a proposes a segregated bus route between Cambourne and Cambridge City Centre, which will separate bus services from all other traffic. Passengers will experience the lowest levels of stress on their journey, as for Option 3a the chances of journey delays and accidents will be lowest of all the options. Moreover, the segregated busway will be separated from A428 and A1303 by a line of trees, which will provide pleasant views and reduce passenger's exposure to pollution and noise from the roadway.

2.1.3. Punctuality

	Option 1		Option 6		Option 3a	
Punctuality	**Tranche 1:** Peak:76% - 94% Off-Peak:65% to 93% **Tranche 2:** Peak: 58% - 79% Off-Peak:66% - 79%	**3**	**Tranche 1:** Peak:76% - 94% Off-Peak:65% to 93% **Tranche 2:** Peak: 58% - 79% Off-Peak:66% - 79%	**3**	**Tranche 1:** Peak:95% Off-Peak:95% **Tranche 2:** Peak: 58% - 95% Off-Peak: 66% - 95%	**4**

Punctuality is the relationship between the time, at which the bus service arrives in real life, compared to the time at which the bus service is supposed to arrive according to the timetable. A punctual service should leave the stop between one minute early and 5 minutes late, when compared to the timetable. The phrase "Peak: 76% - 94%" means the service will arrive between a minute early and 5 minutes late between 76 and 94% of the time during the Peak period.

Punctuality of the bus service is affected by its interactions with other traffic along the route. For all options, Tranche 2 (Madingley Road Roundabout – Cambourne) exhibits lower punctuality compared to Tranche 1 (Madingley Road Roundabout – Cambridge City Centre), as all options interact with traffic more along the A428. Option 1 and Option 6 have no priority over rest of traffic on its A428 section and Option 3a is interrupted more frequently by southbound roads leading away from A428.

Based on the CSRM2 model (as referenced in the End of Stage Report), **Option 3a** has the highest punctuality out of all the options, both during the peak and off-peak. Option 3a is mostly segregated from general traffic, and is less susceptible to delays caused by road accidents and congestion. For bus services operating under Option 3a it will be easier to arrive on time. However, Tranche 2 of Option 3a is subject to uncertainty, with punctuality reaching as low as 58% in the peak. This figure was reached by deriving information from CSRM2 that found that Option 3a is the lowest level of 'congested time' due to less time spent on-road. This is indicative of the risks of Option 3a interacting with traffic between Madingley Mulch Roundabout and Cambourne.

Option 1 and **Option 6** have lower punctuality, because they travel with general traffic along A428, and interact with general traffic along A1303. They are affected by congestion and accidents that happen along the route. Thus, Option 1 and Option 6 are scored same**.**

2.1.4. Reliability

	Option 1		Option 6		Option 3a	
Reliability	**Peak Inbound:** Overall: 87% Tranche 1: 63% Tranche 2:91% **Peak Outbound** Overall: 82% Tranche 1: 65% Tranche 2:67% **Off - Peak Inbound:** Overall: 93% Tranche 1: 93% Tranche 2:93% **Off - Peak Outbound** Overall: 86% Tranche 1: 83% Tranche 2:78%	**3**	**Peak Inbound:** Overall: 90% Tranche 1: 74% Tranche 2:93% **Peak Outbound** Overall: 84% Tranche 1: 78% Tranche 2:82% **Off - Peak Inbound:** Overall: 93% Tranche 1: 93% Tranche 2:93% **Off - Peak Outbound** Overall: 87% Tranche 1: 83% Tranche 2:89%	**3**	**Peak Inbound:** Overall: 93% Tranche 1: 98% Tranche 2:94% **Peak Outbound** Overall: 87% Tranche 1: 90% Tranche 2:94% **Off - Peak Inbound:** Overall: 93% Tranche 1: 98% Tranche 2:94% **Off - Peak Outbound** Overall: 88% Tranche 1: 93% Tranche 2:94%	**5**

Reliability attribute measures how dependable the continuous operation of the bus service is. A bus service is considered reliable if it arrives at its locations at the same time every day. Even if the bus service is consistently late at its destination, as long as it arrives late every time, the bus service will still be considered reliable.

The data for reliability was based on the bus journey times and dwell times of the Citi4 Service, that currently runs from Cambourne and Cambridge. Data was collected every day during the month of November 2016 using an on-board GPS/GSM tracking system, which provides approximate vehicle speeds and a timeline of stopping and dwelling activity across the entire route. The data was processed to generate the results, given in the table above.

Based on the data, **Option 3a** exhibits the highest level of reliability out of the three options. Option 3a is mostly segregated from general traffic, and is less susceptible to delays caused by road accidents and congestion. For bus services operating under Option 3a it will be easier to consistently arrive at the same time.

Option 6 is more reliable than Option 1, but the difference is marginal. On the whole, Option 1 and Option 6 are not as reliable as Option 3a, thus scoring neutral benefits.

2.1.5. Level of mode shift to Public Transport

	Option 1		Option 6		Option 3a	
Level of mode shift to PT	Tranche 1: car- no change bus - no change walk - no change cycle - no change Tranche 2: car- 1% decrease bus - 2% increase walk - no change cycle - no change	**3**	Tranche 1: car- 1% decrease bus - 1% increase walk - 1% increase cycle - no change Tranche 2: car- 1% decrease bus - no change walk - no change cycle - no change	**3**	Tranche 1: car- 3% decrease bus - 3% increase walk - 1% increase cycle - no change Tranche 2: car- 8% decrease bus - 7% increase rail - 1% decrease walk - 1% increase cycle - 1% increase	**5**

The “Level of Mode Shift to Public Transport” attribute assesses how the implementation of the options will affect the usage of other modes of transport within the area. Mode shift compares the changes in modes of transport resulting from an implementation of the option to the “Do Minimum” case. The “Do Minimum” case is the expected usage of modes of transport after the Cambridge City Centre Access Strategy has been implemented.

As an example, if under “Do Minimum” case, 35% of travellers use a private car and 10% use buses, but under Option 1 only 33% of travellers use a private car and 12% use buses, then, as a result of implementing Option 1, there is a 2% decrease in usage of private cars and a 2% increase in usage of buses i.e. a mode shift of 2% from private car to bus.

The high quality attributes of the new bus service should provide enough incentive for private car users to switch to public transport. As all options provide bus services with associated active mode infrastructures, ideally, the implemented option will also encourage travellers to swap from using cars to travelling by bicycle or walking. This attribute favours options that contribute to the largest decrease in private car usage along the route.

Based on the data provided by the CSRM2 model, implementing **Option 3a** has the highest effect on mode shift away from private cars. Under Option 3a, there is a 12% decrease in absolute car trips, mostly along Tranche 2 (Madingley Road Roundabout – Cambourne). Travellers take advantage of the benefits provided by the segregated bus route, such as avoiding congestion and accidents along A428.

In contrast, **Option 1** and **Option 6** have little effect on mode shift.

It should be noted that although there is a mode shift from car and Parka and Ride it does mean that there is a car leg. However, the objective of Cambourne to Cambridge Better Bus Journeys is to reduce congestion within the City Centre by facilitating travel into it.

2.1.6. Resilience/Versatility

	Option 1	Option 6	Option 3a
Resilience/Versatility	**2**	**3**	**5**

The resilience attribute assesses how fast the services can return to full functionality following an unplanned change in traffic, such as an accident. Versatility measures the opportunities of the services negating or avoiding the effects of an unplanned change in traffic.

These attributes favour options that propose bus services that can avoid unplanned changes in traffic, and, if confronted by these changes, swiftly negotiate them.

Option 1 proposes a bus lane only between Madingley Mulch Roundabout and Cambridge City Centre in the eastbound direction. For the rest of the journey bus services travel alongside general traffic. Westbound services have no alternative route to bypass unplanned changes, such as accidents.

Option 6 proposes a tidal lane between Madingley Mulch Roundabout and Cambridge City Centre, allowing bus services to bypass accidents and congestion along this section of the route when travelling in the peak direction. In the counter-peak direction bus services run as part of general traffic and are still affected by accidents and maintenance. Between Cambourne and Madingley Mulch Roundabout, Option 6 bus services are affected by traffic the same way as Option 1.

Option 3a bus services interact with traffic the least. They are unaffected by congestion and accidents along A428 and A1303, as they run on a segregated busway. If there is an accident on the busway, bus services can leave the track and travel along A428 and A1303. This makes Option 3a the most resilient and versatile option.

2.1.7. Future proofing against new public transport mode

	Option 1	Option 6	Option 3a
Future proofing	**2**	**2**	**5**

This attribute measure how well the options would accommodate a new public transport mode to meet future growth in traffic along the Cambourne - Cambridge route. The Cambridge Local Plan 2014 forecasts that, if all of the major sites allocated for development come forward, there could be a daily demand for a further 13,290 trips in the area. In order to avoid compromising the High Quality features of the busway, this increase in demand would have to be offset by an increase in bus services. This attribute favours options that can achieved this increase in bus services in an efficient way.

Qualitative analysis suggests that the new online infrastructure, proposed by **Option 1**, does little to alleviate future traffic growth, as buses still interact with cars throughout the route. It would be particularly difficult to increase number of services, as additional westbound services will directly feed into traffic and will be difficult to introduce a new public transport mode to cater future traffic growth. This makes Option 1 the least future proof option.

Option 6 proposes a tidal lane, which would allow increases in bus services between Madingley Mulch Roundabout and Cambridge City Centre in one direction only. The main difference between Option 1 and Option 6 is that the direction of the tidal lane will change to accommodate the peak. This makes Option 6 more future proof than Option 1, but only marginally. Option 6 proposes no new infrastructure between Madingley Mulch Roundabout and Cambourne. As traffic growth within the A428 corridor is expected to impact the bus reliability and increase delay for services.

On the contrary, **Option 3a** is future proof, because new offline Infrastructure between Cambourne and Cambridge City Centre will allow for future increases in bus services to meet growing number of travellers into Cambridge. Articulated buses can be used with ease, and the route can eventually be converted to Light Rail Transit. This makes Option 3a the most future proof of the three options.

2.1.8. Vehicle - Kilometre Reduction

	Option 1		Option 6		Option 3a	
Vehicle-Km Reduction	437,189 vehicle km	**4**	4,408,287 vehicle km	**5**	34,221 vehicle km	**3**

The Vehicle - Kilometre Reduction attribute compares the reduction in kilometrage travelled by passenger car units (PCUs) as a result of option implementation. The effect of the option is derived by comparing the option to the Do Minimum case. The “Do Minimum” case is the expected usage of modes of transport after the Cambridge City Centre Access Strategy has been implemented. Data is provided by the CSRM2 model for the AM peak.

This attribute favours options, implementation of which has the largest effect of reducing the number of vehicle kilometres travelled in the area.

According to the CSRM2 model, implementing **Option 6** results in the largest Vehicle KM reduction. More travellers will switch from travelling on PCUs, then for the other two options.

In comparison, **Option 3a** results in the lowest reduction in Vehicle KM. This is likely because removing bus services from the Cambourne to Cambridge route results in spare capacity along the route. The CSRM2 model recognises this, and diverts PCUs, which normally avoid the main roads due to congestion (which would be distributed throughout the model by shifting mode or changing journey route), to travel along the A428 and A1303. This negates the positive effect Option 3a has on the Cambourne – Cambridge route, as the regions around A428 and A1303 experience the improvement instead.

Option 1 performs being in between Option 6 and Option 3a.

2.1.9. Volume/Capacity

	Option 1		Option 6		Option 3a	
Volume over capacity (measure of congestion)	Option 1 and 6 have roughly the same volume over capacity.	**3**	Option 1 and 6 have roughly the same volume over capacity.	**3**	Option 3a has slightly higher Volume over capacity than Options 1 and 6	**3**

The Volume over Capacity attribute examines congestion along sections of the route between Cambourne and Cambridge. It is a ratio that compares the number of vehicles in the section to the maximum number of vehicles that the section can hold. A larger value of the attribute implies that the section is more congested.

This attribute favours options that reduce congestion, particularly on the busiest sections of the Cambourne to Cambridge route. To determine the scoring for the options, the CSRM2 model examined the entire section between Madingley Mulch Roundabout and Grange Road, which is considered to be the most congested stretch of the route.

The Volume/Capacity output from the CSRM2 model showed that, in relation to congestion, there were no substantial differences between the options during all peak periods. All options scored the same number of points for this attribute.

The similarity in effects on congestion between **Option 1** and **Option 6** can be explained, as they provide a similar infrastructure solution for the section of the route between Madingley Mulch Roundabout and Grange Road.

Although for **Option 3a** bus services do not travel along Madingley Road, the CSRM2 model fills the spare capacity, generated by taking bus services offline, with other PCUs, which would normally avoid Madingley Road. As a result, any benefits generated by taking bus services of the road under Option 3a, are negated by movement of PCUs from the regions to Madingley Road.

The only noticeable difference between the options is that Madingley Mulch Roundabout is less congested under Option 6. This is due to the fact that the park and ride for this option is situated at Scotland Road, which gives travellers an opportunity to disembark and change their mode of transport before reaching Madingley Mulch Roundabout. However, Option 6 experiences congestions when the bus service travels towards Cambridge City Centre.

2.1.10. Improvements in Active Mode Infrastructure

	Option 1	Option 6	Option 3a
Improvements in Active Mode Infrastructure	**4**	**4**	**5**

This attribute assesses the quality of the infrastructure, provided by the options, which is dedicated to active modes of transport, such as walking and cycling. Active mode infrastructure provides travellers with a path, which can be safely used by bicycles and pedestrians.

High quality active mode infrastructure encourages travellers to walk or cycle to their destination, instead of using a car. This reduces congestion in the area, as well as reducing pollution and noise. This attribute is directly related to the Mode Shift statistic, as high quality active mode infrastructure results in a mode shift from personal cars to bicycles and walking.

This attribute favours options that provide high quality, safe paths for cycling and walking.

Between Cambridge City Centre and Madingley Road Roundabout, **Option 1** and **Option 6** will provide a footway/cycleway adjacent to the Madingley Road, which will connect with existing provision at the M11 J13 bridge. Between Madingley Road Roundabout and Cambourne, Option 1 and Option 6 will provide pedestrian/cycle routes through to St Neots Road, utilising existing infrastructure. Pedestrian/cycle provision through Cambourne will be as existing.

Between Madingley Road Roundabout and Cambourne **Option 3a** will provide the same active mode infrastructure as Option 1 and Option 3. However, between Madingley Road Roundabout and Cambridge City Centre a brand-new footway/cycleway will be provided adjacent to the offline busway section. It will provide traffic free routes for pedestrians and cyclists.

When comparing the three options, the provision of segregated footway/cycleway scores Option 3a provides a safe traffic free route to the City Centre of Cambridge. In contrast, Options 1 and 6 mostly utilise existing infrastructure, which is not segregated from the main road.

2.1.11. Accident Impact

	Option 1	Option 6	Option 3a
Accident Impact	**2**	**2**	**3**

The accident impact attribute examines relevant historic data to infer how, following their implementation, the options are likely to be affected by the level of accidents between Cambourne and Cambridge. Accidents result in damages, diversions and delays. This attribute estimates, based on historic data, how likely a particular type of accident is to occur between Cambourne and Cambridge. This attribute favours options which reduce interaction between bus services and other on-road vehicles and segregate cyclists and pedestrians from road traffic.

As **Option 1** and **Option 6** are online, the data on accidents in the area of Madingley Hill was used. The data showed 50 accidents around Madingley Hill between 2012 – 2016. Out of those accidents, 28 involved cyclists and two wheel motorised vehicles. Option 1 and Option 6 will provide no additional infrastructure to segregate buses from cycles or two wheel motorised vehicles. Option 1 and Option 6 will mostly utilise existing cycling infrastructure, and will thus have little effect on the interaction between bus services and

cyclists. However, Option 1 and Option 6 will provide an additional bus lane between Madingley Mulch Roundabout and Cambridge City Centre, which should have a positive effect on the interaction between bus services, cycles and two wheel motorised vehicles. Option 1 and Option 6 both score the same.

As **Option 3a** is offline, the data on accidents on the Cambridgeshire Guided Busway was used for bench-marking point of view. Cambridgeshire Guided Busway is an existing offline bus service, which is in the same area as the proposed Option 3a Cambourne to Cambridge Guided Busway. This makes the level of accidents on the Cambridgeshire Guided Busway a viable approximation for the potential level of accidents for Option 3a.

Since opening in 2011, there were 19 accidents on the Cambridgeshire Guided Busway. Out of those accidents, 8 involved vehicles, 3 involved pedestrians and 3 involved cyclists. The data implies that the bus services under Option 3a will be affected by less accidents, than Option 1 and Option 6. The offline infrastructure will reduce the interaction between bus services and general traffic. However, there will still be accidents, presumably in the areas where general traffic crosses the busway.

2.1.12. Impact on Performance of Road Network

	Option 1	Option 6	Option 3a
Impact on Performance of Road Network	**2**	**2**	**4**

This attribute assesses the impact that implementing the options will have on the road network around A428 and A1303. Both the online and offline options will in some way interact with general traffic, causing delays at junctions and slowing down traffic. These interactions will have a significant impact on the performance of the road network.

This attribute favours options that reduce the interaction between bus services and general traffic, minimising the impact of the options on the performance of the road network.

Option 1 and Option 6 have a high impact on the performance of the road network. Between Cambourne and Madingley Mulch Roundabout the bus services travel on the A428, directly interacting with other traffic. Between Madingley Mulch and Cambridge City Centre, Option 1 proposes an eastbound bus lane and Option 6 proposes a tidal lane. Although Option 6 is more versatile, allowing bus services to travel in either direction on the tidal lane, this difference with Option 1 is marginal. For both options, there will always be a bus service travelling as part of general traffic, affecting traffic flow. Furthermore, general traffic may be subject to more delay due to bus priority at the bus gates, where Option 1 and Option 6 bus services access and egress the bus lanes. Finally, traffic may slow when turning and crossing the bus lanes.

Option 3a has the lowest impact on the performance of the road network. Due to the offline nature of Option 3a, the only interaction with general traffic will be at junctions. As the bus services will have priority at the junctions, there may be slowing effect on the local traffic in the areas south of A428 and A1303.

2.1.13. Deliverability risk

	Option 1	Option 6	Option 3a
Deliverability Risk	**4**	**3**	**2**

This attribute assesses the potential risks that may arise when delivering the options. All three infrastructure options require additional land, which would be subject to planning permissions, environmental and statutory consents. Deliverability risk (in terms of planning requirements and permissions) is expected to be lowest where schemes are based on upgrades to existing infrastructure. New infrastructure proposed on greenfield sites is expected to have the highest risk.

Option 1 has the lowest deliverability risk as it is likely to require the least amount of land take, and a CPO is required for private land / gardens which will be delivered through HA/CPO.

Option 6 has more deliverability risks than Option 1, as there is the potential requirements for more land take than Option 1 and related acquisition issues. The land will also be acquired through the Highways Act / CPO.

Option 3a has the most deliverability risk, as it would require the most land take, but there is a potential to negotiate greenfield land without CPO. Instead, land can be delivered through TWA, which reduces the land acquisition risk.

2.1.14. Constructability Risk

	Option 1	Option 6	Option 3a
Constructability Risk	**2**	**1**	**3**

This attribute assesses the risk associate with constructing the infrastructure for the options. Delivery of the option infrastructure will take a long time and will involve construction equipment, building materials and worker staff. They will require frequent access to target building sites.

Delivering the infrastructure of **Option 1** poses a significant risk relating to stats diversions and traffic management issues. Constructing an eastbound lane between Madingley Mulch Roundabout and Cambridge City Centre will require the closing of at least one lane of traffic with associated diversion. In addition, Madingley Road has traffic management restrictions in peak periods, so construction windows are likely to be restricted, increasing the complexity of construction.

Delivering the infrastructure of **Option 6** will be more complex than Option 1, because construction of a mid-carriageway tidal flow lane would be associated with significant disruption, stats issues and traffic management issues. M11 Bridge widening may be cheaper than building new bridge, but it is more complex to deliver, because the aged condition of existing structure has to be taken into account.

Delivering the infrastructure of **Option 3a** will be more straightforward, as most of the work will be carried out away from A428 and A1303, thus minimising traffic management issues. Building a new bridge over M11 will be more expensive, but also more straightforward than widening of the existing bridge along the A1303. New materials would be used to construct the bridge.

2.1.15. Disruption During Construction and Maintenance

	Option 1	Option 6	Option 3a
Disruption During Construction and Maintenance	**2**	**1**	**3**

This attribute assesses the disruption caused by the construction of the options, as well as their subsequent maintenance. As the diversion options for traffic using Madingley Road are very limited, construction impacts will be greatest where infrastructure is proposed on Madingley Road and Madingley Rise.

Option 1 has an eastbound bus lane proposed east of Madingley Mulch roundabout. Construction and subsequent maintenance of this lane will cause disruption to the traffic travelling along A1303.

Option 6 has a tidal bus lane proposed east of Madingley Mulch roundabout, construction and maintenance of which will cause greater disruption than Option 1, as the tidal lane is in the centre of the A1303.

In contrast, **Option 3a** is segregated from Madingley Road and Madingley Rise, and should therefore result in lowest disruption during construction and maintenance.

2.1.16. Scheme Capital Costs

	Option 1		Option 6		Option 3a	
Scheme capital costs	£11,531,900	**5**	£18,972,000	**4**	£77,185,000	**1**

This attribute assesses the overall costs that will be incurred following the delivery of the option. All options will require some form of costly new infrastructure, which will include new road surfaces, additional signage, etc. This attribute favours options that can deliver the bus service at a lower cost.

The costs have been estimated via a surveyor assessment. These costs include all infrastructure costs between Cambourne and Cambridge and do not include land costs. All costs are given in a 2010 pound basis.

Based on the cost assessment, **Option 1** is the cheapest option, as it proposes the least new infrastructure.

Option 6 proposes more infrastructure than Option 1, including gantries, necessary for directing the bus services on the tidal lane, and additional signage, advising general traffic how to travel around the tidal lane. Therefore, Option 6 will be costlier than Option 1.

Option 3a will be the most expensive option out of the three, as it proposes the largest amount of new infrastructure, including offline busway tracks and a new bridge over M11.

2.1.17. Maintenance and Renewal Costs

	Option 1		Option 6		Option 3a	
Maintenance and Renewal costs	£26,000	**5**	No estimation available, but likely to be higher than Option 1 but lower then Option 3a	**4**	£80,000	**1**

Maintenance and Renewal Costs attribute assesses the costs that will be incurred after the option has been delivered. All options will require some form of new infrastructure, which will include new road surfaces, additional signage, etc. Upon completion of the project, this infrastructure will have to be maintained and renewed. This attribute favours options that result in lower maintenance and renewal costs following its implementation.

Based on the maintenance and renewal cost assessment, **Option 1** is the cheapest option, as it proposes the least amount of new infrastructure.

There was no data available on the maintenance and renewal costs for **Option 6** at the time of this assessment. However, as Option 6 proposes more infrastructure than Option 1, including the gantries, necessary for directing the bus services on the tidal lane, and additional signage, advising general traffic how to travel around the tidal lane, Option 6 will be costlier to maintain than Option 1.

Option 3a will be the most expensive option to maintain and renew, as it proposes the largest amount of new infrastructure, including offline busway tracks and a new bridge over M11.

2.1.18. Future proofing for likely required housing and employment growth

	Option 1	Option 6	Option 3a
Future proofing	**1**	**4**	**5**

This attribute assesses the extent to which implementing the option will influence the growth of surrounding housing and employment. New housing developments east of Cambridge, such as Cambourne and Bourne Airfield, require fast and easy access to Cambridge City centre. A high quality, reliable transport connection to employment areas in Cambridge will further stimulate the growth of housing developments in the area.

There are 6 key employment sites in Cambridge, which will deliver a large part of the forecasted growth of 22,100 net additional jobs in Cambridge by 2031. The sites include Addenbrooks Hospital, West Cambridge Science, Cambridge Station West. All these sites require good reliable transport into Cambridge City Centre. Good connection to city centre will encourage future growth in employment.

Option 1 will stimulate housing and employment growth the least, as it will be seen as standard bus transport, that interacts with traffic and may prove slow and unreliable in the peaks.

Option 6 will stimulate housing and employment growth, as it provides a dedicated tidal lane in and out of Cambridge City centre, and serves many local housing developments and employment areas.

Option 3a will stimulate housing and employment growth the most, as it will be seen as a fast and reliable transport link unhindered by traffic, which allows easy access to the Cambridge City centre and serves many local housing developments and areas of employment.

2.1.19. Accessibility

	Option 1	Option 6	Option 3a
Accessibility	**3**	**3**	**5**

Accessibility assesses how easy it will be to get into Cambridge City Centre using the bus services provided by the options. Work undertaken by the Cambridgeshire County Council indicates that if all of the major sites allocated for development in the local plan come forward, there could be a daily demand for a further 13,290 trips in the area of Cambridge. Madingley Road is already considered highly congested. Increasing the number of trips in the area will exacerbate the situation. Thus, this attribute favours the options that will improve accessibility into Cambridge City Centre.

Option 1 and **Option 6** propose moderate improvements in accessibility, as the bus lane and tidal lane allow improved access into Cambridge City Centre. However, Option 1 and Option 6 bus service will not have priority over traffic on the A428 section of the route, meaning that they will be affected by accidents and congestion along the A428 and might experience longer journey times. Option 1 and Option 6 score the same.

The guided busway proposed under **Option 3a** will avoid accidents on the A428 and congestion on Madingley road, so will provide reliable access to Cambridge City centre as buses will travel offline and have priority over cars at junctions where they interact.

2.1.20. Environmental Impacts

In June 2017, Atkins has undertaken a Strategic Environmental Overview, where it assessed the proposed options on their impacts on various parts of the environment. The following section summarises the findings of the Strategic Environmental Overview.

	Option 1	Option 6	Option 3a
Air Quality	**2**	**2**	**2**
CO2 emissions	**3**	**3**	**3**
Noise Impact on households	**2**	**2**	**1**
Impact on water environment	**3**	**3**	**3**
Landscape and Visual Impacts	**3**	**2**	**1**
Heritage impact	**1**	**2**	**1**
Biodiversity impact	**2**	**2**	**3**

2.1.20.1. Air Quality

Air quality impacts are not anticipated to significantly differ between **Option 1** (adjacent to the existing carriageway), **Option 6** (within the existing carriageway lanes) and **Option 3a** (offline, adjacent to the existing carriageway), as no additional vehicles are being proposed from one option over the other.

2.1.20.2. CO2 emissions

Use of nine buses per day into Cambridge will result in fewer vehicles travelling into and out of Cambridge during rush hour and provide public transport for the local villages. A reduction in air pollution, corresponding to the removal of vehicles from the carriageway, is anticipated to result. **Option 1** and **Option** 3a has the additional benefit of bringing the transport users into the centre of town without a change of

transport being required. These two options score the same. For **Option 6**, bus users would be required to change their method of transport at Madingley Mulch roundabout before continuing into Cambridge.

2.1.20.3. Noise Impact on households

Noise impacts are likely to be the same for both **Option 1** and **Option 6** for most of the route, due to the additional land take required and the distance between the receptors and the noise source. Both options are likely to generate a slight reduction in overall traffic noise during operation, due to the addition of the nine buses per day and reduction in associated vehicle numbers. Option1 and Option 6 score the same.

For **Option 3a**, noise assessment found that the overall impact of noise on affected households will be negligible.

2.1.20.4. Impact on water environment

Callow Brook to the north of Hardwick and two streams to the north of Cambourne, which are adjacent to the A428, could be affected by construction works. Significant impacts upon these features are not likely to differ between the **Options 1** and **Option 6**, as both options require similar land take adjacent to the carriageway.

Option 3a crosses Bin Brook once at an existing location. At this location, Bin Brook is designated as a Main River. Bin Brook could be affected by construction works, but significant impacts upon these features are not likely to differ from Options 1 and 6.

2.1.20.5. Landscape and Visual Impacts

Options 1 and **Option 6** will both require online signage for the bus lanes and gantries. The options will require additional hardstanding to accommodate the new lanes. These options will generate a significant loss of screening on both sides of the carriageway for the addition of the bus lanes, which will encroach onto the existing agricultural landscape.

The landscape impact will be more significant for the **Option 3a** offline route than for the online routes; however, due to the urban character of the settlements and existing transportation corridor present within the landscape, a significant adverse permanent impact on the area is not anticipated. A new offline highways corridor would cut through an existing agricultural landscape with interspersed urbanised centres. Due to the route options being run in parallel to the existing A428 and A1303 transport corridors the landscape and visual impact would be minimised.

2.1.20.6. Heritage Impacts

There are fourteen listed buildings along the route corridor for **Option 1**. Short term impacts will be of higher significance due to the increased visibility of the carriageway to the residents and businesses surrounding the A428. The environmental setting of the Conservation Areas and listed buildings is not likely to be significantly affected due to the existing highways infrastructure at these locations.

There are only three listed buildings along the route corridor for **Option 6**. Short term impacts will be of higher significance due to the increased visibility of the carriageway to the residents and businesses surrounding the A428. The environmental setting of the Conservation Areas and listed buildings is not likely to be significantly affected due to the existing highways infrastructure at these locations.

The offline route corridor of **Option 3a** has a higher potential for significant heritage impacts due to the requirement for new infrastructure outside existing highway corridors. The environmental setting of the area would be permanently affected by option 3a running through the Bourne Airfield, with the potential for buried Iron Age and Romano Britain historic remains to be present within the site.

2.1.20.7. Biodiversity Impacts

At the eastern end of the **Option 1** and **Option 6** route there is a local wildlife site, Madingley Wood SSSI. Options 1 and 6 will directly affect Madingley Wood SSSI by removing some roadside woodland to accommodate the new bus lane.

Option 3a will avoid direct impacts on Madingley Wood SSSI wildlife site. However, indirect impacts related to air quality, lighting and noise will need to be considered.

2.1.21. Public Support

	Option 1	Option 6	Option 3a
From public consultation	Tranche 1: Strongly Supported Tranche 2: Neutral	Not part of a public consultation	Tranche 1: Strongly Opposed Tranche 2: Strongly Supported

In November 2015, Cambridgeshire County Council held a public consultation, where participants were asked to provide their opinion on the "Cambourne to Cambridge Better Bus Journeys" Project.

The results of the public consultation indicated that the most widely supported option was **Option 1**. Particularly, the section between Madingley Mulch and Cambridge City Centre, where a bus lane is proposed, was strongly supported by the public.

According to the public consultation, **Option 3a** was less popular than Option 1. Particularly, the section between Madingley Mulch and Cambridge City Centre, where an offline busway is proposed, was strongly opposed by the public.

Option 6 was not part of the November 2015 public consultation, as it was not developed until 2017. Public support for this option is not known. As a result, it was not possible to assess and compare the options on the grounds of public support.

2.2. Changes between the first and second option assessments

The second-high level assessment (MCAF2) incorporates several attributes from the previous high level assessment (MCAF1) carried out last year. Below is the comparison of how the view on these attributes has changed between MCAF1 and MCAF2:

	Option 1		Option 6		Option 3a		Change Rationale
	MCAF 1	MCAF 2	MCAF 1	MCAF 2	MCAF 1	MCAF 2	
Scheme Capital Costs	5	5	4	4	1	1	There have been no changes between the assessments
Landscape/Visual Heritage	3	3	2	2	1	1	There have been no changes between the assessments
Noise Impact	3	2	3	2	2	1	No relative change; change only in numerical value
Constructability Risk	2	2	1	1	4	3	More information is available from engineering about the complexity involved with Option 3a
Deliverability Risk	4	4	3	3	2	2	There have been no changes between the assessments
Mode Shift	3	2	3	3	4	5	New data was made available from the CSRM2 model

3. Conclusion

	Option 1	Option 6	Option 3a
Total Score	**77**	**76**	**91**

The outcome of the Second Multiple Criteria Framework Assessment indicates that, out of the three proposed options, Option 3a is the best option.

Option 3a received high scores for its high quality public attributes and journey ambience. This implies that Option 3a will provide passengers with a safe and pleasant experience while travelling on the busway. Furthermore, through high scores in punctuality, reliability, mode shift and future proofing, Option 3a exhibits potential in being a highly efficient mode of transport, that will appropriately address the challenges facing the area, surrounding Cambridge, in the future.

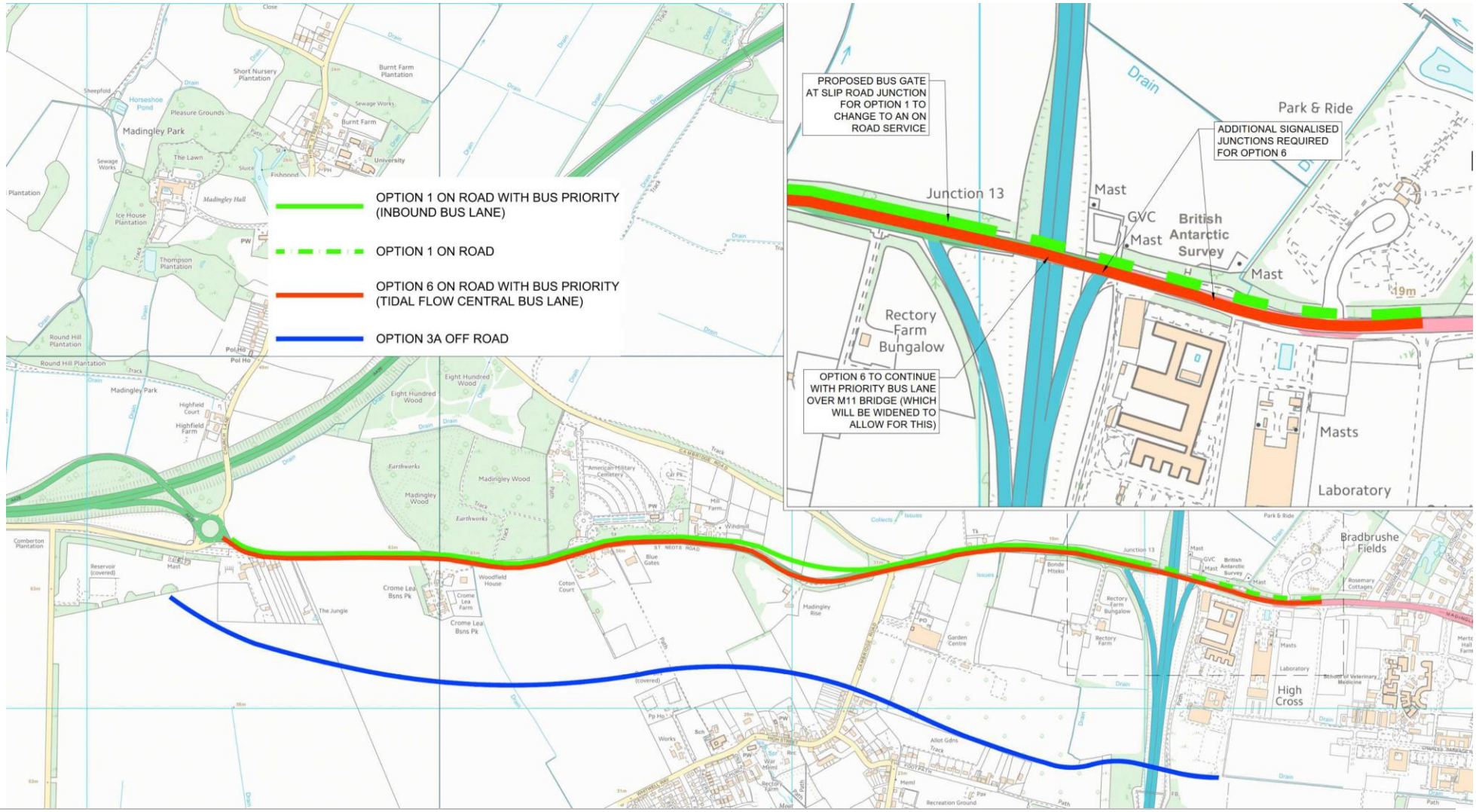
The main weakness of Option 3a is its high cost of delivery and subsequent maintenance/renewal. Option 3a proposes a large amount of new infrastructure, that goes above and beyond the proposals of the other two options, thus increasing the associated costs. Furthermore, due to its offline nature, Option 3a will have significant impacts on the environment between Cambourne and Cambridge.

In contrast, Option 1 and Option 6 propose smaller scale solutions, which will have a lesser impact on the environment around them. However, Option 1 and Option 6 lack the reliability, versatility and mode shift of Option 3a, as well as many other technical attributes. This makes them less future proof.

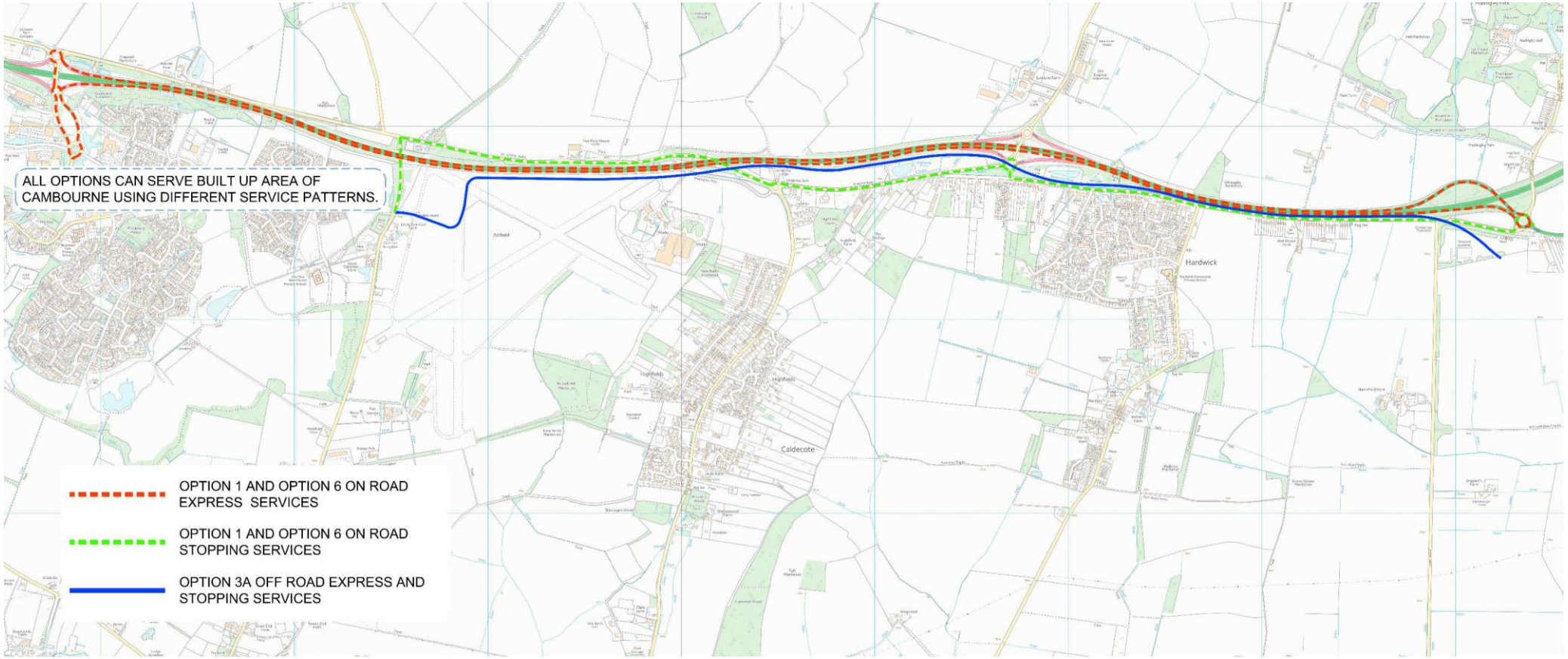
However, there are certain attributes which are qualitative and there is no/little evidence available for the MCAF. Also, Option 1 and Option 3a have been developed to a certain extent for the public consultation last year, but Option 6 does require more investigation so that a fair comparison can be carried out across all three options. Based on these observations, this note recommends that Option 6 should be further developed at an appropriate level for its comparison with Option 1 and Option 3a.

Appendix A. : Map of Options 1, 6 and 3a

A.1. Tranche 1: Madingley Road Roundabout – Cambridge City Centre



A.2. Tranche 2: Cambourne – Madingley Road Roundabout



Appendix B. : MCAF Table