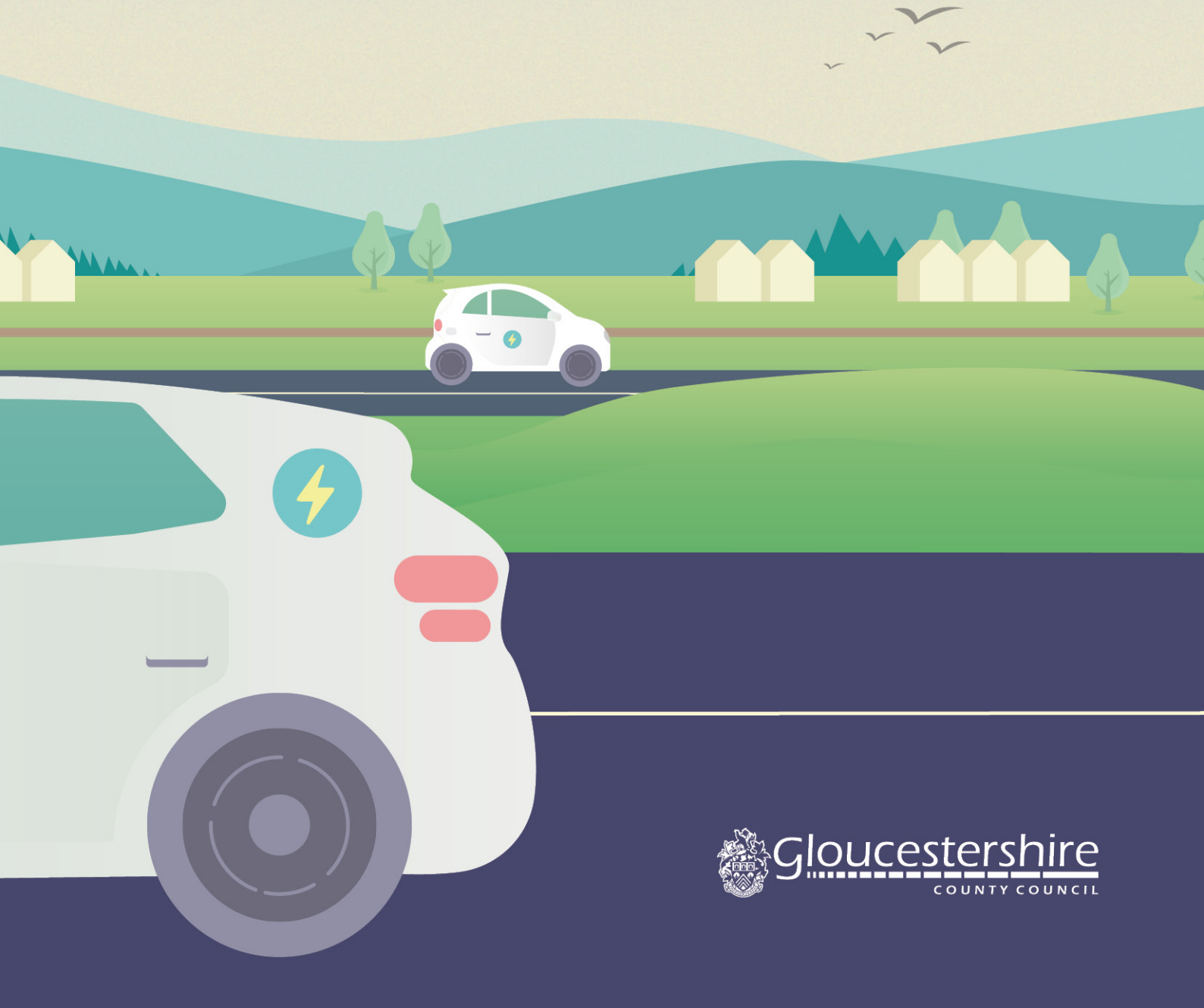
M5 Junction 10 Improvements Scheme

Technical Appraisal Report

Coombe Hill Junction / A4019 Widening



Gloucestershire COUNTY COUNCIL

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Document history

Revision	Status	Purpose description	Originated	Checked	Reviewed	Authorised	Date
C02	A1	Final Issue	CG	CJ	AM	LJ	10/09/20
C01	A1	Second issue	CG	CJ	AM	LJ	20/08/20
P01	S3	First issue	CG	CJ	AM	---	30/07/20

Client signoff

Client	**Gloucestershire County Council**
Project	**M5 Junction 10 Improvement**
Job number	**5188483**
Client signature / date	

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Executive Summary

Purpose of this Report

This report is to be read in conjunction with the main M5 Junction 10 Improvement Scheme Technical Appraisal Report (TAR) document reference GCCM5J10-ATK-GEN-XX-RP-ZM-000001. The M5 J10 TAR covers solutions for:-

- An all-movements junction at M5 Junction 10;
- A new West Cheltenham Link Road from J10; and
- Dualling of the A4019 to the East of the Link Road

This TAR focuses on the A38/A4019 junction improvements at Coombe Hill which is part of the wider M5 Junction 10 Improvement Scheme and included in the Business Case to the Housing Infrastructure Board (HIF).

Where appropriate, and not already covered by the M5 J10 TAR, this report also provides additional information on the dualling of the A4019 to the east of the link road.

Current Issues

A4019 Widening

The key improvement proposed on the A4019 are:

- Upgrading of existing single carriageway to two-lane dual carriageway to increase its capacity to accommodate the predicted increased traffic generated from the proposed housing and employment developments.
- Provision of dedicated cyclist and pedestrian facilities to encourage higher use of non-motorised forms of transport along the A4019 and provide a continuation of the cycleway/footways proposed for the separate Elms Park (North West Cheltenham) development.

A38/A4019 Coombe Hill junction

The key improvements proposoed for Coombe Hill junction are:

- Improvements to the junction layout to improve the flow of traffic from the A38 to the A4019.
- Upgrading the existing signalised junction to improve resilience of local network on occasions when the M5 is closed.
- Improving the pedestrian facilities, which are very limited at the existing junction with only one uncontrolled crossing point currently provided.
- Improving cycling facilities at the junction.

Options Identified for Appraisal

A4019 Widening

Improvements for the A4019 were first identified in the August 2016 Transport Assessment as part of the Elms Park (North West Cheltenham) development application which included plans to improve the A4019 over the approximate extents from the Fire Station to its junction with the B4633 Gloucester Road. Following this development application, Amey Consulting developed a Concept Option for extending the proposed improvements of the A4019 to the west to link to the proposed M5 Junction 10 and West Cheltenham Link Road improvements. These proposed improvements included the widening and upgrade of the existing A4019 to dual carriageway standard with improvements to

existing junctions. The Concept Option was included and assessed in the Homes England Business Case for funding in March 2019.

Following submission of the Homes England Business Case a review was undertaken to consider the Concept Option included with the submission and to identify potential new options. The advantages and disadvantages of each option in relation to known constraints were considered.

The options that were considered most likely to provide the required benefits and have the least impact on known constraints were:

- Option 1 – Standard dual carriageway (D2UAP)
- Option 2 – Reduced central reserve width dual carriageway
- Option 3 – No central reserve dual carriageway

A sifting exercise was undertaken on the above three concept options based on an assessment of their ability to provide the benefits required. With the reduced central reserve width in Option 2 and no central reserve in Option 3 a vehicle restraint system would not be able to be provided between opposing traffic flows. This would result in the safety of the options being compromised. Partial mitigation for this would be to reduce the speed limit to 40mph. However, even with a reduced speed limit it is considered that neither of these options would be as safe as Option 1. Neither do they significantly reduce the impact on land and properties to the north of the A4019. Therefore Options 2 and 3 have been sifted out at this stage.

Coombe Hill

Amey Consulting previously developed three Concept Options which were reduced to a single signalised junction option and included and assessed in the Homes England Business Case for funding in March 2019.

Following submission of the Business Case, a review was undertaken to consider all previous options identified and to identify potential new options. Three options for a signalised junction were developed which were:-

- Option 1 – As per the Amey Consulting signalised junction concept option, but with reduced lane requirements on A4019 approach and A38 southern arm to suit forecast demand and the addition of controlled pedestrian crossing facilities.
- Option 2 – As per Option 1, but with a give way arrangement for left turning vehicles from the A38 northern arm to the A4019, in place of the free-flow left turn and auxiliary lane. The location of pedestrian crossing facilities are also different to Option 1.
- Option 3 – As per Option 2, but with the left turn from the A38 to the A4019 being signalised alongside the straight-ahead lane.

A sifting exercise was undertaken on the above three concept options and it was concluded that all the options offer slightly different benefits so we would carry all of these forward to the appraisal stage.

Traffic Analysis

The traffic analysis undertaken highlight the fact that flows on A4019 near J10 and on Coombe Hill do not vary significantly between the M5 J10 scheme options recommended for further consideration in the TAR, and therefore Option 2 option flows could be used in further analysis for updating the A4019 design and signals.

The analysis demonstrates the need for improvements along the A4019 if the full development is to be built and that some turning movements are placing the Coombe Hill junction under stress.

Environmental Assessment

The environmental assessment outlined in this report provides a qualitative summary of the potential environmental impacts of the single option for the A4019 dualling and the three options for Coombe Hill. The assessment covers impacts on the historic environment (archaeology and cultural heritage), biodiversity, landscape and the water environment.

Of the topics assessed, the environmental assessment indicates that environmental impacts are likely to be limited to those caused by land take outside of the alignment of the highway. Further, more detailed and quantitative assessments will be undertaken at Stage 3, and will include an assessment of effects on the human environment (noise, air quality and greenhouse gases, and population and human health), and soils and geology (land contamination, geology, geomorphology and agricultural land). These further assessments may change the potential effects identified here.

Additional Assessments

Engineering impacts, safety, operational, technology and maintenance assessments were also appraised for each option in their respective chapters of this report.

Options to be taken forward

For the A4019 it is recommended that Option 1 is taken forward for further development.

For the Coombe Hil junction improvements it has been concluded that Option 1 and 2 should not be taken any further forward due having similar or less operational benefits and greater costs, land and environmental impacts than Option 3.

1. Introduction

1.1. Purpose of this Report

1.1.1. This report is to be read in conjunction with the main M5 Junction 10 Improvement Scheme Technical Appraisal Report (TAR) document reference GCCM5J10-ATK-GEN-XX-RP-ZM-000001. The M5 J10 TAR covers solutions for:-

- An all-movements junction at M5 Junction 10;
- A new West Cheltenham Link Road from J10; and
- Dualling of the A4019 to the East of the Link Road

1.1.2. This TAR focuses on the A38/A4019 junction improvements at Coombe Hill which is part of the wider M5 Junction 10 Improvement Scheme and included in the Business Case to the Housing Infrastructure Board (HIF).

1.1.3. Where appropriate, and not already covered by the M5 J10 TAR, this report also provides additional information on the dualling of the A4019 to the east of the link road.

1.1.4. The TAR brings together the traffic, safety and environmental assessments, and is the basis for deciding which option(s) should be further developed. The purposes of the TAR are broadly to:

- Set out the physical, environmental and traffic conditions of the area surrounding the junctions;
- Validate the need for the scheme under the terms of reference set out in the Client Scheme Requirements;
- Identify and evaluate sustainable options having regard to value for money, engineering, safety, effect on the economy, social and environmental factors;
- Describe the alternatives investigated and set out the reasons for rejection of any of those alternatives; and
- Recommend options for further development or recommend a single option for further development where there is the only one sustainable option, or one option is clearly the more sustainable than the others.

1.1.5. Following a public consultation into the whole scheme, a Scheme Assessment Report will be produced that takes into account the comments and views expressed and make a recommendation, if any, for the Preferred Option. The Preferred Option will be the scheme that Gloucestershire County Council recommends should be taken forward to an application for statutory powers to construct.

2. Existing Conditions

2.1. Description of the Locality

2.1.1. For a description of the A4019 locality please refer to section 3.1 of the M5 J10 TAR.

2.1.2. Located in the parish of Leigh, Coombe Hill is at the junction of the A38 and A4019 south of Tewkesbury at approximate OS Grid Reference 388841, 227037. The junction is a signalised junction and is located approximately 2.1 km north-west of the M5 Junction 10 interchange.

2.1.3. Coombe Hill is rural in nature with residential and commercial properties present, largely accessed directly from the A38. Located immediately to the north of Coombe Hill junction is a public house, a Texaco petrol filling station, a Morrisons Daily store, garage and a car dealership. The fields to the west and east of the petrol filling station are future development plots with planning applications in place. Coombe Hill Canal SSSI lies immediately west of Coombe Hill junction.

2.2. Existing Highway Network

2.2.1. The A4019 is a largely single carriageway road running in a northwest to southeast alignment between Coombe Hill to the west and Cheltenham to the east, crossing the M5 via a dual two-lane carriageway overbridge located approximately 2.1 km south-east of Coombe Hill. For full details of the existing A4019 at and to the west of the M5 J10 interchange please refer to section 3.2 of the M5 J10 TAR.

2.2.2. The A38 is largely a single carriageway road running in a north to south alignment between Tewkesbury to the north and Gloucester to the south. A 2.9 km length section of dual two-lane carriageway commences approximately 2.5 km south of Tewkesbury and ends approximately 0.7 km north of Coombe Hill junction.

2.2.3. Coombe Hill junction is a signalised junction between the A38, A4019 and a minor road known as The Wharf. A 40mph speed limit is present at the junction.

2.2.4. The junction is a 4-stage signalised junction controlling movements from the A4019 to the A38 in both directions, from the A38 northbound to the A4019 eastbound and from the minor road known as The Wharf. A left filter lane provided from the A38 southbound to the A4019 eastbound is not signal controlled and as such requires traffic to give way to traffic either turning from the A38 northbound or from The Wharf onto the A4019. A bus lay-by is provided on the eastbound side of the A4019 commencing approximately 60 m south-east of the junction.

2.2.5. Pedestrian footways are provided on both sides of both the A38 and A4019 at the junction. An uncontrolled pedestrian crossing is provided across the A38, immediately to the north of the junction. No dedicated cycling facilities are provided at the junction either within or segregated from the carriageway.

2.3. Reason for Improvement

2.3.1. The dualling of the A4019 to the east of the link road the A38/A4019 junction improvements at Coombe Hill form part of the wider M5 Junction 10 Improvement Scheme and were included in the Business Case to the Housing Infrastructure Board (HIF). To unlock the housing and job opportunities of the strategic development plan for the area, a highways network is needed that has the capacity to accommodate the increased traffic it will generate, within a sustainable transport context.

A4019 Widening

2.3.2. The key reasons for improvement identified for the A4019 are:

- Upgrading of existing single carriageway to two-lane dual carriageway required to increase its capacity to accommodate the increased traffic to be generated from the proposed housing and employment developments.
- Provision of dedicated cyclist and pedestrian facilities to encourage higher use of non-motorised forms of transport along the A4019 and provide a continuation of the cycleway/footways proposed for the separate Elms Park (North West Cheltenham) development.

A38/A4019 Coombe Hill junction

2.3.3. The key reasons for improvement identified for Coombe Hill junction are:

- Improvements to the junction layout to improve the flow of traffic from the A38 to the A4019.
- Upgrade of existing signalised junction to improve resilience of local network on occasions when the M5 is closed.
- Improvement of pedestrian facilities which are very limited at the existing junction with only one uncontrolled crossing point currently provided.
- Introduction of cycling provisions at the junction as none are currently provided.

2.4. Existing Structures

2.4.1. Based on information obtained through consultation with Gloucestershire County Council (GCC), no existing structures have been identified within the boundaries of either Coombe Hill junction or the A4019 improvement schemes. Existing structures associated with A4019 and M5 Junction 10 interchange have been covered previously within section 3.4 of the M5 Junction 10 Improvements Scheme TAR (GCCM5J10-ATK-GEN-XX-RP-ZM-000001).

2.5. Existing Road Pavement

2.5.1. Information on the existing road pavement on the GCC network is described in section 3.5 of the M5 J10 TAR.

2.6. Existing Traffic Conditions

2.6.1. This section summarises the existing traffic conditions along the A4019 in the area surrounding Junction 10 of the M5 and the proposed improvement scheme. Data presented and analysed here has been obtained from a variety of sources including the data used for the development of the Central Severn Vale (CSV) model which was used for the PCF Stage 2 modelling work undertaken by Atkins on behalf of GCC.

2.6.2. The peak hours, that is the hours during which traffic volumes are greatest was determined during the development of the CSV model using existing traffic count data. Peak hours were found to be 08:00 – 09:00 in the morning and 17:00 – 18:00 in the evening peak. Inter-peak refers to the hours between 10:00-16:00 and flows presented in Table 2.2 are for an average of these hours.

2.6.3. The A4019 runs east-west through Junction 10 connecting the A38 via at the Coombe Hill junction to the west and Cheltenham to the east as such the A4019 provides direct access to the M5 from Cheltenham.

2.6.4. The data presented is from the CSV base model year of 2013, which at the time of writing is around 7 years old. In order to determine how traffic volumes have changed since 2013 on the A4019, additional traffic data was sourced from GCC.

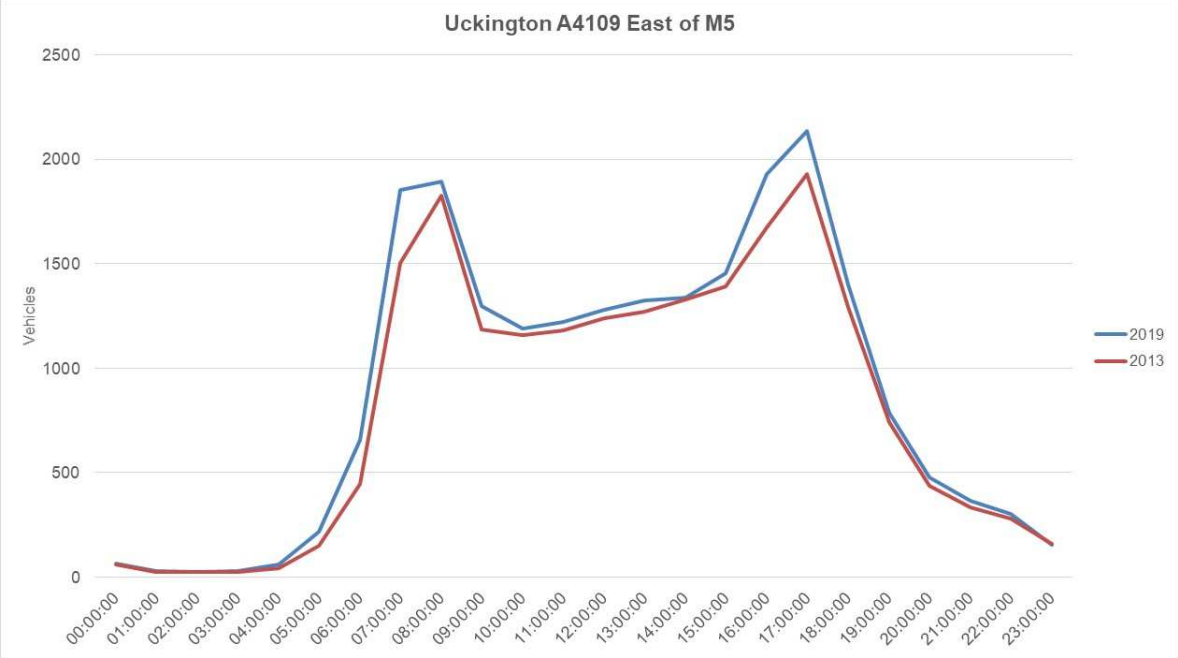
2.6.5. This data is presented (Figure 2-1 and Figure 2-2) for two sites along the A4019 to the east of the M5, Uckington and Tewkesbury Road West and covers the period of March 2013 and 2019. Tuesday 12th – Friday 15th of March have been omitted from the dataset owing to the occurrence of the Cheltenham Horse Racing Festival.

Table 2.1 – 2019 vs 2013 Observed Traffic Volumes – A4019

Location	Year	AM Peak (08:00 – 09:00)	PM Peak (17:00 – 18:00)
Uckington (east of M5 J10)	2013	1827	1891
	2019	1926	2133
% Difference		**+3%**	**+11%**
Tewkesbury Road West (west of Princess Elizabeth Way RB)	2013	2123	1891
	2019	2228	2123
% Difference		**+5%**	**+4%**

Figure 2-1 Uckington Traffic Flows

Figure 2-2 Tewkesbury Road West Traffic Flows



2.6.6. Growth factors for Gloucestershire overall were extracted from National Trip End Model (NTEM 7.2, March 2017) and found to be 1.0127 and 1.0124 for productions and attractions respectively. This indicates that expected traffic growth between 2013 and 2019 in Gloucestershire according to NTEM is around 1.25%. The corresponding growth factors for Cheltenham were larger indicating traffic growth of around 2% over the period more locally. The graphs demonstrate that traffic volumes at Uckington and Tewkesbury Road have increased over and above the 2% growth predicted by NTEM.

2.6.7. Though the actual traffic growth on the A4019 corridor is slightly more than the forecasted area wide growth of 2% it should be noted that the NTEM growth factors used for forecasting only provides growth within areas rather than traffic growth on roads, which could still vary depending on many factors including, congestion/transport schemes elsewhere. The modelled traffic as per NTEM is likely to provide a fair representation at Tewkesbury Road west having a growth of up to 5% in peaks and at Uckington Road having a max growth of 11% in PM peak and 3% in AM peak. The model will be updated in Stage 3 and will use a more focussed and up to date GCTM model, however these numbers provide a fair comparison with observed 2019 data.

2.6.8. As observed flows are slightly lower than the observed flows in 2019, it is expected that any model results in future forecast scenarios are likely to provide only conservative estimates with benefits likely to increase in stage 3, with slightly more congested forecasts representing a better fit with observed data.

2.6.9. It can be seen from the graphs that, generally, the daily pattern is consistent between years with some indication of peak spreading occurring in the AM at Uckington. This peak spreading can be seen by the relative increase in volumes leading up to the peak hour in 2019 relative to 2013.

Table 2.2 – Observed Traffic Volumes – A4019 - 2013

Site	Dir.	AM	IP	PM
A4019 Tewkesbury Rd (East of Withybridge Lane)	WB (to J10)	739	696	1,127
	EB (from J10)	1,212	830	888
A4019 Tewkesbury Rd (West of J10 near 'Old Spot' junction)	WB (from J10)	323	257	639
	EB (to J10)	583	463	411

2.6.10. The eastern and western sections of the A4019 both have single lane approaches towards Withybridge, widening out to two lanes over the structure itself. As with the M5 mainline the WebTAG TAG Unit A5.4 provides typical capacities for urban roads of this type with an average capacity of 1100 PCUs/lane/hour, which can vary depending on carriage width and road condition.

2.6.11. Again, noting that the figures presented in Table 2.2 are in vehicles not PCUs, the peak hourly traffic volumes are generally well within capacity. The maximum volume in any time period is 1,212 vehicles which is approaching the point at which delays may be experienced, however it is unlikely that on an average day this volume causes significant congestion.

2.6.12. The eastern section experiences peak hour flows of 1,212 eastbound in the AM peak and 1,127 in the westbound direction in the PM peak with far lower flows in the opposing directions suggesting a tidal flow of commuter traffic accessing Cheltenham via the A4019 and Junction 10 and leaving via the same route in the evening peak.

2.6.13. Low flow volumes may also be a result of congestion, if traffic volumes on a link reach a critical threshold, average vehicle speeds decrease resulting in a lower volume of traffic passing over a traffic count detector. Section 2.6.15 of this report reviews the journey time data available around Junction 10, no evidence was found for low speeds through the scheme location. Table 2.3 below shows the traffic flow volumes for both cars and total vehicles for the A38 approaches and exits from Coombe Hill Junction. Data presented is for the peak hour from 2017 and was sourced from the J10-J11 Paramics model LMVR developed by Jacobs.

Table 2.3 – Observed Traffic Volumes – A38 – 2017

Site	Dir.	AM Cars	AM Total	PM Cars	PM Total
A38 South of Coombe Hill Junction	SB	437	511	535	632
	NB	674	838	402	446
A38 North of Coombe Hill Junction	SB	815	941	518	574
	NB	651	829	610	713

2.6.14. The volumes for the A38 are within the capacity for a single carriageway road both to the north and south of Coombe Hill. This is true for both AM and PM peaks and in all directions. From this data alone there is no conclusion that the A38 is experiencing congestion, however it is noted that the specific turning volumes and associated signal design may cause some delays or queue build up at the junction.

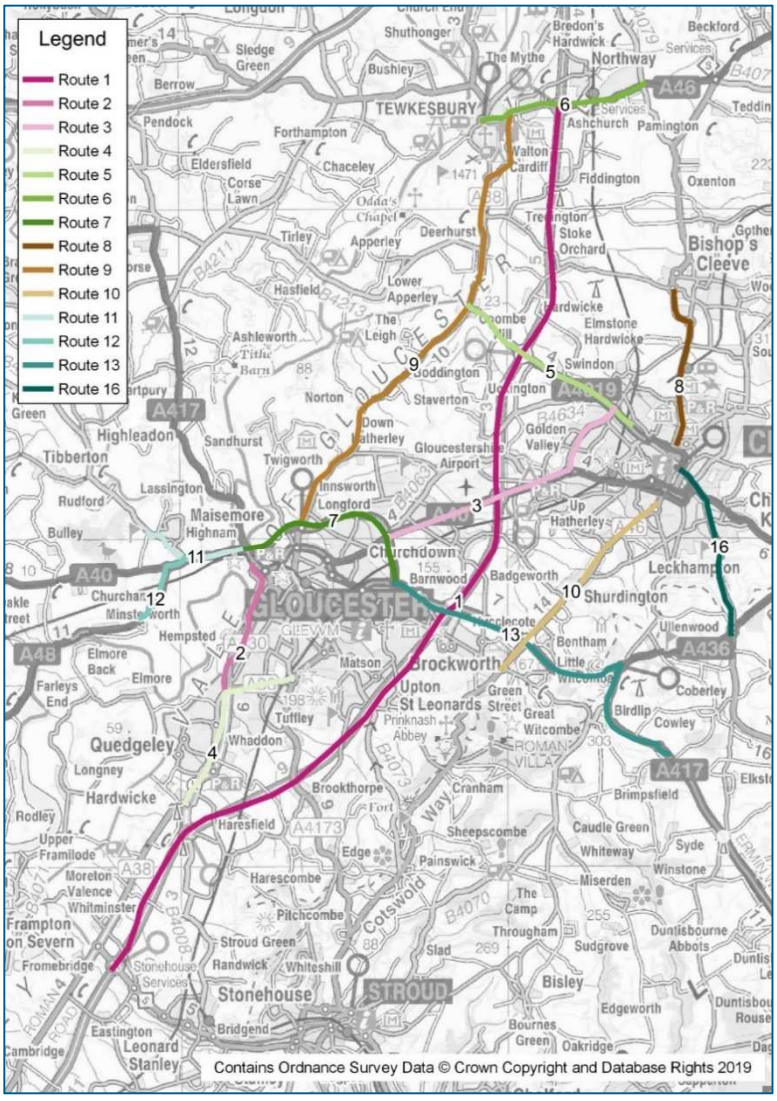
Journey Time Reliability

2.6.15. Percentile travel times around the median are the ideal way to report and understand reliability along a route. Generally, the 25th and 75th percentile journey times can be said to represent the core 50% of journeys and represent day-to-day variability whereas the 95th percentile journey time provides an understanding of how the route performs under more extreme conditions and corresponds to incident related variability.

2.6.16. For this Technical Appraisal Report the Highways England journey time database was queried, however no data is available for the A4019. There are other methods for journey time reliability assessment as presented in TAG Unit A1.3 but none of them were found to be directly relevant for this section. An alternative method that could possibly provide some insight could be based on section C.5 ' Stress based approach'. This again only provides evidence if the network is reaching capacity rather than any variability in journey times. As such it has not been possible to undertake a journey time reliability analysis for this route.

2.6.17. Journey time data was collected for the CSV model development and has been presented in the 2013 CSV LMVR. The routes obtained are shown in Figure 2-3 below.

Figure 2-3 CSV Journey Time Routes



2.6.18. Journey time data for Route 5 – along the A4019 is presented in Table 2.4.

Table 2.4 – CSV Journey Time Data - A4019

Route		Dir.	Length (km)	Average Journey Times (s)			Average Journey Speed (kph)		
				AM	IP	PM	AM	IP	PM
5	**A38 Coombe Hill to A4019 Tewkesbury Rd, Cheltenham**	EB	6.23	661	522	616	34	43	36
		WB	6.23	480	477	510	47	47	44

2.6.19. The journey time data above shows that speeds along the A4019 are particularly low in the eastbound direction during the peak hours.

2.6.20. Moving from the west at Coombe Hill junction, the speed limit along the A4019 is 40 mph, increasing to 50 mph around 700m to the east. The 50mph limit is replaced by a 40mph limit at the approach to the Gallagher retail park, however despite the 50mph speed limit there are several small access points and lay-bys along the stretch. These will serve to limit observed speeds, coupled with wait times at the signalised junctions providing access to the Gallagher retail park it is unsurprising that the observed speeds shown in Table 2.4 are considerably lower than the speed limit. Even under low congestion conditions there will be increased travel time owing to signal delays, so the relatively low speeds alone do not necessarily indicate a congested road link. Thus, reliability of journeys within the three time periods cannot be concluded from the journey time data. However, the differences in observed speed indicates larger delays in AM which could lead to more unreliable journeys in AM peak compared to Inter-peak or PM peak.

Queues

2.6.21. Queue data was collected in November 2017 to inform the J10-J11 Paramics model developed by Jacobs for GCC and is presented in Table 2.5 below. The only suitable location on the A4019 where data is available is the approaches to Princess Elizabeth Way Roundabout. Some additional queue data is also available at the M5J10 slip roads and is presented in section 3.6 of the M5 J10 TAR (GCCM5J10-ATK-GEN-XX-RP-ZM-000001).

Table 2.5 – J10-J11 Paramics Model - Queue Data (for peak 15 mins interval)

Site	AM	PM
A4019 (West of Tewkesbury Rd/Princess Elizabeth Way Roundabout)	123	114
A4019 (East of Tewkesbury Rd/Princess Elizabeth Way Roundabout)	135	99

2.6.22. The data in Table 2.5 above shows the queues (in vehicles) that occur during the peak hours at the Tewkesbury Road/Princess Elizabeth Way Roundabout. The A4019 west does experience significant queue build-up in both peaks however the approach to the roundabout has three lanes and the impact of queues of this magnitude further upstream along the A4019 is likely to be minimal. Moreover, this particular junction is outside the current scheme and will be revisited by GCC during planning application for Elms Park development site.

Collisions

2.6.23. Collision data for the five-year period from 1 July 2014 to 30 June 2019 was obtained from Gloucestershire County Council for the junction of the A4019 Coombe Hill / A38 Tewkesbury Road. During this period 3 personal injury collisions (PICs) were recorded.

Of the 3 collisions, 2 resulted in serious injury and one slight injury. No fatalities were recorded in the five-year period.

2.6.24. All three collisions occurred in daylight in dry conditions and none involved pedestrians or cyclists. Two of the collisions involved, or were caused by, vehicles emerging from the petrol garage forecourt on the A38. These collisions suggest that a strategy to improve conditions for users of the petrol station may be required to allow them to safely join the A38 on exiting the forecourt.

2.6.25. The proposed options for the junction will involve the retention of the petrol station however there will be some changes required to the access points due to the realignment proposed along the eastern side of the A38. There is the opportunity to improve access at this location as part of the scheme.

2.6.26. However, with fewer than one collision per year at the junction, there are currently no significant safety issues at this location.

2.6.27. Collision data for the A4019 was also obtained for the same period from a point east of Withybridge Lane to a point west of Homecroft Drive. Along this section of road a new roundabout and a new signal controlled junction will be constructed and the route will become dualled.

2.6.28. Five collisions were recorded along this defined section of the route. One of these collisions resulted in serious injury while 4 were slight injury collisions. Three were recorded between Withybridge Lane and The Green. All three collisions occurred in daylight in dry conditions. Two were rear-end shunts (one involving a vehicle waiting to turn right into a private access) and one involved a vehicle exiting the lay-by. Two collisions occurred to the east of the The Green / Moat Lane junctions. One involved a pedestrian running into the road and being struck by a vehicle (resulting in serious injury) and the other involved a vehicle overtaking and becoming trapped on the wrong side of the road by a central refuge island and colliding with an oncoming vehicle.

2.6.29. The collisions which have occurred along this section of the A4019 do not suggest that there is an ongoing or significant safety issue or that there is a specific location where collisions are more likely to occur. The only common factors identified were the two rear-end shunt collisions. However, these collisions and the collision involving an overtaking vehicle may suggest that vehicles are travelling at high speeds. The contributory factors attributed to the collisions also suggest that high speeds may be a cause with ‘failed to judge speed’ or ‘aggressive driving’ assigned to three of the five collisions.

2.7. Topography, Land Use, Property and Industry

2.7.1. Information on the existing topography, land use, property and industry for the area is described in section 3.7 of the M5 J10 TAR.

2.8. Climate

2.8.1. Information on the climate in the project area is provided in section 3.8 of the M5 J10 TAR.

2.9. Flood Risk

2.9.1. Refer to Section 14.5.

2.10. Existing Road Drainage

2.10.1. The assessment of the existing drainage has been undertaken based primarily on information available from Google Street View, Highways England Drainage Data Management System (HE DDMS) data, the Gloucestershire County Council (GCC) GIS and by applying engineering judgement. No as-built drainage drawings are available.

Coombe Hill

2.10.2. Existing collection systems local to Coombe Hill junction, including the A38, A4019 and The Warf, consist of a mix of gully and kerb arrangements and kerb inlets. Localised changes to the highway alignment will affect the existing drainage arrangement. Existing drainage collection system data can be obtained from the Gloucestershire County Council GIS (https://gis.gloucestershire.gov.uk/LocalViewPub). No information regarding conveyance systems or outfalls is currently available.

A4019

2.10.3. For details of A4019 existing drainage see section 3.10 of the M5 J10 TAR.

2.11. Geology

2.11.1. The Geology underlying the site is summarised below, and is based on the 1:50,000 scale British Geological Survey (BGS) Map Sheet 216 (Tewkesbury), the geological memoir 'Geology of the Country around Tewkesbury' and the online BGS GeoIndex.

Made Ground

2.11.2. Published information indicates one small area of artificial ground located approximately 30m northwest of Coombe Hill Junction. It is described as "Made Ground (Undivided) – Artificial Deposit" and appears to be associated with the historic Coombe Hill canal wharf. In addition, made ground associated with the construction and ongoing maintenance of the A38 and A4019 will be present across the site.

Superficial Deposits

2.11.3. Published information indicates no superficial deposits are expected beneath Coombe Hill junction itself. However, a small 100m wide finger of Alluvium associated with Leigh Brook is shown to cross-cut the A4019 approximately 120m southeast of the junction. These deposits are described as "Alluvium –Clay, Silt, Sand and Gravel". The depth of this deposit is unknown but its location corresponds to a northeast-southwest orientated fault which cross-cuts the A4019 approximately 150m to the southeast of Coombe Hill junction.

Bedrock Geology

2.11.4. Published information indicates that Coombe Hill junction is likely to be underlain by interbedded mudstones and limestones of the Wilmcote Limestone Member. In addition, mudstone of the Saltford Shale Member will be present beneath the A4019 to the southeast of the junction. The parent unit for both these rock types is the Blue Lias Formation.

2.12. Geohazards

2.12.1. The following geohazards have been identified:

- Buried concrete structures within Lias Group mudrocks are prone to Thaumasite Sulphate Attack (TSA), particularly where the concrete is in contact with saturated un-weathered Lias-derived fill. The result is a transformation of the concrete fabric into a weak paste, which has serious consequences for the integrity of the concrete and may result ultimately in failure.
- There is no existing ground information for the site and a site-specific ground investigation will be necessary to confirm the actual ground model. Testing will be required to confirm the concrete class required for any potential retaining structures based on the risk of TSA mentioned above. The ground investigation should also confirm if soft compressible Alluvium is present within the scheme extents, the shrink-swell potential of the Blue Lias mudstones which are documented as having a 'medium' shrink-swell potential and the presence of hard limestone bands within the underlying bedrock which is anticipated to be at shallow depth beneath the junction.

2.13. Groundwater

2.13.1. General details of groundwater at the site are included in Section 14.5. A site-specific ground investigation will be necessary to determine groundwater levels.

2.14. Contaminated Land

2.14.1. Information on contaminated land is provided in section 3.14 of the M5 J10 TAR.

2.15. Agricultural Soils

2.15.1. Information on agricultural soils is provided in section 3.15 of the M5 J10 TAR.

2.16. Public Utilities

C2 Preliminary Enquiries

2.16.1. In order to fully understand the extent to which Statutory Undertakers' apparatus is present in the study area, preliminary (C2) enquiries were sent out to all Statutory Undertakers in the region in accordance with the New Roads and Streetworks Act 1991 (NRSWA 1991). This preliminary enquiry process requests the Statutory Undertaker's to provide any information they have available that may impact on the scheme.

2.16.2. For details of the Statutory Undertakers that were consulted during the C2 Preliminary Enquiry stage for the A4019 improvements please refer to section 3.16 of the M5 J10 TAR.

2.16.3. Table 2.6 identifies the Statutory Undertakers that were consulted during the C2 Preliminary Enquiry stage for the Coombe Hill improvements. Drawings identifying the locations of existing utilities are included in Appendix C.

Table 2.6 – List of Statutory Undertakers Consultees

Statutory Undertaker	Date Received	Apparatus Present	Potential to be affected by an Improvement Scheme
Openreach - BT	13/05/20	Yes	Yes
Severn Trent Water (STW) – Foul	18/05/20	Yes	No
Severn Trent Water (STW) – Water	18/05/20	Yes	Yes
Virgin	14/05/20	Yes	No
Wales and West Utilities	13/05/20	Yes	Yes
Western Power Distribution	13/05/20	Yes	Yes
SSE – (Telecom, Gas, Electric, Water, Sewage, Steam)	13/05/20	Yes	No
Gigaclear Plc	13/05/20	Yes	Yes
LinesearchbeforeUdig	13/05/20	Yes	Yes
Environment Agency	13/05/20	No	No – (Note: environmental permit may be required)
Vodafone	13/05/20	No	No
GTC (Telecom, Gas, Electric, Water)	13/05/20	No	No
C.A Telecom UK (Colt Technology Services)	14/05/20	No	No
Network Rail	13/05/20	No	No
Sky Telecommunications	13/05/20	No	No
Utility Assets	13/05/20	No	No
Verizon	13/05/20	No	No
CityFibre	13/05/20	No	No
Last Mile	13/05/20	No	No
DIO (MOD Abandoned Pipelines)	Awaiting response		
Gloucestershire County Council	Awaiting response		
Instalcom – [CenturyLink, Global Crossing, Fibernet & Fiberspan]	Awaiting response		

2.17. Operational Maintenance Regime

2.17.1. Maintenance of assets at the Coombe Hill junction will not change significantly. Where new assets are provided such as lighting and signs their maintenance demand will be evaluated to minimise road worker exposure and risk.

2.18. Existing Road Lighting

2.18.1. Existing road lighting provision at Coombe Hill junction is provided by a single 10m mounting height lighting column with an LED luminaire. The lighting column is positioned on the A38 immediately to the south of the A38/A4019 junction.

2.19. Existing Technology Provision

2.19.1. Existing traffic signalling at Coombe Hill junction is provided by 7.4m traffic signal poles. The junction operates with 4 stages. All movements are signalled controlled except for the left turn from the A38 northern arm to the A4019, which is currently a give way lane. Further detail on the staging at the existing junction is provided in section 9.1.

2.19.2. A set of Wig Wag signals (TSRGD Diagram 3014) are present on the A4019; where there are two signals either side of the Community Fire Station. These will be configured to display warning lights when emergency vehicles are exiting the Fire Station.

3. Options Identified for Appraisal

3.1. A4019 Scheme History

3.1.1. In August 2016 a Transport Assessment was prepared as part of the Elms Park (North West Cheltenham) development application. This Transport Assessment included plans to improve the A4019 over the approximate extents from the Fire Station to its junction with the B4633 Gloucester Road, with sections of widening to provide a dual carriageway, bus lanes and improved pedestrian and cyclist facilities. These plans also included the upgrade of existing junctions and the inclusion of new junctions to access the proposed development.

3.1.2. Following this development application, Amey Consulting developed a Concept Option for extending the proposed improvements of the A4019 to the west to link to the proposed M5 Junction 10 and West Cheltenham Link Road improvements. These proposed improvements included the widening and upgrade of the existing A4019 to dual carriageway standard with improvements to existing junctions. The Concept Option was included and assessed in the Homes England Business Case for funding in March 2019.

3.2. Options Identified at Options identification Stage

3.2.1. Following submission of the Homes England Business Case a review was undertaken to consider the Concept Option included with the submission and to identify other potential options for dualling. The advantages and disadvantages of each option in relation to known constraints were considered.

3.2.2. As part of this exercise, options for wide single carriageways and part dualling of the A4019 were considered. WebTAG TAG Unit A5.4 – Marginal External Costs includes guidance on average capacities for urban roads by road type and geographical area. Table A2 includes Cheltenham in Area 7 – Urban large (>100,000) and using this area in Table A6 for an 'A Road' gives a suggested average capacity (PCU per lane km per hour) of 1100. However, following an assessment using forecast traffic flows obtained from the scheme Saturn model, this showed that all the individual links along the A4019 within the study area had a forecast flow exceeding 1100 pcu in either the eastbound, westbound or both carriageways, so this would rule out these options.

3.2.3. The options that were considered most likely to provide the benefits required and have the least impact on known constraints were identified. These were:

- Option 1 – Standard dual carriageway (D2UAP)
- Option 2 – Reduced central reserve width dual carriageway
- Option 3 – No central reserve dual carriageway

3.2.4. A typical cross section for each of these three options is shown in drawing Nos. GCCM5J10-ATK-HML-L1_SR-SK-CH-000004 and 000005 C01 in Appendix A.

3.2.5. As part of the above exercise, the potential for alternative route corridors were considered but none were identified due to severity of impacts on land, existing property and proposed developments.

3.3. Sifting of Options at Options identification Stage

3.3.1. A sifting exercise was undertaken on the above three concept options based on an assessment of their ability to provide the benefits required.

3.3.2. The difference between Options 1,2 and 3 relates to the proposed width of the central reserve and imposed speed limit. Lane widths, verge widths and walking/cycling facilities are common on all three options. Within Option 1 the central reserve width would be 1.8m, Option 2 would have a central reserve width of 1.0m and Option 3 would not have a central reserve. Due to the reduced width and removed central reserve in Options 2 and 3 respectively, it is considered that a reduction in the speed limit from 50mph to 40mph would be required.

3.3.3. With the central reserve width in Option 1 there would be sufficient width to provide a vehicle restraint system with an allowable relaxation in the set-back value. With a VRS in place it would be considered acceptable to maintain the existing 50mph speed limit if required.

3.3.4. With the reduced central reserve width in Option 2 and no central reserve in Option 3 a vehicle restraint system would not be able to be provided between opposing traffic flows. This would result in the safety of the options being compromised. Partial mitigation for this would be to reduce the speed limit to 40mph. However, even with a reduced speed limit it is considered that neither of these options would be as safe as Option 1 and neither would they significantly reduce the impact on land and properties to the north of the A4019. They were therefore sifted out at this stage.

3.4. Description of Option carried forward for Appraisal

Option 1 – Standard Dual Carriageway (D2UAP)

3.4.1. The proposed layout for Option 1 is shown on Drawing Nos. GCCM5J10-ATK-HML-L1_SR-SK-CH-000001 and 000002 C01 in Appendix A.

3.4.2. The option includes for the existing A4019 between the proposed new M5 Junction 10 gyratory roundabout and the Fire Station to be widened to provide a standard two-lane dual carriageway with 3.65 m lane widths and a 1.80 m wide central reservation.

3.4.3. Approximately 560m east of the M5 Junction 10. a new two-lane gyratory roundabout would be provided connecting the A4019 to M5 J10 to the west and the B4634 to the south via a new two-lane dual carriageway discussed as part of the M5 J10 TAR (the West Cheltenham link Road). At the eastern extent, near the Fire Station, the proposed option would tie into A4019 improvements included in the separate Elms Park (North West Cheltenham) development application.

3.4.4. The existing priority junction between Cook Lane and the A4019 would be retained with only minor kerb realignment works. Due to the proposed dualling of the A4019 and presence of a central reservation, a left-in and left-out arrangement would be necessary for Cook Lane and would therefore only be accessible from the A4019 westbound carriageway. When entering the A4019 from Cook Lane, vehicles would only be able to turn left and enter the westbound carriageway. In order to travel on the A4019 eastbound, vehicles would be required to travel westbound to the proposed new roundabout and perform a U-turn.

3.4.5. A new signalised junction is proposed at the existing staggered crossroad junction between The Green and Moat Lane in Uckington. The carriageway would be widened to provide right-turn lanes from the A4019 westbound and eastbound to The Green and to Moat Lane respectively, allowing two lanes for through traffic in both directions at the junction. Traffic would be able to enter the A4019 in both directions from both The Green and Moat Lane. Bus lay-bys would be provided in both directions, to the east of signalised junction.

3.4.6. In order to provide a continuation of the proposed walking and cycling provision included as part of the separate Elms Park (North West Cheltenham) development application, a

two-way 4 m wide cycle track is proposed on the northern side of the A4019 for the extents of the proposed dualling section between the proposed West Cheltenham Link roundabout and the Fire Station. The cycle track would be separated from the carriageway by a 1.5 m wide separation strip with a full-height kerb present at the carriageway edge. Adjacent to the cycle track and separated by 0.5 m wide strip, a 2 m wide footway is proposed with a 1 m wide level verge provided to the back of the footway. A signalised cycle and pedestrian crossing would be provided across The Green as part of the new signalised junction at Uckington.

3.4.7. To accommodate the proposed A4019 cross-section including the new cycle track/footway, the frontages of a number of properties on the northern side of the A4019 would need to be reduced and the demolition of two houses would be required. Existing property and field accesses direct onto the A4019 would also be reconfigured to accommodate the new cross-section. Due to the introduction of a central reservation along this section as part of the proposed dualling, direct accesses would have a left-in and left-out arrangement. As such properties and fields with direct accesses on the southern side of the A4019 would only be accessible via the A4019 westbound carriageway. Conversely, properties/fields on the northern side of the A4019 would only be accessible via the A4019 eastbound carriageway.

3.4.8. It should be noted that U-turns would be prohibited at the proposed signalised junction at Uckington, similar to U-turn prohibitions currently present at existing signalised junctions along the A4019. Therefore, vehicles entering the A4019 from the direct accesses on the southern side would be required to travel on the A4019 westbound to the proposed new roundabout in order to perform a U-turn onto the A4019 eastbound. Conversely, vehicles entering the A4019 from the direct accesses on the northern side would be required to travel on the A4019 eastbound to the A4019/A4013 roundabout in order to perform a U-turn onto the A4019 westbound.

3.4.9. Alternatively, under the existing layout there are a number of junctions and retail areas on the northern side of the A4019 which may be utilised by A4019 eastbound traffic wishing to join the westbound carriageway. Additionally, separate planning applications are in place to upgrade the existing junctions and provide new roundabouts to access new development sites on the northern side of the A4019 which will offer additional opportunities for eastbound traffic to access the A4019 westbound without the need to travel to the A4019/A4013 roundabout.

3.4.10. It should be noted that restricting right turns on this section of the A4019 around Uckington may increase the journey times marginally for trips coming from or wishing to join the opposite carriageway as they would need to travel a little further to make a U-turn. However there are only a handful of such trips due to a limited number of developments connecting directly at this section of the A4019. As the alternate arrangements for allowing U-turns are nearby the overall impact is likely to be negligible in the wider context and restricting right turns is likely to provide overall benefits by improving the safety of the scheme.

3.5. Coombe Hill Junction Scheme History

3.5.1. Three outline options for improving the Coombe Hill junction were developed by Amey Consulting in February 2019. These included options for a signalised junction, an online roundabout and an offline roundabout. Both roundabout options would have significant land requirements and the online roundabout option would also include the need to demolish several properties. The two roundabout options were discounted on the basis on their land/property impacts and the signalised junction option was included in the Homes England Business Case.

3.6. Options Identified at Options identification Stage

3.6.1. Following submission of the Homes England Business Case a review was undertaken to consider the Concept Option included with the submission and to identify potential new options. The advantages and disadvantages of each option in relation to known constraints were considered.

3.6.2. At the start of this stage the three outline options produced by Amey Consulting were reviewed to explore the feasibility of alternative forms of junction at Coombe Hill. This exercise confirmed Amey Consulting's conclusions that any appropriate roundabout option would have significant land, property and business impacts and this junction type should be discounted.

3.6.3. The conceptual signal option was reviewed using the latest traffic model for the Option 2 M5 J10 improvement, with input from specialists in engineering, traffic signalling and traffic modelling. Three options for a signalised junction were developed which were:-

- Option 1 – As per the Amey Consulting signalised junction concept option, but with reduced lane requirements on A4019 approach and A38 southern arm to suit forecast demand and the addition of controlled pedestrian crossing facilities.
- Option 2 – As per Option 1, but with a give way arrangement for left turning vehicles from the A38 northern arm to the A4019, in place of the free-flow left turn and auxiliary lane. The location of pedestrian crossing facilities are also different to Option 1.
- Option 3 – As per Option 2, but with the left turn from the A38 to the A4019 being signalised alongside the straight-ahead lane.

3.7. Sifting of Options at Options identification Stage

3.7.1. Consideration was given to sifting the above three concept options but it was concluded that all the options offer slightly different benefits so we would carry all of these forward to the appraisal stage.

3.8. Description of Option carried forward for Appraisal

Option 1

3.8.1. Option 1 was developed on the same concept as the Amey Consulting signalised junction option but the approach lanes on the A4019 and A38 southern arm were amended to suit forecast demand. This resulted in the proposed three lane approach on the A4019 reducing to two lanes. The proposed two lane exit on the A38 southern arm also reduced to one lane.

3.8.2. The proposed layout for Option 1 is shown on Drawing No. GCCM5J10-ATK-HML-J5_JN-SK-CH-000001_C01 in Appendix B.

3.8.3. The option includes a free flow left turn lane connecting the A38 northern arm to the A4019 via an axillary lane. Due to the length of the proposed auxiliary lane the existing A4019 bus stop would need to be relocated to the east.

3.8.4. Pedestrian facilities were proposed across the A4019, The Wharf and the A38 Eastern arm. Additionally, a crossing across the left turn (A38 to A4019) is proposed, which runs independently of the rest of the junction.

3.8.5. Cycling facilities in the form of Advanced Stop Lines (ASLs) and lead in cycle lanes are provided on all arms except for The Wharf, where they have been omitted due to the low traffic flows.

3.8.6. At the A38 southern arm, the existing carriageway would be widened to the west in order to provide additional width for the lead in cycle lane and traffic island. The existing footway would be reinstated over this length and a retaining wall would be required at the back of the proposed footway as the existing ground rises from the back of the existing footway to the front boundary of the adjacent properties.

3.8.7. At The Wharf, the existing road would be widened on the northern side to provide sufficient carriageway width to allow an entering vehicle to pass another vehicle that is waiting at the stop line.

3.8.8. On the A38 northern arm, carriageway widening for the free flow left turn lane would generally be provided to the west of the existing road, in order to minimise impacts to the fuel station located on the eastern side of the existing road. The access and egress from the fuel station would be slightly repositioned to suit the realigned kerb line positions. South of the fuel station the road would be widened to the east to provide the left turn and auxiliary lane.

Option 2

3.8.9. Option 2 was developed with the aim of removing the auxiliary lane from the free flow left turn lane in order to minimise scheme land impacts and costs. The auxiliary lane is replaced in this option by a give-way arrangement for left turning traffic.

3.8.10. The proposed layout for Option 2 is shown on Drawing No. GCCM5J10-ATK-HML-J5_JN-SK-CH-000002_C01 in Appendix B.

3.8.11. Apart from the removal of the auxiliary lane, the lane arrangement on each of the arms is the same as Option 1 and would also provide pedestrian facilities. However, rather than an A4019 crossing, which would no longer be possible due to the reduced length of the left turn refuge island, both A38 arms would have pedestrian facilities.

3.8.12. Cycling facilities would also be provided as described in Option 1.

3.8.13. There would be a similar requirement as Option 1 to widen the A38 southern arm to the west and provide retaining walls. There would also be a similar requirement to widen The Wharf on the northern side.

3.8.14. On the A38 northern arm, the extent of the improvements would be reduced compared to Option 1 as the taper length required for the give way arrangement is less than that required for the taper to the free flow left turn and auxiliary lane layout included in Option 1. As with Option 1, access to and from the fuel station would be slightly repositioned to suit the realigned kerb line positions. South of the fuel station the road would also need to be widened to the east to provide the left turn lane.

3.8.15. The extent of the A4019 improvements would also be reduced compared to Option 1 as a result of the removal of the auxiliary lane and the existing bus stop could remain.

Option 3

3.8.16. Option 3 was developed with the aim of further minimising scheme land impacts and costs with the left turn lane from the A38 to the A4019 being signalised alongside the straight-ahead lane.

3.8.17. The proposed layout for Option 3 is shown on Drawing No. GCCM5J10-ATK-HML-J5_JN-SK-CH-000003_C01 in Appendix B.

3.8.18. Apart from the amendment to the left turn lane, the lane arrangement on each of the arms is the same as Options 1 and 2 and would also provide pedestrian facilities at similar locations to Option 2.

3.8.19. Cycling facilities would also be provided as Options 1 and 2.

3.8.20. There would be a similar requirement as Options 1 and 2 to widen the A38 southern arm to the west and provide retaining walls. There would also be a similar requirement to widen The Wharf on the northern side.

3.8.21. On the A38 northern arm, the extent of the improvements would be similar to Option 2. As with Options 1 and 2, access to and from the fuel station would be slightly repositioned to suit the realigned kerb line positions. South of the fuel station the road would also need to be widened to the east but to a lesser degree than Options 1 and 2.

3.8.22. The extent of the A4019 improvements would be similar to Option 2 and would also allow the retention of the existing bus stop.

4. Traffic Analysis

4.1. Traffic Data Collection

4.1.1. As part of the M5 J10 HIF business case submission, an existing 2013 base year Central Severn Vale (CSV) traffic model previously developed by consultants Waterman Group was enhanced by Amey in 2019 while retaining the existing 2013 base year.

4.1.2. Full details of the model, including the traffic data collection undertaken is provided in the CSV Local Model Validation Reports produced by Amey:

- CSV LMVR 2013 IP Update Jan19 – Amey (2019 LMVR)
- CSV LMVR 2017_030317_ISSUE_a – Amey (2017 LMVR)

4.1.3. For CSV base model update undertaken by Amey, all available data was collected, reviewed and processed to produce peak hourly traffic flows at key locations and journey times along key routes.

4.1.4. Details of the data sources used in the CSV model development are provided in section 10.1 of the M5 Junction 10 TAR (GCCM5J10-ATK-GEN-XX-RP-ZM-000001) document.

4.2. Model Development

4.2.1. It was agreed with the client that the existing Central Severn Vale (CSV) model would provide the basis for developing traffic forecast scenarios for Stage 2. The CSV model was updated by Amey in 2019 to ensure that the model was appropriate to appraise transport interventions and policies, including the Joint Core Strategy and Gloucestershire Major Schemes like the M5 Junction 10 Improvements. Gloucestershire County Council (GCC) is already undertaking development of an enhanced 2015 base year model, which will available for use in Stage 3 assessment.

4.2.2. The model development and key characteristics are presented in section 10.2 of the M5 Junction 10 TAR (GCCM5J10-ATK-GEN-XX-RP-ZM-000001) document.

4.2.3. Further, section 2.6 presents analysis to show that current traffic condition in 2019 is not much different to 2013 around the A4019, though there is a slight reduction in traffic on the motorway in AM/PM peak hours and an increase in the average Inter-peak. Further, latest queue information from 2017 J10-J11 Paramics model shows the southbound off-slip and Princess Elizabeth Junctions as main hotspots for the queues and rest of the networks in the vicinity operating well in 2019.

4.2.4. We acknowledge that traffic within CSV 2013 model will not be identical to the current situation and could lead to uncertainties which could be better addressed with more recent models. GCTM model to be used in Stage 3 should be able to provide more robust results.

4.3. Model Forecasting

4.3.1. Full details of the traffic forecasting assessment work undertaken by Atkins for this Stage of the M5 Junction 10 Improvement Scheme can be found in the Transport Forecasting Package Report (GCCM5J10-ATK-HTA-XX-RP-TR-000006).

4.3.2. The purpose of developing a well validated base model that accurately represents current network conditions is to provide a robust basis for developing traffic forecasts. The M5 Junction 10 Improvement forecast scenarios have been developed using the CSV base model as a starting point to assess the environmental and economic impacts of the scheme options.

4.3.3. The forecasting methodology has been summarised in section 10.3 of the M5 Junction 10 TAR document.

4.4. Model Results

4.4.1. The overall model results for each of the model scenarios including network statistics, flow diagrams and flow difference plots are included in section 10.4 of the M5 Junction 10 TAR. This section summarises the model forecast results with a focus on the A4019 to supplement these wider results.

4.4.2. Flow diagrams are presented in Figure 10-2 to Figure 10-5 of the M5 J10 TAR document (GCCM5J10-ATK-GEN-XX-RP-ZM-000001) show the modelled flows in vehicles for the AM and PM peaks in 2041 for the Do–Minimum (Scenario P, deadweight developments) and for each of the three Do-Something scheme options (Scenario R, deadweight plus dependent developments).

A4019 to the east of J10 to the west of B4634

4.4.3. From the analysis of link flows on A4019, we can see that flow on A4019 to the east of J10 to the west of B4634 varies between 1602 to 1905 vehicles in the EB direction and between 1041 to 1093 in the WB direction amongst various M5J10 options in the AM peak.

4.4.4. Similarly, in the PM peak, EB direction flows vary between 1196 to 1426 vehicles and in the WB direction between 1682 to 1883 vehicles.

A4019 to the east of Coombe Hill

4.4.5. From the analysis of link flows on the A4019, we can see that flow at this location varies between 717 to 885 vehicles in the EB direction and between 437 to 497 in the WB direction amongst various M5J10 options in AM peak.

4.4.6. Similarly, in the PM peak, the EB direction flows varies between 580 to 640 vehicles and in the WB direction between 727 to 893 vehicles.

A38 north of Coombe Hill Junction

4.4.7. From the analysis of link flows on the A38, we can see that flow at this location varies between 649 to 689 vehicles in the NB direction and between 603 to 626 in the SB direction amongst various M5J10 options in the AM peak.

4.4.8. Similarly, in the PM peak, NB direction flows vary between 829 to 835 vehicles and in the SB direction between 550 to 594 vehicles.

A38 south of Coombe Hill Junction

4.4.9. From the analysis of link flows on the A38, we can see that flow at this location varies between 774 to 903 vehicles in the NB direction and between 408 to 489 in the SB direction amongst various M5J10 options in the AM peak.

4.4.10. Similarly, in the PM peak, NB direction flows varies between 573 to 682 vehicles and in the SB direction between 479 to 657 vehicles.

Flow Summary

4.4.11. Thus, we can see on the A4019 within the scheme area and the A38 at Coombe Hill, traffic flows are quite consistent between various M5J10 scheme options. Thus, as

recommended in TAR report, the traffic flows from Option 2 scheme (i.e. improvement of the existing junction) are taken forward for design updates including junction improvements and signal updates where required.

4.4.12. Figure 4-1 and Figure 4-2 show the link flows in vehicles for the Do-Minimum Scenario P and the Do-Something Option 2 Scenario R in the AM and PM peaks respectively. In the Do-Something scenario the flow along the A4019 to the east of Junction 10 is significantly increased. This is as expected given the addition of the full dependent development trips from the JCS housing site in Scenario R and illustrates the increased demand on this portion of the A4019 when the housing development is built.

4.4.13. The flow volumes along the A4019 and the A38 approach to the Coombe Hill Junction remain relatively consistent between Do-Something and Do-Minimum scenarios.

4.4.14. There is a similar increase in flows along the A4019 in the Do-Something Scenario R as shown in Figure 4-1 and Figure 4-2 to the east of the new roundabout.

Figure 4-1 2041 AM – M5J10 Option 2 flows (vehs)

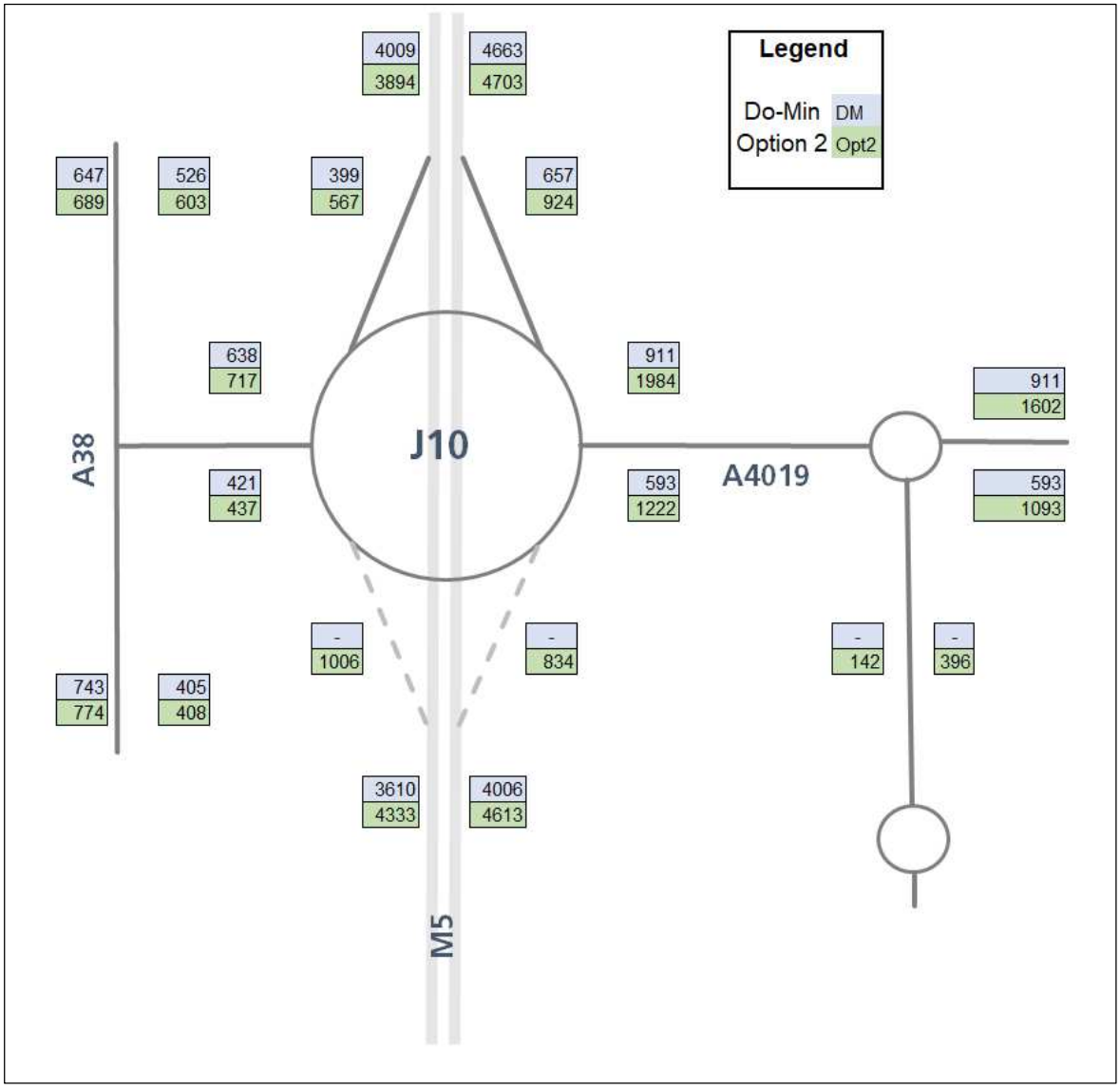
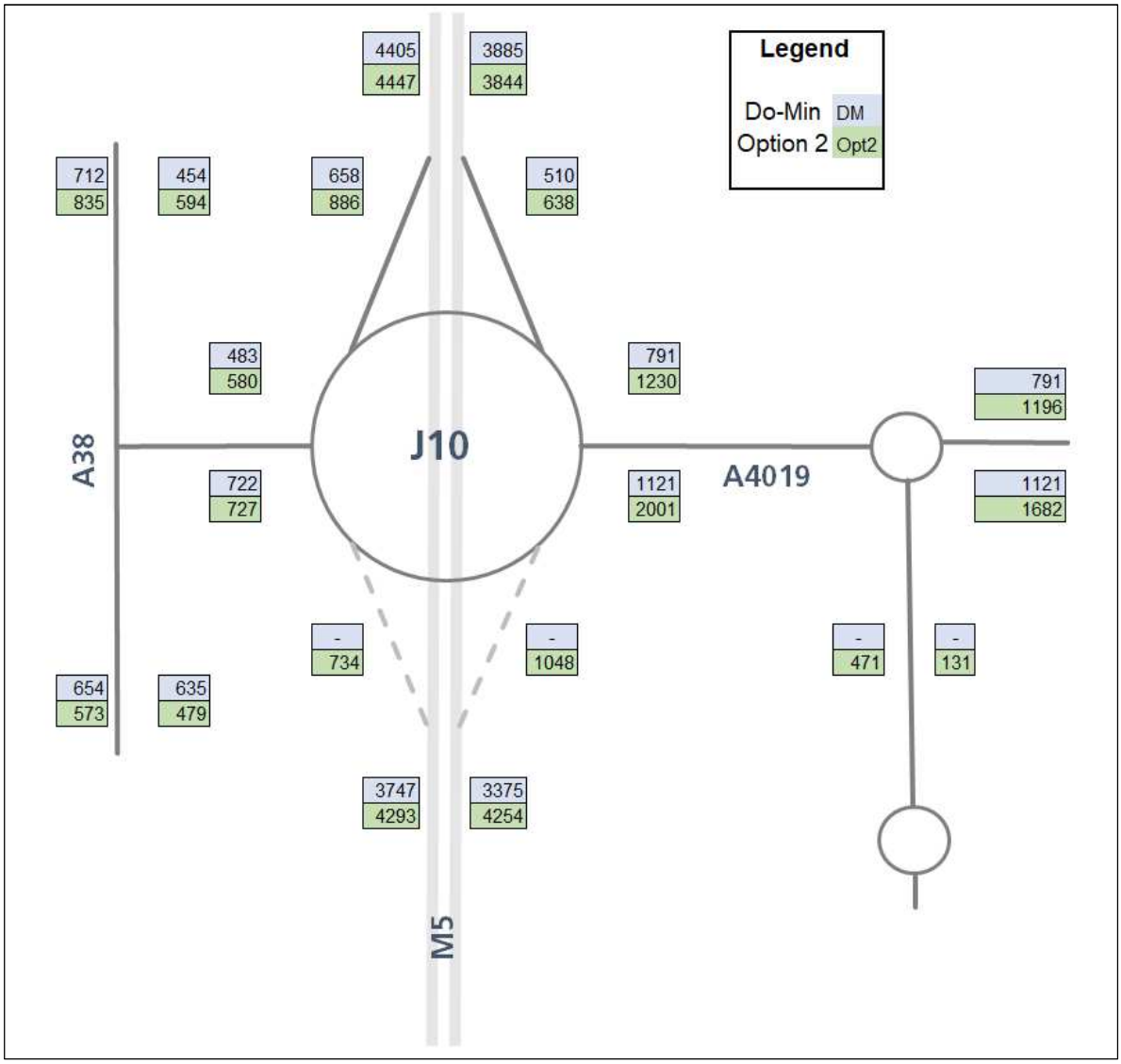


Figure 4-2 2041 PM – M5J10 Option 2 flows (vehs)



Volume to capacity ratios

4.4.15. The volume to capacity ratio (V/C) of a model link (expressed as a percentage) provides an indication of the level of network congestion present at a particular location in a model scenario. Generally, links with V/C of 85% or more are considered to be congested with delays increasing significantly as V/C surpasses 100%.

4.4.16. Figure 4-3 and Figure 4-4 below show the V/C ratios for the 2041 model forecast year in the AM and PM peaks. The hypothetical Do-Minimum (Scenario Q) has been provided to illustrate the network conditions in the absence of the scheme with all JCS trips included.

Figure 4-3 2041 AM – M5J10 DM & Option 2 V/C (%)

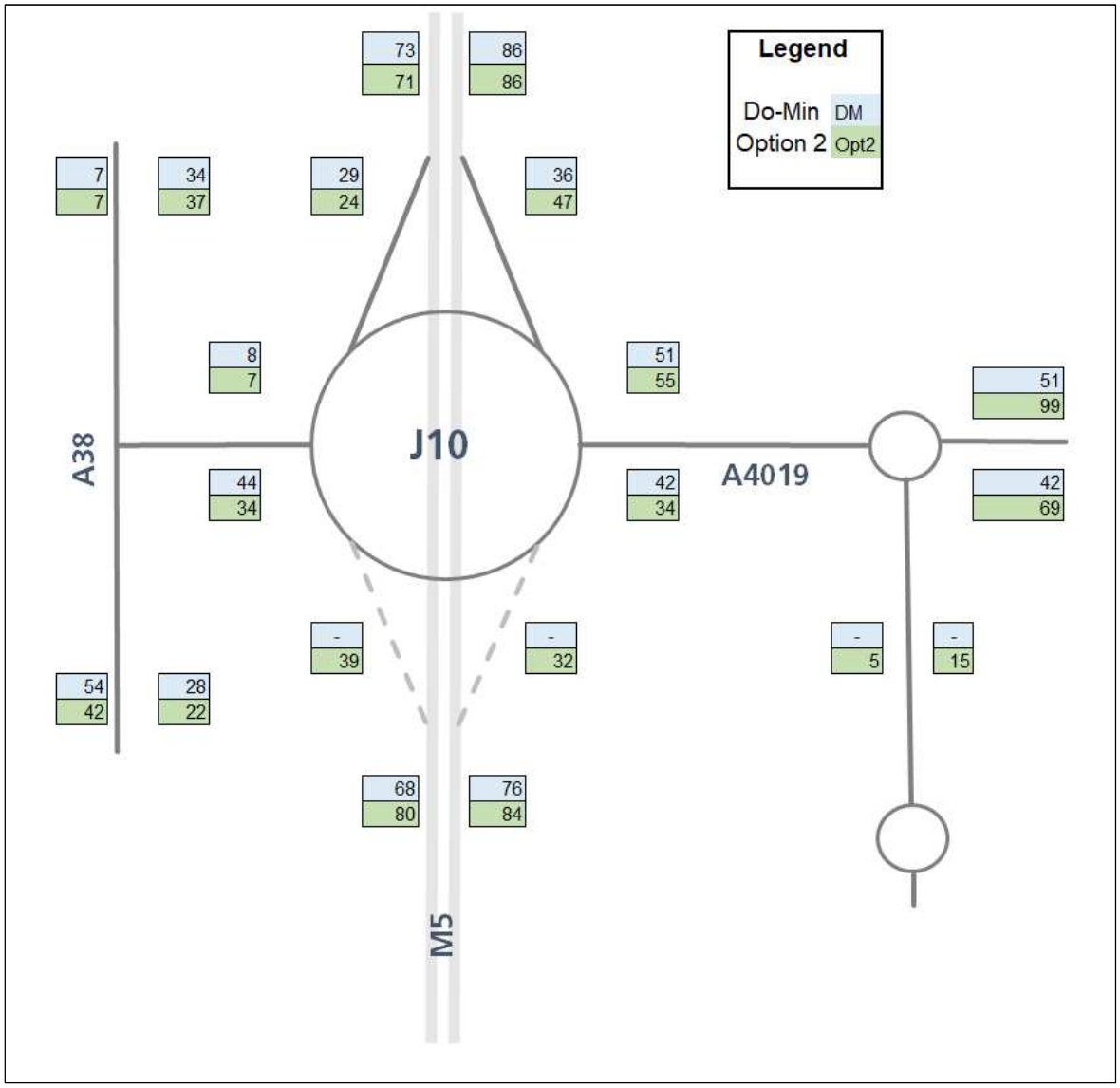
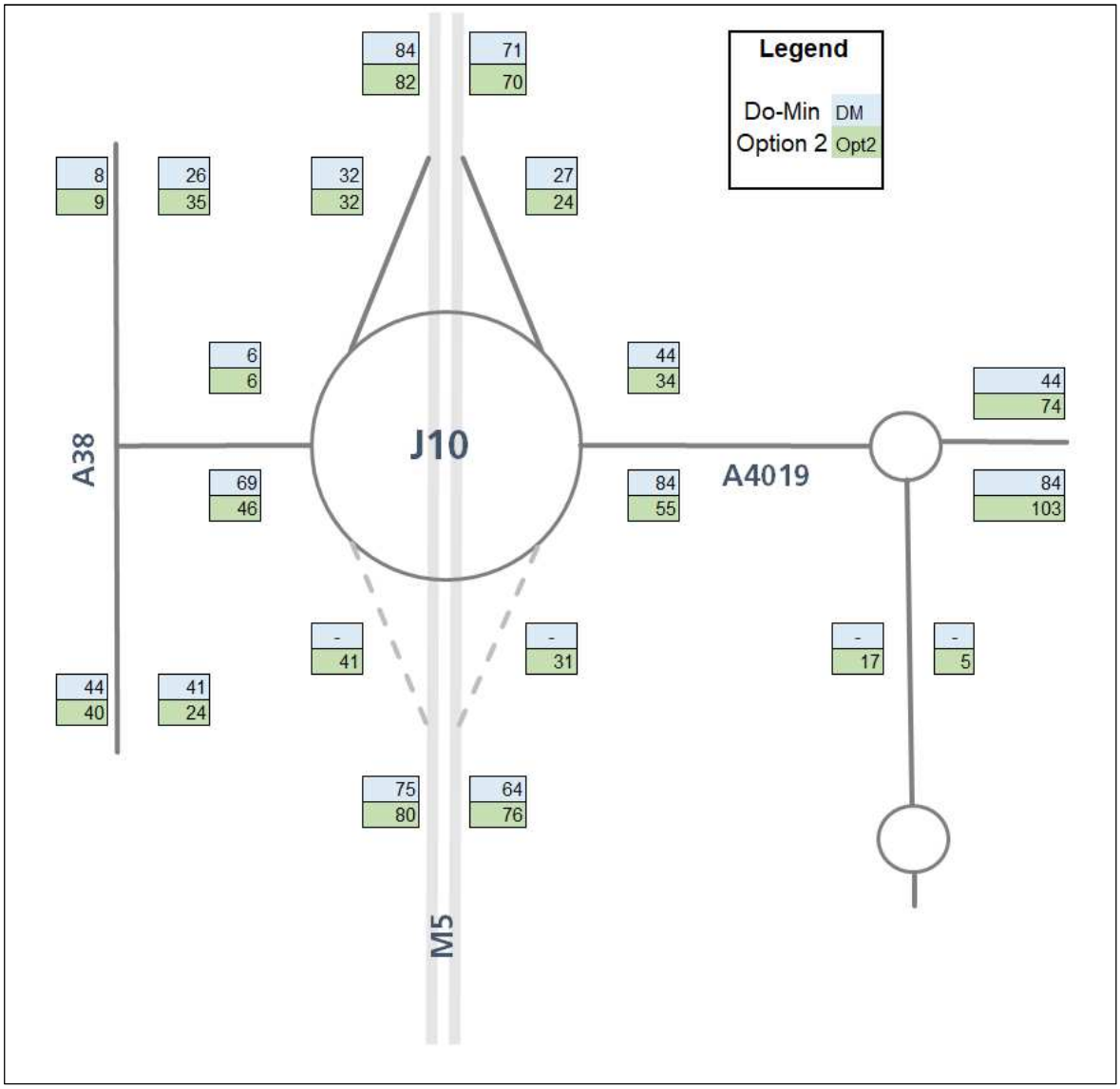


Figure 4-4 2041 PM – M5J10 DM & Option 2 V/C (%)



4.4.17. These figures show that the DM scenario Q is operating within acceptable levels in the AM 2041. Whereas in PM peak westbound traffic to the east of new roundabout starts to show some stress with V/C of around 84%.

4.4.18. AM and PM peaks for option 2 shows slightly more stress as compared to DM on A4019 to the east of J10 with V/C ratios going well above the 85% threshold. This looks counter intuitive but is reflective of the fact that new south facing slips at J10 attracts more traffic and provides an alternative route to SB traffic. This higher stress is also reflective of need for a road upgrade scheme when the main J10 scheme is constructed.

Figure 4-5 2041 AM Scenario Q Turning V/C – Coombe Hill Junction

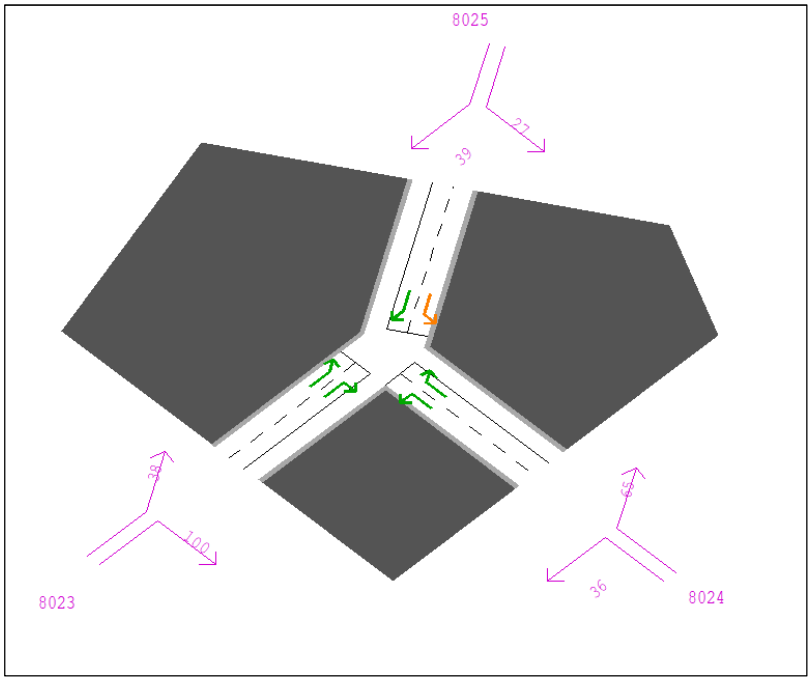
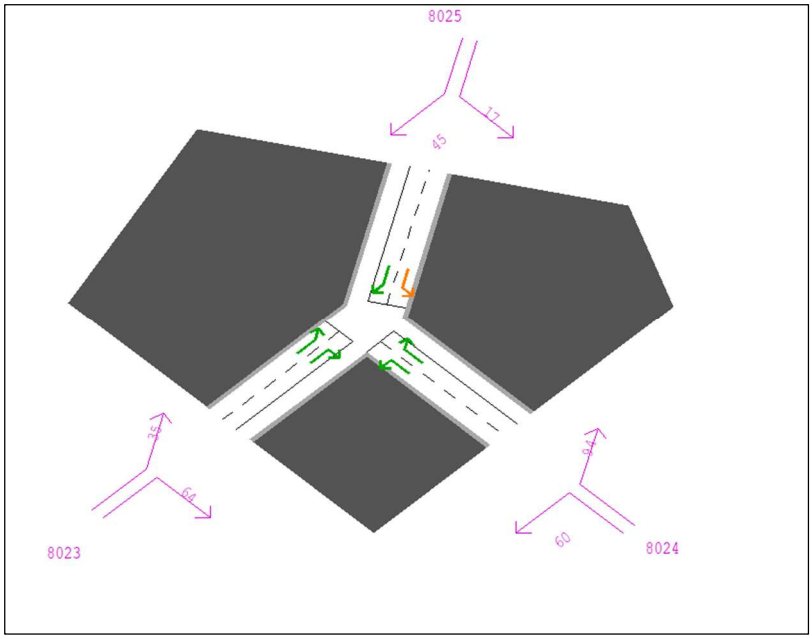


Figure 4-6 2041 PM Scenario Q Turning V/C – Coombe Hill Junction



4.4.19. Figure 4-5 and Figure 4-6 show the V/C for the specific turning movements at Coombe Hill junction in DM. These figures illustrate the fact that although the overall link V/C is within 85% the right turn from the northbound A38 approach in AM is operating significantly over the capacity as there is no south facing slip as in DS which provides an alternate route for right turning traffic in DS.

4.4.20. Also, the left turn from the westbound A4019 approach shows stress in PM which highlights the need for a scheme at this location.

4.5. Conclusion

4.5.1. The CSV model has been used to develop forecast scenarios P, Q, R and S with three different scheme options for J10 (Option 1, Option 2 and Option 5) tested in both with (Scenario R) and without (Scenario S) the dependent portion of the JCS development.

4.5.2. The model results presented in this report are focussed on the A4019 surrounding the M5 Junction 10 with overall results having been previously presented in the Core TAR document.

4.5.3. The results highlight the fact that flows on A4019 near J10 and on Coombe Hill do not vary much between the scheme options and thus Option 2, proposed preferred option flows could be used for further analysis for updating design and signals.

4.5.4. The V/C data presented for Scenario Q clearly demonstrates the need for intervention along the A4019 if the full development is to be built. The section to the east of Junction 10 has areas with V/C in excess of 100% in the 2041 PM peak and as evidenced by the turning V/C data, Coombe Hill is under stress.

5. Safety Assessment

5.1. Impact on Road User – Strategic Safety Action Plan

5.1.1. All three design options for the Coombe Hill junction involve retaining signal control but they all involve improvements to pedestrian and cycle provision.

5.1.2. Option 1 provides controlled crossings across three out of the four arms (no crossing is provided on the southern arm) and ASLs for bicycles are provided on all arms with the exception of the western arm. On the northern arm a free flow left turn lane is provided and therefore there are two crossings provided here. Two eastbound exit lanes are provided along the A4019 to accommodate the left turn free flow lane from the northern arm which merge into a single lane prior to a new eastbound bus lay-by.

5.1.3. Option 2 provides staggered crossings on the northern and southern arms and a straight across crossing on the western arm. No crossing is provided on the eastern arm. Vehicles using the left turn free flow lane from the northern arm are required to give-way to traffic entering the eastern arm as a single lane is provided on the junction exit. ASLs are provided on 3 arms in a similar fashion to Option 1.

5.1.4. The main difference with Option 3 is that there is no left turn free flow lane. A staggered crossing is provided on the southern arm and straight across crossings provided on the northern and western arms. ASLs are provided on 3 arms in a similar fashion to Options 1 and 2.

5.1.5. Pedestrian facilities under the existing junction layout are limited, with uncontrolled crossing points provided only on the southern and western arms and no pedestrian provision on the northern and eastern arms. No cycle facilities are currently provided. The proposed junction layouts will provide a safer environment for pedestrians and cyclists and may provide improved clarity of junction operation particularly at the petrol station access off the northern arm.

5.1.6. The location and geometry of the entry and exit points to the petrol station on the A38 northern arm will be explored in greater detail at the preliminary design stage however it is intended that these access points are incorporated into the realigned layout for all options.

5.1.7. Option 1 involves the provision of an eastbound bus lay-by on the A4019 eastern arm. The location of this lay-by at the end of the merge on the junction exit may increase the risk of conflict between buses slowing to enter the lay-by and vehicles completing the merge manoeuvre. There may be an increased risk of nose-to-tail collisions caused by sudden braking. Mitigation measures to reduce the risk of a collision occurring at this location will be investigated as the scheme progresses.

5.1.8. In order to establish a safety baseline for the junction it would be necessary to establish the current collision rate. Any safety objectives should seek an improvement in the collision rate as a result of the implementation of the scheme or at least nil detriment to road users. However, an increase in traffic volume and/or an increase in its use by pedestrians and cyclists could see an increase in the collision rate and therefore the safety objectives would need to consider these factors.

5.1.9. The proposals for the A4019 east of Withybridge Lane include a new roundabout, and a new signal-controlled junction at Moat Lane. The carriageway would also become dualled.

5.1.10. A new four-arm roundabout would be constructed on the A4019 between Withybridge Lane and The Green. This new junction would create new conflict points from new turning

movements and give-way requirements hence it is likely that there would be an increase in collisions at this location. The new signal-controlled junction at The Green / Moat Lane may also lead to an increase in collisions as there have been no collisions at this location in the last five years. Vehicles on the A4019 would be required to stop at a red signal creating the potential for rear-end shunt collisions. There is also a risk that drivers will disobey a red signal with a resultant collision occurring. However, the junction may improve the safety of pedestrians and cyclists and will make right turn manoeuvres easier.

5.1.11. The dualling of the route in both directions may lead to an increase in vehicle speeds with drivers able to overtake slower moving traffic. However, the central reserve will eliminate the risk of head-on collisions with oncoming traffic and the overtaking provision may reduce driver frustration and resultant risk taking behaviours.

5.2. Construction (Design and Management) Regulations 2015

5.2.1. The objective of the Construction Design and Management (CDM) Regulations 2015 is to ensure that the systematic management of projects from conception through to completion with hazards are identified, reduced and controlled and where possible eliminated.

5.2.2. The following measures will need to be considered to ensure a robust management of all hazards during construction;

- Use of speed enforcement to protect workforce and road users during periods of temporary traffic management;
- Use of narrow lanes to ensure that sufficient working space is provided to enable safe completion of the works and provide sufficient traffic capacity.
- Use of temporary vehicle restraint systems to prevent incursions into the works area by errant vehicles, maintaining safety to the construction work force and pedestrians.
- Work at night when additional space is required and roads reduced to single lane traffic or closed to generate adequate safe working areas.

5.2.3. Existing Utilities plans for the A4019 (drawing nos. GCCM5J10-ATK-VUT-ZZ-DR-CH-000002 and 000005) and Coombe Hill (drawing no. GCCM5J10-ATK-VUT-J5_JN-DR-CH-000002) are shown in Appendix C.

5.2.4. Both the A4019 and Coombe Hill improvements have similar risks in respect of construction adjacent to live statutory utilities and the need to divert such apparatus. The A4019 improvements will require the diversion of gas mains, water mains, electricity cables and telecommunication services. All Coombe Hill options would require some diversion works, however, the extent of diversionary works required for Option 2 and 3 would be less compared with Option 1 due to the reduced extent of works proposed, and as such have a reduced level of risk.

During Construction, Operation and Maintenance

5.2.5. The options that have been considered throughout the Technical Appraisal Report will have the same operation and maintenance requirements as would be expected by an all-purpose trunk road, dual carriageway or motorway and as currently experienced with the existing layout. The provision of the following in addition to the measures outlined in Chapter 7 would enable the operation and maintenance requirements to be optimised.

- Existing access arrangements to fields and housing to be maintained or safely reinstated, dependent on which option is taken forward
- Existing access to footways and bridleways are to be maintained or safely reinstated dependent on which option is taken forward

5.2.6. Off network access is to be considered to enable assets to be maintained, reducing the need to implement temporary traffic management. The reduction of temporary traffic management required has a significant impact on reducing risk to both road workers and road users.

6. Operational Assessment

6.1. Scheme's Operating Regime

6.1.1. The Coombe Hill junction currently operates as a four-stage signal control junction with no pedestrian crossing phases. The western arm of the junction is a cul-de-sac and the road does not appear wide enough for two-way traffic.

6.1.2. Two southbound approach lanes are provided on the A38 (northern arm). The nearside lane bypasses the signal control as a left turn free flow requiring drivers entering the A4019 to give-way. Two lanes are also provided northbound on the A38 (southern arm) and on the A4019 westbound approach. The western arm has a single approach lane. Splitter islands separate opposing traffic flows on all arms apart from the western arm. A splitter island also provides separation between the ahead lane and the left turn free flow lane on the northern arm.

6.1.3. Footways are present along all arms with the exception of the western arm which is too narrow to accommodate pedestrians. A bus lay-by is provided on the A4019 eastbound exit.

6.1.4. All three options involve upgrading the junction to include controlled pedestrian crossing and cycle facilities in the form of ASLs and lead in cycle lanes. The proposals also involve widening of the western arm which is currently too narrow for two-way traffic. Minimal street lighting is currently provided by a single lighting column however the proposals might require the introduction of lighting to ensure that pedestrians can be seen at the crossings, improve night time visibility of cyclists and to improve the operational safety of the junction during the hours of darkness. There should be no significant impact on maintenance regimes or traffic management aside from the new lighting. However, if the ASLs are to be surfaced in a coloured material this may need to be renewed more regularly increasing maintenance demand slightly.

6.1.5. The A4019 between Withybridge Lane and Homecroft Drive is currently single carriageway subject to a 50mph speed limit. It is a straight route with priority junctions at The Green and Moat Lane. There are private accesses and a minor road junction to the west of The Green. A right turn deceleration lane is provided on the approach to The Green.

6.1.6. A narrow strip of footway is provided along the north side of the A4019 set back from the carriageway behind the grass verge. There is no footway provision on the south side.

6.1.7. The A4019 is a bus route. The bus stops to the east of The Green are both located in lay-bys adjacent to the running lanes. A westbound bus stop is provided to the west of The Green.

6.1.8. The proposed design involves widening the A4019 to a dual carriageway with two lanes in both directions. This wider carriageway will increase winter maintenance demand with four lanes requiring gritting rather than just two. This may affect the number or type of gritters and resources required.

6.1.9. The proposals to provide a roundabout to the east of Withybridge Lane and a new signal-controlled junction might require the installation of street lighting to ensure road users can see each other and the layout of the road ahead during the hours of darkness. The presence of the roundabout may lead to queuing along the A4019 with an increase in the potential for rear-end shunt collisions to occur and an increase in journey times. This may impact on bus services.

6.1.10. The new roundabout will provide a facility for drivers and the emergency services to turn around which will be particularly beneficial to those drivers requiring access to properties on the opposite side of the road. The signal-controlled junction may increase delays along the route. The provision of a signal-controlled junction where the speed limit is 50mph will require the installation of high friction surfacing on the major approaches to assist braking. Depending on the 85th percentile speed of the route it may be necessary to provide overhead signals to supplement the standard signal poles and make the junction more conspicuous.

6.1.11. The installation of a central reserve along the A4019 will restrict direct access to properties and accesses to a left-in left-out arrangement. Drivers unable to turn right into the accesses would need to find somewhere to turn around. This may not be seen as convenient particularly for those travelling east where there is no turn around facility beyond the roundabout.

6.2. Driver Compliance

6.2.1. There would be no changes in speed limit at the Coombe Hill junction which is subject to 40mph speed limit. The collisions which have occurred at the junction in the five-year period do not indicate that there are any issues with drivers running red lights and therefore red light running enforcement is unlikely to be required.

6.2.2. The 50mph speed limit along the A4019 will not be subject to change however the creation of a dual carriageway may lead to an increase in vehicle speeds. An increase in speeds could have a detrimental impact on the safety of the new roundabout, signal controlled junction and accesses of the route. The straight nature of the road may compound any speeding issues and the central reserve may make drivers feel more protected from oncoming traffic leading to higher speeds.

6.2.3. Speed camera signs are already in place along the route and reminder 50 roundels on red surfacing are provided suggesting that speed may be an existing problem. Speed surveys will need to be undertaken to establish existing 85th percentile speeds. Consultation with the police will also provide evidence should a speeding problem exist. Methods of enforcement may then need to be investigated if the road is to be dualled.

7. Structures Assessment

7.1. Basis of Structures Assessment

7.1.1. This section explains the approach taken in assessing the three proposed highway alignments options for Coombe Hill Junction and the three separate options for the A4019 improvements. Each option has been assessed to determine indicative details of required new structures.

7.1.2. Details relating to the structural assessment of existing and proposed structures relating to the M5 Junction 10 improvement scheme have been covered separately in section 14 of the previous TAR and are unaffected by the schemes detailed within this report.

7.1.3. The Structures Assessment has been based on the scheme layout drawings provided in Appendix A and B, and in combination with further Highways Cross Section sketches of Coombe Hill Junction.

7.2. Coombe Hill Junction – New Structures Assessment

7.2.1. Although the layouts of the three scheme options are significantly different, the requirements in terms of proposed structures are very similar. All three options involve widening of the A38 south approach to the junction to accommodate a cycle lane and a compliant width footway to the west side of the carriageway. This will require land take and cutback of an existing earth embankment by up to 3.1m, along a total length of approximately 44m.

7.2.2. The slope angle of the existing embankment is unknown but appears to be reasonably steep. Therefore, regrading of the slope to accommodate an approximate cutback of up to 3.1m does not seem feasible at this stage. However, this should be reviewed at the next design stage, once more detailed topographical and ground information is available.

7.2.3. The cutback required to provide the additional carriageway width could be achieved by installing a soil retaining structure within the existing embankment slope. This would require a maximum retained height of 1m, meaning a simple gravity retaining structure would be a suitable option. This could be in the form of gabion baskets or a modular crib or blockwork wall. Alternatively, a reinforced earth green wall such as Webwall Geocell could be used. However. this would require additional excavation of the existing embankment to install the reinforced geogrid which may cause unnecessary disruption to the adjacent residential properties.

7.2.4. All options would be similar in cost and are all considered feasible at this stage. Further consultation with the residential property owns and the council should be undertaken at the next design stage to determine a preferred option.

7.2.5. As the required structures are common to all three Coombe Hill Junction options and are considered to be minor, it is not appropriate to make an overall scheme options recommendation based on structures alone.

7.3. A4019 Improvements – New Structures Assessment

7.3.1. A review of the proposed improvement options for the A4019 has not highlighted the need for any proposed structures at this stage. This should be reviewed again once further highway design development has been completed at Preliminary design.

8. Road Pavement Assessment

8.1. The impact of the options identified for appraisal

8.1.1. The road pavement impact on road sections managed by GCC are discussed in section 15.1 of the M5 J10 TAR.

9. Technology Assessment

9.1. Coombe Hill Traffic Signals Assessment

9.1.1. Options for the junction layouts were informed by traffic signal modelling using Linsig. Flows and turning counts were taken from the 2041 DM and Option 2 models, as well as the 2013 base model and 2019 surveyed flows. For full details please refer to the technical note (document reference GCCM5J10-ATK-HTS-CHJNC-TN-CH-000001) included in Appendix D.

9.1.2. Options 1, 2 and 3 were compared against the existing layout for all flow scenarios. Since all options have scope for pedestrian facilities, the impact of these facilities was also considered. The staging diagrams for each option are shown below:

Figure 9-1 Staging Diagram for Existing Layout

Existing Layout

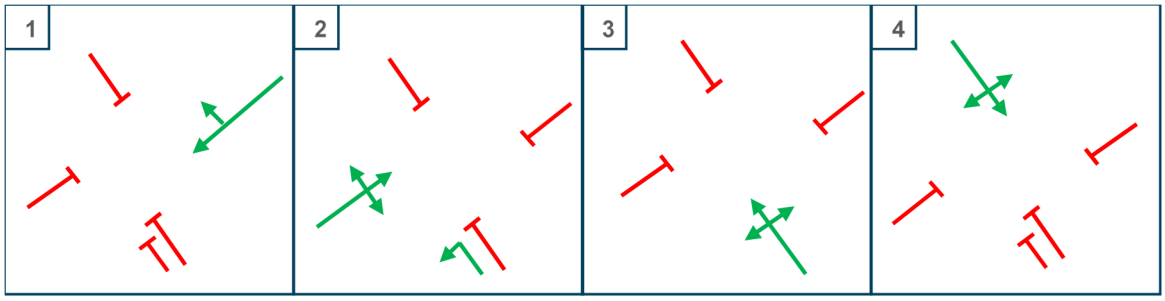
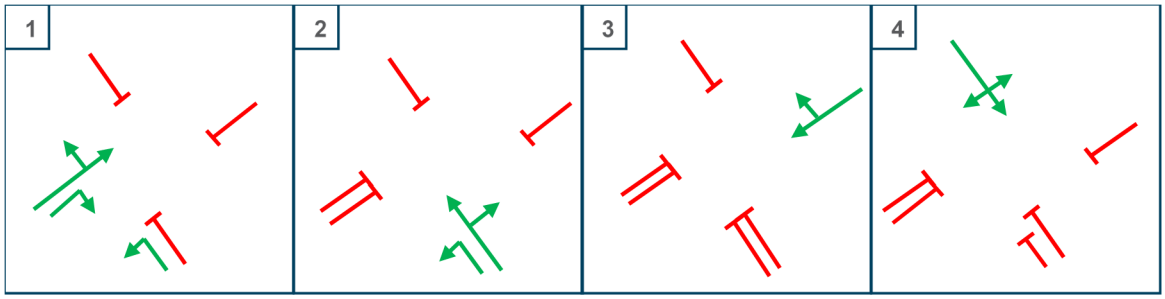


Figure 9-2 Staging Diagrams for Option 1

Option 1 – Without pedestrian demands



Option 1 – With pedestrian demands

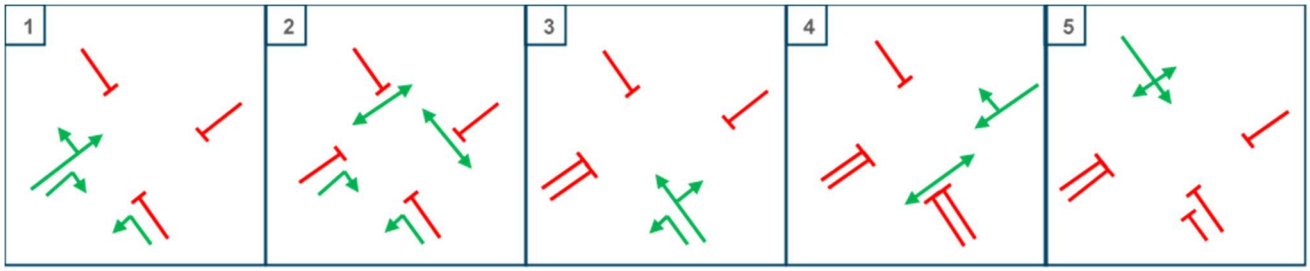
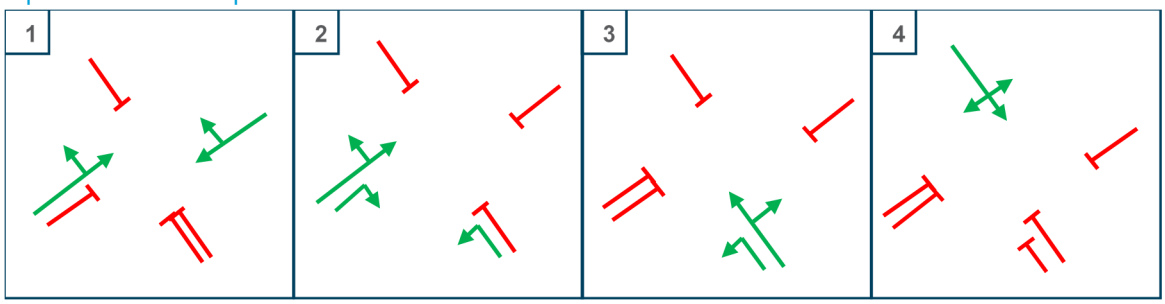


Figure 9-3 Staging Diagrams for Option 2

Option 2 – Without pedestrian demands



Option 2 – With pedestrian demands

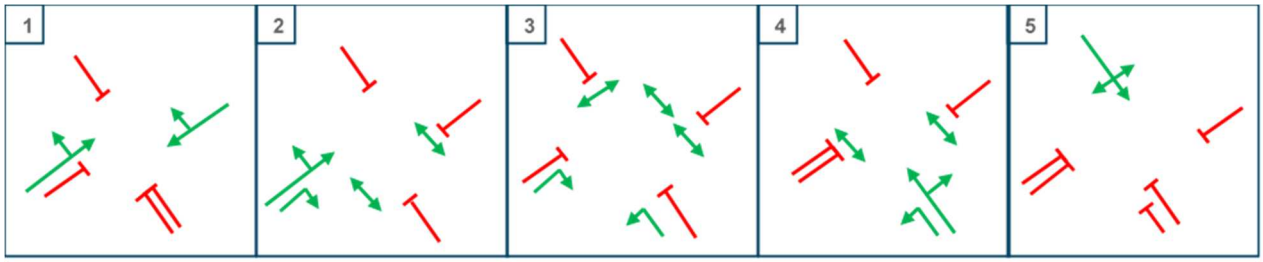
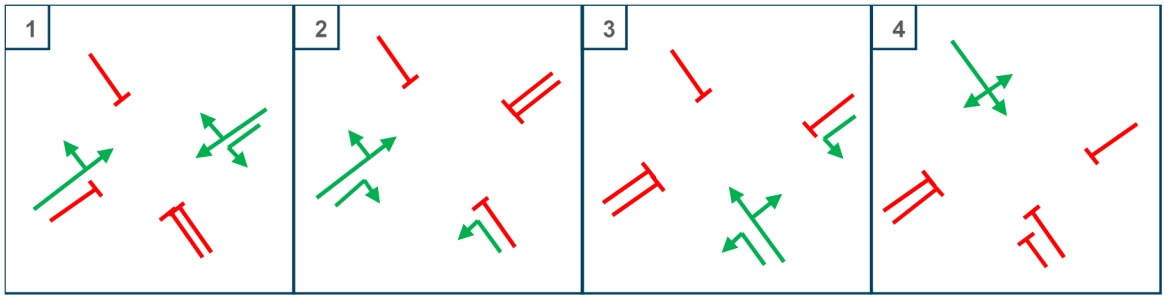
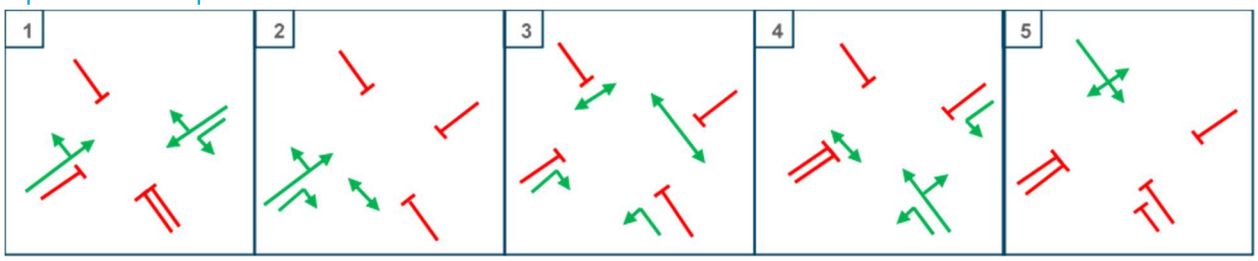


Figure 9-4 Staging Diagrams for Option 3

Option 3 – Without pedestrian demands



Option 3 – With pedestrian demands



9.1.3. Pedestrian facilities can be provided with all options, with the availability of crossings on each junction arm as shown in Table 9-1:

Table 9-1 – Potential crossings available for each layout

Layout	The Wharf	A38 East Arm	A4019	A38 West Arm
Option 1	✓	✓	✓	×
Option 2	✓	✓	×	✓
Option 3	✓	✓	×	✓

9.1.4. Capacity and delay results for 2041 Option 2 model flows are shown below. A junction operating at above 0% Passenger Reserve Capacity (PRC) is said to be running within capacity. Delay should be as minimal as possible.

Table 9-2 – PRC and Delay for 2041 Option 2 Scenario - without pedestrians

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	23.9	10.48	28.2	10.45
Layout Option 1 (without pedestrians)	25.3	10.80	27.4	10.75
Layout Option 2 (without pedestrians)	56.8	**8.20**	39.6	8.78
Layout Option 3 (without pedestrians)	**59.5**	8.70	**42.6**	**8.53**

Table 9-3 – PRC and Delay for 2041 Option 2 Scenario - with pedestrians

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	23.9	10.48	28.2	10.45
Layout Option 1 (with pedestrians)	-7.7	28.09	-0.2	19.98
Layout Option 2 (with pedestrians)	24.8	**11.75**	6.0	13.26
Layout Option 3 (with pedestrians)	**25.3**	11.93	**12.1**	**12.95**

9.1.5. As can be seen in Table 9-2, without pedestrians the junction operates significantly better with Options 2 and 3, whereas small improvements are seen with Option 1. When pedestrians are introduced to the junction as per Table 9-3, the junction operation is comparable to the existing layout for Options 2 and 3, whereas Option 1 is over capacity. The results in Table 9-3 assume pedestrians request to cross during each cycle which is unlikely. The true performance of the layouts will in reality be somewhere between the values in Table 9-2 and Table 9-3.

9.1.6. From a signals perspective, Options 2 and 3 are deemed the preferred layouts, both with and without pedestrians. All 3 layouts have the flexibility to alter the approaches on which pedestrian facilities are included. Feedback from local consultation will be a factor in deciding this. Results for the addition of signalised pedestrian crossing points on the existing layout have not been included as the physical layout would need changing. However, as a comparison to the other pedestrianised layouts this has less capacity, therefore would have increased queue lengths and congestion at the junction.

9.2. A4019/Moat Lane/The Green Traffic Signals

9.2.1. As part of the A4019 upgrades, a new signalised arrangement has been proposed at the A4019 junction with Moat Lane/The Green. This is to facilitate movements in and out of the side roads, allowing for future development on the northern side of the A4019. Preliminary works on the layout of the junction will commence following consultation and will aim to improve facilities for sustainable travel modes as well as considering vehicular capacity associated with new development.

9.3. A4019 Wig Wag Signals

9.3.1. As mentioned in 2.19.2, 4no. Wig Wag signals are currently located around the Community Fire Station on the A4019. Wig Wag signals would be retained following the works, with analysis to be carried out on the condition of the existing signals, to determine whether they shall be reused or replaced.

9.4. Further considerations

9.4.1. In addition to traffic signal implementation along the A4019, potential for the use of Intelligent Transport Systems (ITS) exists along the A4019 and in surrounding areas. This could include the following systems:

- Air quality monitoring.
- Measuring journey times (ANPR or floating vehicle data) for all travel modes.
- Variable message signs (Potentially without infrastructure i.e. in-car information).
- CCTV enabling responses to be validated.
- Traffic signal bus priority at key junctions.
- Advanced pedestrian and cycle detection for improved junction operations.

9.4.2. Capital investment in these systems could provide a great deal of benefit to all stakeholders. Some of these benefits include reduced congestion, improved air quality, improvements to public transport punctuality and reduced emissions. Additionally, these systems could greatly improve walking and cycling facilities.

10. Public Utilities Assessment

10.1.1. This section provides an assessment of the potential impacts on statutory undertakers' apparatus of the A4019 and Coombe Hill improvement options. It should be noted that the statutory utility apparatus identified as being affected for each option has been based on the plans provided by the statutory undertaker as part of the New Roads and Streetworks Act (NRSWA) C2 enquiry undertaken. Details of any diversionary or protective works to statutory utilities and associated budgetary estimates will be requested as part of stage C3.

10.2. A4019 Carriageway Improvements

10.2.1. The A4019 is the main route into Cheltenham from the M5 and therefore the main arterial route for many utilities including telecommunications, gas, water/sewers and electricity. Overhead and underground utilities are situated along the A4019, to both the north and south sides of the carriageway, with numerous carriageway crossings and spurs to properties throughout.

10.2.2. Generally, utilities located within the existing northern verge of the A4019 would either need to be diverted or protected due to the proposed carriageway widening which is predominantly into the northern verge. There would also be some carriageway widening into the southern verge, particularly at the new signalised junction at Uckington, so some diversion/protection works will also likely be required at these locations. Space for utilities has been allowed for in the proposed A4019 cross-section with a minimum 2 m wide verge to the south and 9 m wide corridor to the north made up of a 4 m cycle track, 2 m wide footway and 1 m verge plus separation strips.

10.2.3. For full details of the utilities affected by the proposed upgrade of the A4019 to a two-lane dual carriageway please refer to section 17.5 of the M5 J10 TAR.

10.3. Coombe Hill Junction Improvements

10.3.1. A number of overhead and underground utilities are located within the extents of Coombe Hill junction. Underground utilities including telecommunications, water, gas and electricity are predominantly located within the existing footways/verges present at the junction with some carriageway crossings also present. British Telecom (BT) underground, water mains and gas mains are also located within the carriageway through the junction. A Western Power Distribution (WPD) low voltage 11kV overhead runs from the petrol station to the existing highway boundary at the eastern corner of the junction and continues underground within the northern verge of the A4019.

10.3.2. The utilities that would likely be affected by the proposed options for Coombe Hill are discussed below.

Option 1

10.3.3. Utilities that would be affected by the construction of Option 1 include;

- Gas; A Medium Pressure (MP) gas main is shown to be running in the verge through the north-eastern corner of the junction at the location of the proposed left turn auxiliary lane which, under the proposals, would be located within the carriageway and therefore likely require diverting or protecting. The existing MP main continues to the east within the footway on the northern side of the A4019. As such, it would likely be affected by the proposed carriageway widening and relocation of the existing bus lay-by. As a minimum it's diversion would likely extend to the eastern tie-in point on the A4019. The MP main also extends north of the junction initially within the

footway on the western side of the A38, past the petrol station and then crossing back to the eastern footway. Under the proposals the main would likely remain in the footway, so should be unaffected. However diversion/protection works may be required at the location of the proposed accesses subject to separate planning applications. A Low Pressure (LP) main is also shown within the A38 carriageway through the junction and continues within the western footway to the south of the junction. This may be affected by the proposed carriageway widening to the west of the A38 possibly requiring diversion.

- Communication Network; An existing GIGACLEAR Fibre Optic network is shown to be running in the footway past the petrol station and continuing in the verge through the north-eastern corner of the junction to the A4019 which is the location of the proposed left turn auxiliary lane. Under the proposals it would be located within the carriageway and therefore would require diverting. East of the junction the cables are shown to be running in the northern verge so may be affected by the A4019 widening and relocation of the bus lay-by. GIGACLEAR cables are also shown to be running within the existing footways on the A38 southern arm and along the northern verge of The Wharf so may be affected by the proposed carriageway widening at these locations, possibly requiring diversion.
- Western Power Distribution (WPD); Low voltage overhead cables running from the petrol station to the existing highway boundary at the western corner of the junction and continuing underground as low voltage and high voltage 11kV cables within the northern verge of the A4019. These would likely be affected by the widening for the proposed left turn auxiliary lane and as such require diverting. An existing high voltage 11kV overhead crosses the A4019 approximately 180m east of Coombe Hill junction, but should be unaffected by the proposals. However, a low voltage underground crossing the A4019 at the same location and running to the property named The Bellows may be affected by the widening works required for the auxiliary lane. Low voltage underground is also shown to be running within the existing footways on the A38 southern arm so may be affected by the proposed carriageway widening to the west of the A38 possibly requiring diversion.
- British Telecom (BT) Network; Underground BT cabling is shown running in the carriageway in multiple locations throughout the junction. BT chambers are shown to be located within the carriageway, footways and verges. Due to the proposed carriageway widening for the left turn auxiliary lane it is likely the chambers located in the verge in the north-eastern corner of the junction would need to be relocated to the proposed verge and the cables diverted accordingly. Overhead BT lines are also present crossing the A38 to the north and south of the junction and also running on the southern side of The Wharf, but these would likely be unaffected by the proposals.
- Water; Two Severn Trent Water mains are shown to be running within the A38 northern arm continuing through the junction to the A4019 where they continue east. As the mains are currently located within the carriageway at the junction it is unlikely that diversion works would be required. However, the existing depth of the mains would need to be confirmed to determine if protective works would be necessary. A third main is also shown running in the eastern footway of the A38 southern arm but this is unlikely to be affected.

Option 2

10.3.4. Utilities that wouldl be affected by the construction of Option 2 include;

- Gas; A Medium Pressure (MP) gas main is shown to be running in the verge through the north-eastern corner of the junction and continues east within the footway on the northern side of the A4019. The MP main may be affected by the realignment and widening of the left turning lane and may require a diversion. The extent of diversionary works would however be less compared with Option 1 due to the reduced extent of widening works proposed. The MP main also extends north of the junction, initially within the footway on the western side of the A38 past the petrol station, and then crossing back to the eastern footway. Under the proposals the main

would likely remain in the footway so should be unaffected. A Low Pressure (LP) main is shown within the A38 carriageway through the junction and continues within the western footway to the south of the junction, so may be affected by the proposed A38 carriageway widening possibly requiring diversion.

- Communication Network; An existing GIGACLEAR Fibre Optic network is shown to be running in the footway past the petrol station and continuing in the verge through the north-eastern corner of the junction to the A4019. This may be affected by the realignment and widening of the left turning lane and therefore require diversion. GIGACLEAR cables are also shown to be running within the existing footways on the A38 southern arm and along the northern verge of The Wharf, so may be affected by the proposed carriageway widening at these locations, possibly requiring diversion.
- Western Power Distribution (WPD); Low voltage underground is shown to be running within the existing footways on the A38 southern arm so may be affected by the proposed carriageway widening to the west of the A38, possibly requiring diversion. Unlike Option 1, a low voltage overhead running from the petrol station to the existing highway boundary at the western corner of the junction, and continuing underground as low voltage and high voltage 11kV cables within the northern verge of the A4019, should remain unaffected.
- British Telecom (BT) Network; Underground BT cabling is shown running in the carriageway in multiple locations throughout the junction. BT chambers are shown to be located within the carriageway, footways and verges. Due to the proposed realignment and widening of the left turning lane, it is likely that the chambers located in the verge in the north-eastern corner of the junction would need to be relocated to the proposed verge and the cables diverted accordingly. Overhead BT is also present crossing the A38 to the north and south of the junction, and also running on the southern side of The Wharf, but these would likely be unaffected by the proposals.
- Water; Two Severn Trent Water mains are shown to be running within the A38 northern arm, continuing through the junction to the A4019, where they continue east. As the mains are currently located within the carriageway at the junction it is unlikely that diversion works would be required. However, the existing depth of the mains would need to be confirmed to determine if protective works would be necessary. A third main is also shown running in the eastern footway of the A38 southern arm, but this is unlikely to be affected.

Option 3

10.3.5. Utilities that would be affected by the construction of Option 3 include;

- Gas; A Medium Pressure (MP) gas main is shown to be running in the verge through the north-eastern corner of the junction and continues east within the footway on the northern side of the A4019. The MP main also extends north of the junction, initially within the footway on the western side of the A38 past the petrol station, and then crossing back to the eastern footway. Under the proposals the main would likely remain in the footway or verge so should be unaffected, however the depth of the A38 carriageway crossing would need to be confirmed to determine if protection works would be required. A Low Pressure (LP) main is shown within the A38 carriageway through the junction and continues within the western footway to the south of the junction, so may be affected by the proposed A38 carriageway widening, possibly requiring diversion.
- Communication Network; An existing GIGACLEAR Fibre Optic network is shown to be running in the footway past the petrol station, and continuing in the verge through the north-eastern corner of the junction to the A4019, so may be affected by the proposed widening on the A38 northern arm and may require diversion. GIGACLEAR cables are also shown to be running within the existing footways on the A38 southern arm and along the northern verge of The Wharf ,so may be affected by the proposed carriageway widening at these locations, possibly requiring diversion.

- Western Power Distribution (WPD); Low voltage underground is shown to be running within the existing footways on the A38 southern arm, so may be affected by the proposed carriageway widening to the west of the A38, possibly requiring diversion. Unlike Option 1, low voltage overhead cables running from the petrol station to the existing highway boundary at the western corner of the junction and continuing underground as low voltage and high voltage 11kV cables within the northern verge of the A4019 should remain unaffected.
- British Telecom (BT) Network; Underground BT cabling is shown running in the carriageway in multiple locations throughout the junction. BT chambers are shown to be located within the carriageway, footways and verges. The chambers located in the verge in the north-eastern corner of the junction may be affected by the widening of the A38 northern arm, but their exact location would need to be confirmed. Overhead BT is also present crossing the A38 to the north and south of the junction and also running on the southern side of The Wharf, but these would likely be unaffected by the proposals.
- Water; Two Severn Trent Water mains are shown to be running within the A38 northern arm, continuing through the junction to the A4019, where they continue east. As the mains are currently located within the carriageway at the junction it is unlikely that diversion works would be required. However, the existing depth of the mains would need to be confirmed to determine if protective works would be necessary. A third main is also shown running in the eastern footway of the A38 southern arm, but this is unlikely to be affected.

11. Drainage Assessment

11.1. Proposed drainage strategy

Coombe Hill

11.1.1. The proposed junction upgrade would represent an increase in the impermeable footprint of the highway, which would create greater amounts of surface water runoff compared to the current situation. Therefore, the proposed surface water drainage strategy will seek to replicate the site's existing hydrology through SuDS principles, where feasible. The drainage design for Coombe Hill junction would consist of gravity drainage networks, which would convey flows to a suitable outfall or outfalls.

11.1.2. It would be the intention to re-use as much as possible of the existing drainage network, including outfalls. Ongoing design in subsequent stages would involve reviewing the existing drainage within the scheme and confirm its compliance with current design standards. It may be necessary to replace or make improvements to existing assets.

11.1.3. The drainage design would be undertaken in accordance with the latest DMRB standards and IANs.

11.1.4. Key constraints and assumptions identified at this stage for Coombe Hill are:

- It is assumed that the storage required as a result of replicating the existing runoff rates can be accommodated within oversized pipes within the footprint of the highway.
- Based on topographical information it is assumed that existing outfalls to be utilised, or any new outfalls, would be to the local watercourses to the east of the junction. No outfalls are expected to the Coombe Hill Canal to the west of the site.

11.1.5. For general constraints, assumptions and risks see section 18.1 of the M5 J10 TAR.

A4019

11.1.6. For details of A4019 proposed drainage strategy see section 18.1 of the M5 J10 TAR.

12. Lighting Assessment

12.1.1. The proposed junction remodelling at Coombe Hill could introduce formal cycle and pedestrian facilities, with an expected increase in use as a result of residential developments in the vicinity. Provision of a system of road lighting compliant with BS5489 Code of Practice for the Design of Road Lighting might be required.

12.1.2. It is recommended that consideration should be given to provision of compliant road lighting design to promote walking and cycling use and to help ensure safety of road users during the hours of darkness. Lighting extents would be approximately 100m along each approach to the junction.

12.1.3. The potential and desirability of providing lighting (or otherwise) would be discussed and agreed with Gloucestershire County Council road lighting team.

12.1.4. For details of the A4019 lighting please refer to section 19 of the M5 J10 TAR.

13. Maintenance Assessment

13.1.1. Maintenance of assets at the Coombe Hill junction would not change significantly. Signal control is present at the junction under the existing layout and therefore a maintenance regime would already be in place to maintain the signal equipment. Where new assets would be provided, such as lighting, maintenance demand will be evaluated to minimise road worker exposure.

13.1.2. Maintenance demand on the A4019 will increase where new signals and lighting would be provided and as a result of the introduction of a central reserve, however any new assets would be designed to minimise this.

13.1.3. New signing would be required both at the Coombe Hill junction and along the A4019 and the maintenance of these items will need to be considered. It would be necessary to incorporate maintenance lay-bys into the design of the new roundabout on the A4019 to provide maintainers with a simple but safe method of access to any equipment and landscaping present at the junction.

13.1.4. There are no new structures proposed at the two locations which would require maintenance apart from the potential for a low retaining feature at the Coombe Hill junction.

13.2. Maintenance and Repair of Civil Infrastructure

13.2.1. The purpose of inspection, testing and monitoring is to verify that highway equipment is safe and fit for purpose, and to provide the data required to support effective maintenance management and planning.

13.2.2. To keep equipment in a good state of repair and to avoid the need to replace items and employ specialist services it is necessary to frequently perform basic maintenance.

13.2.3. Routine maintenance is minor work carried out on a regular or cyclic basis that helps to maintain the condition and functionality of the equipment and reduces the need for other maintenance works.

13.2.4. Preventative maintenance (planned or unplanned) is work carried out to keep the infrastructure open and safe to use.

13.2.5. All of the options for Coombe Hill and the proposals for the A4019 involve some civil infrastructure and technology works and would require comprehensive monitoring, inspection and maintenance plans to be developed if they are to remain in service for their expected design life and beyond.

13.2.6. The proposals all involve lengths of new highways, new or modified junctions, earthworks, drainage and other items of highways infrastructure including electrical systems. All of these would require a programme of maintenance and periodic renewals.

14. Environmental Assessment

14.1.1. This environmental assessment provides additional information to the environmental assessment presented in the M5 Junction 10 TAR for the M5 J10 project, and provides a separate summary of the potential environmental impacts and consequential effects of the A38/A4019 junction improvements at Coombe Hill (the Scheme), located at the junction of the A38 and A4019 (the Site) to the west of M5 J10. Environmental assessment is not provided here for the dualling works planned on the A4019. From an environmental perspective the dualling works are considered to be covered by the environmental assessments undertaken for the A4019 in the PEAOR produced at Stage 2[1] and covered by the effects reported in both that document and section 21 of the main TAR document.

14.1.2. An environmental assessment of this Scheme was not included in the Preliminary Environmental Assessment of Options Report (PEAOR) (produced in 2019 as part of Stage 2 of the project), as this Scheme was not part of the M5 J10 project at that time. As such it was not included in the main TAR document.

14.1.3. The environmental assessment presented here covers the options described in Section 3.6. Because of the similarities in these three options from an environmental perspective (in particular geographical location and landtake), the three options have been assessed collectively.

14.1.4. The environmental assessment in this document provides a summary of the potential environmental impacts and consequential effects of the Scheme, for the environmental topics for which there is information available to make an assessment, namely Landscape and Visual Amenity, Cultural Heritage, Water Environment, and Biodiversity. Some context is added for other environmental topics, noting that a formal assessment will be undertaken at Stage 3, when further information, in particular details of traffic flows, and a preliminary design of the new Scheme will be available.

- For the topic areas of Materials and Waste and Population and Health there is insufficient information on the proposed design at this stage to undertake assessments of these two topics. These will be considered at Stage 3. The potential mitigation measures presented in section 21.10 of the main TAR document for the Materials and Waste topic are applicable.
- For the Geology and Soils topic the majority of the works for the Site are to be undertaken within the existing highway boundary. Therefore, there may be some potential for contaminated materials to be identified which will be identified through the detailed design phase, and mitigated and removed from site during construction. Due to the minimal effect on land outside the highway boundary, it is expected the Scheme would have negligible effect upon the loss of agricultural soils.

Traffic related environmental topics

14.1.5. For the topic areas of Noise and Vibration, Greenhouse Gases, and Air Quality, there is limited information that can be presented in this document as details are still to be developed on expected traffic flows and numbers. A new traffic model is being produced for Stage 3 and this will include traffic flows and numbers for the Scheme. These topic areas will therefore be assessed in Stage 3.

14.1.6. However, there are numerous residential receptors in proximity to the existing junction which would have the potential to be affected by changes in noise created by changes in traffic flows and speeds from the operation of the Scheme. The nearest NIA (NIA 11921)

[1] Scope of the A4019 dualling works that was assessed in the PEAOR at Stage 2: The dualling will principally be undertaken within the existing highways boundary by making use of existing grassed verge. However, some land-take outside the existing highways boundary is required to facilitate the works in this section. This land-take will be largely undertaken on the north side of the carriageway to avoid encroachment into the larger proportion of properties on the south side of the existing highway.

to the Site is approximately 450m east on the A4019. This is very likely to be within the affected road network from the changes at the Scheme, with increased efficiency of the junction potentially increasing speeds and therefore road noise in this location.

14.1.7. The properties at the junction also have the potential to be affected by construction works at the Site, as noise levels may increase dramatically beyond the baseline levels whilst works are progressing. This may be a particular issue if works at the junction are planned at night to minimise local traffic disruption. Therefore, further work will be undertaken during Stage 3 to understand the construction noise impact of the works in this location. This is particularly important with the knowledge that recent planning applications have been submitted on land immediately north-west and north-east of the Site. These schemes will bring with them potential additional receptors, and therefore liaison with Tewkesbury Borough Council will be required to understand the status of these applications and how these will inform the Cumulative Impact Assessment for the Scheme.

14.1.8. Whilst the Site is not in an AQMA, there remains the potential for significant air quality effects if air pollutant levels increase extensively due to the Scheme. Coombe Hill SSSI is located approximately 250m west of the Scheme, so there is some potential for increased nitrogen deposition at this receptor as a result of any changing flows. The distance between the SSSI and the Scheme and the dispersion of NOx make significant increases relatively unlikely, but these will need to be investigated further as part of the air quality modelling completed during Stage 3 when traffic data is available.

14.1.9. Likewise, these same receptors (residential receptors and the SSSI) have the potential to be affected by dust emissions from site during construction. In likelihood, dust measures will be mitigatable, and the majority of receptors are sufficiently set back from the highway edge to make significant effects unlikely. Despite this, air quality modelling undertaken during Stage 3 will identify if there are any significant effects from the proposals. This modelling will also quantify the additional greenhouse gas emissions produced by the scheme.

14.2. Landscape and Visual Amenity

14.2.1. The Site is the junction of A38 with A4019, around which is the small community of Coombe Hill consisting of detached rural properties, a public house (The Swan) and petrol station; set within a rural, farming landscape, including Coombe Hill Vineyard. All properties have direct views towards the Site.

Baseline

14.2.2. According to Gloucester County Council's Forest of Dean Landscape Character Assessment (LCA 2002) the Site sits between the County Landscape Character Types of (12) Flooded Farmland and (18) Settled Unwooded Vale. Due to the extent of works it is not anticipated that the Scheme would have an overall noticeable effect upon these character areas.

- North of the junction, the A38 has a narrow footpath bordered by a high hedge to the west and a low hedge to the east, allowing long distance views over open fields. At the petrol station and The Swan, the hedge falls away to allow access to the car park, petrol station and car sales area.
- South of the junction, the A38 has narrow footpaths which on the west side are bordered by a wide grass sloping verge with hedge or garden wall. The east side is bordered by garden walls and hedges and a low field hedge which allows long distance open views over it. The hedges and gardens also include some large mature trees close to the boundary.
- West of the junction, The Wharf is a single narrow lane with no footway and tall dense hedges on raised banks, creating a sunken lane effect.

- East of the junction, the A4019 on the south side has a narrow footpath bordered by a tall trimmed hedge or garden wall with narrow grassed verge. At Coombe End farm, the footway recedes into grassed verge and field hedge. On the north side there is a footway with wide grass verge with individual trees and then open fields beyond. At The Bellows, a hedge of tall evergreen and poplar trees edge the garden. There is then a narrow footway and dense tall hedge with trees with pastoral fields beyond.

Potential Effects

14.2.3. The proposed Scheme includes adjusting the alignment of the A38 and A4019 to widen the carriageway around the junction accommodating an additional lane and improving connectivity along the A38 and A4019.

14.2.4. The draft Scheme indicates that the following aspects of work affecting the landscape would be required:

- North of junction:
  - Loss of a section of hedge on the west side to accommodate realignment of the road adjacent to the existing bus stop. The east side hedge would be retained, and the verge area would be widened.
- South of junction:
  - The Scheme is likely to require a retaining wall on the west side, resulting in the loss of grass verge and some hedge, potentially also the root area of some mature evergreen trees, or possibly the trees themselves, may be affected. It is anticipated that the vegetation to the east would be retained.
- West of junction:
  - There is likely to be some loss of hedge to allow widening.
- East of junction:
  - The existing boundary would be extended on the north side meaning a wide area of amenity verge, trees and shrubs will be removed, along with the tall evergreen and poplar trees and a section of dense hedge.

14.2.5. The visual amenity of the whole junction area is expected to be affected due to loss of grass, shrubs, hedge and trees, however, as long as appropriate reinstatement of vegetation is actioned the adverse effect would be temporary during construction and until proposed planting had matured. The removal of most of the vegetation is not expected to greatly increase the visibility from the majority of the visual receptors as it does not currently provide screening value. Assuming that the trees on the west of the A38 south of the junction are retained; the greatest impact is expected to be along the north side of the A4019, where the loss of the tall evergreen trees would open up views for The Bellows, potentially causing significant effects. The loss of hedge along The Wharf (west of junction) would have some adverse impacts on the landscape character of this attractive sunken lane effect and potentially open up views from adjacent properties.

Mitigation

14.2.6. Vegetation removal should be kept to an absolute minimum. Verge extension planting mitigation should be proposed to all areas affected and enhancement measures, such as provision of new hedge, infill hedging and new trees should also be explored where feasible. Replacement planting with large sized evergreen trees is suggested for mitigating the effect adjacent to The Bellows and reduce the adverse effect here in the longer term.

14.2.7. Once the work is completed, the road widening of the A38 and A4019 would ensure the efficient and safe movement of both vehicles and pedestrians. The character of the area is not expected to change significantly and, given appropriate landscape mitigation and

enhancement measures, it is expected that the proposed work would integrate back into the surrounding area, limiting any negative impact on visual amenity. Care must be taken to ensure vegetation removal is kept to a minimum and if the removal of the existing screening trees cannot be avoided, reinstatement planting of large evergreen trees should help to limit medium to long term effects on The Bellows.

14.3. Heritage and historic resources

14.3.1. There are two Grade II Listed Buildings within 500m of the Site at Walton Grange Farm to the north of the A38/A4019 junction, and at Vine Tree Farm to the south of the junction. Both buildings are outside the footprint of the Scheme. However, the works may lead to potential effects on the existing setting of these assets due to increased noise and air quality effects that may arise out of the revised junction, although this cannot be assessed at this point as traffic flows remain unknown. There is some potential for effects on the visual setting of the Listed Buildings, however, upon desk review, a change in visual setting from the proposed option layout appears unlikely.

14.3.2. Whilst a review of Historic Environment Record (HER) data has yet to be undertaken for the Site, the works are largely within the existing highway boundary and are likely to have been excavated as part of the original carriageway construction. This means the likelihood of disturbance of as-yet unknown archaeological remains would appear low based on the current design proposals.

14.3.3. A review of HER data will be undertaken as part of Stage 3, which will inform whether any geophysical evaluation or trial trenching is necessary for the Scheme.

14.4. Biodiversity

14.4.1. The study areas for ecological features were determined by the potential Zone of Influence (ZoI) of the Scheme:

- 30 km for European Sites where bats are a qualifying feature;
- 2 km for other statutory designated sites (extended where there is a direct hydrological connection) and records of bats;
- 1 km for non-statutory designated sites, priority habitats, ancient woodland and records of protected and notable species;
- 500 m for waterbodies that could support great crested newt;
- 250 m for records of ancient and veteran trees;
- 100 m for habitat assessment; and
- 50 m for building and tree bat roost assessments.

14.4.2. A desk study has been undertaken to identify ecological features within the above study areas. To date, field surveys have comprised a bat roost survey (of buildings and trees), great crested newt survey and deployment of dormouse tubes where access has been possible. At the time of writing (June 2020), the results of these surveys were not yet available for consideration in this report. Access arrangements are currently being made to allow further field surveys during 2020.

14.4.3. Two statutory designated sites are present within the study areas:

- Wye Valley and Forest of Dean Bat Sites Special Area of Conservation (SAC) – approx. 23 km south-west of Scheme; and
- Coombe Hill Canal Site of Special Scientific Interest (SSSI) – approx. 250 m west of the Scheme.

14.4.4. One non-statutory designated site, a Conservation Road Verge called Cotswold Farm, the Leigh, is located approximately 320 m south of the Scheme adjacent to the A38.

14.4.5. There are no records of ancient woodlands or ancient/veteran trees within the study areas. Records of priority habitats within 1 km comprise deciduous woodland, traditional orchard and coastal and floodplain grazing marsh.

14.4.6. Habitats within the Scheme boundary include hardstanding associated with the A4019 and A38, adjacent hedgerows and field boundaries, such as grass margins. Hardstanding is of negligible ecological value but hedgerows are a priority habitat[2]. Habitats within 100 m of the Scheme include residential properties and gardens focused around the junction, and agricultural fields. Two pockets of broadleaved woodland also appear to be present. It should be noted that, at this stage, the habitat assessment has largely been from aerial photographs and online resources as access has not yet been granted to all areas.

14.4.7. The desk study has identified 15 ponds within 500 m of the Scheme.

14.4.8. Suitable habitats appear to be present for protected and priority species. These are summarised in Table 14.1, along with details of any survey evidence and/or previous records of protected and notable species.

Table 14.1 – Protected and notable species confirmed or potentially present within the study area

Species / Group	**Suitable Habitats within Study Area**	**Survey Evidence**	**Previous Records**
Bats	Yes – Buildings and trees within the study area which may have potential to support roosting bats, plus suitable commuting and foraging habitats.	None to-date, but surveys ongoing.	Yes - records of five species, the closest of which was from approximately 250 m west of the Scheme.
Dormouse	Yes – hedgerows and woodland.	None to-date, but surveys ongoing.	No.
Badger	Yes – range of habitats	None to-date, but surveys ongoing.	No.
Otter	Field drain potentially present which may be suitable.	Evidence of otter presence at a pond approximately 115 m south of the Scheme boundary found during the great crested newt survey.	No.
Water Vole	Field drain potentially present which may be suitable.	None to-date, but surveys ongoing.	No.
Other Mammals	Yes – range of habitats.	None to-date, but surveys ongoing.	Yes – record of hedgehog from within the Scheme on A4019. Also records of polecat and brown hare from approximately 500 m south

[2] Priority habitats are those habitats listed in accordance with Section 41 of the Natural Environment and Rural Communities Act 2006 (the NERC Act) as being of principal importance for the conservation of biodiversity in England.

Species / Group	Suitable Habitats within Study Area	Survey Evidence	Previous Records
			and west of the Scheme respectively.
Birds	Yes – range of habitats.	None to-date, but surveys ongoing.	Yes – records of over 50 notable species, predominantly associated with Coombe Hill Canal SSSI.
Reptiles	Yes – field boundaries, hedgerows and woodland edge.	None to-date, but surveys ongoing.	Yes – records of grass snake, the closest of which is from approximately 200 m west of the Scheme.
Amphibians	Yes – ponds identified within 500 m of the Scheme and suitable habitats potentially present within the Scheme boundary including hedgerows and field boundaries.	None to-date.	Yes – Natural England has previously granted a great crested newt European Protected Species licence for a location at Knightsbridge, just east of the Scheme. There are also records of great crested newt and smooth newt from approximately 1 km from the Scheme boundary.
Invertebrates	Unlikely to be suitable habitat for priority invertebrates within study area, but this needs to be verified by field surveys.	None to-date, but surveys ongoing.	Yes – records of a number of priority invertebrate species, all of which were from the Coombe Hill Canal area, approximately 250 m west of the Scheme.

Impacts

14.4.9. Further survey work is required and/or under way to enable assessment of the impacts of the Scheme on ecological features. A preliminary assessment of the potential impacts has been made at this stage based primarily on the baseline ecological information collected during the desk study. This assessment must be updated and refined as further information is gathered.

14.4.10. The Scheme is predominantly located within the hardstanding associated with the existing roads. Hardstanding is of negligible ecological value. The proposals, however, also appear to result in the loss of short stretches of adjacent hedgerows, a priority habitat[2].

14.4.11. Regarding protected and priority species, taking a precautionary approach and assuming the presence of dormice within the hedgerows, an important flight line for bats along the hedgerows, and the presence of a bat roost within trees or buildings adjacent to the Scheme boundary, there is potential for significant impacts to these ecological features. Considering the scale of the proposals and the baseline ecological information collected to date, significant impacts to other protected and priority species are considered unlikely, although mitigation measures may be required to ensure legal and good practice compliance, as explained below.

14.4.12. Coombe Hill SSSI is located approximately 250m west of the Scheme. During construction, without mitigation there is potential for dust and water quality impacts upon this receptor. Likewise, during operation, there is the potential for water quality impacts from road pollution events should the drainage design not adequately manage these risks. There are also potential impacts from increased nitrogen deposition from increased traffic flows as a result of the Scheme which will need to be investigated as part of Stage 3.

Mitigation measures

14.4.13. The overarching aims of the mitigation will be to ensure legal compliance and deliver a net gain for biodiversity, in accordance with national and local planning policy.

14.4.14. In accordance with the mitigation hierarchy[3], the primary mitigation measure will be avoidance of impacts via Scheme design (e.g. alteration of the Scheme footprint to avoid loss of a particular habitat). The next step will be to minimise effects that cannot be avoided. Generic measures that will be employed to minimise ecological effects include:

- Design amendments to minimise habitat loss;
- Design amendments to incorporate habitat connectivity features, such as habitat corridors, wildlife underpasses and/or green bridges;
- Establishment of an appropriately sized, resourced and experienced site environmental management team (including at least one Ecological Clerk of Works (ECoW)) to ensure effective implementation of all environmental mitigation;
- Ecological briefings / toolbox talks for all site operatives to make them aware of relevant constraints and requirements prior to commencing work on the Scheme;
- Clear demarcation (i.e. fencing) of retained habitats and no allowance of vehicles or storage of materials within these areas;
- Use of sediment control measures during construction, such as:
  - Timing works to avoid exposure of soil during autumn/winter;
  - Seeding/planting exposed topsoil at earliest opportunity;
  - Use of silt fencing, drainage ditches, attenuation ponds, etc;
- Use of pollution control measures during construction, such as:
  - Use of low emission plant;
  - Regular maintenance and inspection of machinery;
  - Use of designated, bunded areas away from sensitive ecological features for fuel storage and refuelling (i.e. following Guidance for Pollution Prevention (GPPs)[4] and the Construction Industry Research and Information Association (CIRIA) guidance on the control of water pollution from construction sites[5]);
- Location of haul roads away from sensitive features and use of dust suppression measures during dry periods;
- Covering excavations overnight or incorporating features such as ramps to prevent animals getting trapped;

[3] The 'mitigation hierarchy' seeks as a preference to avoid impacts then to mitigate unavoidable impacts, and, as a last resort, to compensate for unavoidable residual impacts that remain after avoidance and mitigation measures (The British Standards Institution (2013). *BS 42020:2013. Biodiversity — Code of practice for planning and development.*)
[4] http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/
[5]The CIRIA documents are a series of publications developed by the Construction Industry Research and Information Association. Each document is targeted at a particular type of business or activity and covers environmental good practice to minimise pollution. Particular attention should be given to CIRIA C532 (Control of water pollution from construction sites, 2001). The CIRIA publications also make reference to environmental legal obligations and are available from: http://www.ciria.org/CIRIA/Resources/Resource_overview/Resources/Resources_overview.aspx?hkey=a80608d2-a045-4d72-8bb9-5ecf23f8d761"

- Designing the construction and operation drainage to maintain or enhance[6] the existing hydrological conditions; and
- Designing the operation drainage to minimise the risk of pollution from the road surface coming into contact with sensitive habitats.

14.4.15. In addition to the generic measures set out above, specific mitigation strategies could potentially be needed for bats, dormouse, badger, otter, water vole, breeding birds, reptiles and great crested newt, including provision of compensatory habitats, disturbance avoidance measures and adoption of sensitive habitat clearance methods (under Natural England licences where appropriate) to avoid harm during construction. Specific measures may also be required to prevent the spread of invasive non-native species of plant.

14.5. Water Environment

14.5.1. A high-level desk study of flood risk issues to assess the likely extent of flood risk within the 1 km study area has been completed. This was undertaken to identify whether there are any flooding or surface water management issues related to the development that may warrant further consideration.

- No consultation has been made with the Environment Agency, as there are no Main River watercourses within 8m of the Site (or tidal Main River watercourses within 16m), nor are the works within any denoted Flood Zones or in the flood plain; nor with Tewkesbury Borough Council the Lead Local Flood Authority (LLFA) as there are no Ordinary Watercourses impacted by the proposals.

Baseline

14.5.2. Waterbodies within the 1 km study area of the Site fall within the Severn River Basin District (RBD) as set out within the Severn River Basin Management Plan (RMBP)[7]. A 1 km study area was chosen as research indicates that impacts associated with soluble pollutants will be sufficiently diluted beyond 1 km, thereby reducing any potential impact (DMRB, HD45/09). Surface watercourses within the study area have been identified. These can be classified as Main Rivers, Ordinary Watercourses, ditches and artificial waterbodies including the Coombe Hill Canal. All fall within the Severn River Basin District (RBD). The current condition and aims are set out within the Severn River Basin Management Plan (RMBP).

14.5.3. Within the study area this RBD is split further into three WFD assessed (2000/60/EC) surface water body catchments. These are all classified as Main River and are as follows:

- The River Chelt – M5 to conf. R. Severn (GB109054032810) – located approximately 0.5 km to the south east. This has been assigned a very high to high importance at the time of reporting as although classified under the WFD, the Q95 flow is unknown, a distinguishing criteria in LA 113, between very high and high. Importance will be confirmed at Stage 3 when more data has been acquired.
- Leigh Brook - source to conf R Chelt (GB109054039770) – located approximately 0.3 km to the south east this has been assigned a very high to high importance. As above the differentiation of importance is based on flow, which is unknown at the time of reporting. Importance will be confirmed at Stage 3 when more data has been acquired.
- Coombe Hill Canal (GB70910059) – located approximately 0.3 km to the north west this has been assigned a very high importance at the time of reporting as in addition

[6] Enhancement in this context means the enhancement of one or more features' ecological condition or value, without detriment to other ecological features.
[7] https://www.gov.uk/government/publications/severn-river-basin-district-river-basin-management-plan

to being classified under the WFD, this is further classified as a Special Site of Scientific Interest (SSSI) as it provides aquatic habitat for rare UK plant species and invertebrates, and is thereby protected under UK legislation and of National significant importance. It is one of the most important known wetland sites within Gloucestershire.

14.5.4. There are several Ordinary Watercourses throughout the study area that will be in hydraulic connectivity to these Main Rivers. Included within the Ordinary Watercourse category are several drains and ditches. The importance of the Ordinary Watercourses has been assigned a medium importance and drains and ditches as low importance on the assumption that the former is of moderate quality and having a Q95 flow of >0.001m^3s, and the latter of lower quality with a Q95 flow of <0.001m^3s. These importance assumptions will be verified at Stage 3.

14.5.5. There are no WFD designated lakes within the study area and therefore these features have not been considered further. With regard to the groundwater baseline, superficial deposits are absent underlying the Site, however, alluvial deposits associated with surface water features are present within the study area, to the east and west of the site. The alluvial deposits are designated by the Environment Agency as Secondary A aquifers.

14.5.6. Bedrock deposits underlying the study area are Wilmcote Limestone Member, Penarth Group, Saltford Shale Member, Rugby Limestone Member, Branscome Mudstone Formation, Arden Sandstone Formation and Sidmouth Mudstone Formation. The bedrock deposits are designated by the Environment Agency as Secondary Aquifers (Secondary A, Secondary B and Secondary Undifferentiated).

14.5.7. The study area is underlain by the Severn Vale – Secondary Combined WFD Groundwater Body (ID: GB40902G204900) which is classified as being of Good Quantitative and Chemical status.

14.5.8. There are no Source Protection Zones within the study area, however, confirmation of the presence (or lack thereof) of licensed groundwater abstractions and discharges should be sought from the Environment Agency.

14.5.9. Where surface water features are underlain by permeable superficial deposits, there is the potential for them to receive base flow from groundwater.

14.5.10. The Site is located within Flood Zone 1. However, areas of land inside the 1 km study area to the east and west of the Site, include the floodplains of the River Chelt, Leigh Brook and Coombe Hill canal. These are classified as Flood Zone 3.

14.5.11. The surface water flooding map (Risk of Flooding from Surface Water – RofSW) shows that there is a risk of surface water flooding along the field topography between Coombe Hill junction and Knights Bridge over the Leigh Brook. This is some 225 m from the road junction. The risk level varies from low to high, i.e. from the annual exceedance probability (AEP) band 0.1% to 1% to and AEP greater than 3.33%. The 'high' risk of surface water flooding appears to sit north of the A4019 which limits the risk downstream, to the south of the road. This is shown to affect the residential property of 'The Bellows'.

14.5.12. There is a small area of high risk (i.e. greater than 3.33% annual exceedance probability [AEP]) beside the highway junction on the A38. This is likely to be a local highway drainage issue.

14.5.13. Beyond the proposed site, the risk and extent of surface water flooding is linked to the rural farmland and beside the watercourses and field drains. Instances of surface water flooding in the study area are likely to be associated primarily with pluvial ponding.

14.5.14. As the potential surface water flooding affects The Bellows residential property and the existing Coombe Hill junction, the importance of surface water flood risk is classed as high.

14.5.15. The Site is not considered to be at risk of flooding from other sources (tidal, canals, reservoirs and sewers), although information on historical flooding from sewers has not been sourced at this stage, and will be considered further at Stage 3.

Potential impacts

Construction

14.5.16. Potential impacts at construction stage are limited to surface water flood risk, which can be exacerbated by use of heavy plant during construction. Managing runoff from the Site would need to ensure that the existing overland flow path across/under the A4019 is not obstructed as a result of the improvement works, not least by the highway work along the A4019.

14.5.17. Any temporary outfalls would require appropriate consent from the Environment Agency and the LLFA. Sediment runoff from the Site could result in blockage of existing structures, such as the culvert underneath the A4019 highway.

14.5.18. Temporary ponds constructed to attenuate water and manage sediment could cause flooding of adjacent land in the event of overtopping or a breach.

14.5.19. The topography of the land surrounding the Site means that surface water from the highways within the Site is expected to drain eastwards. However, the proximity of the Coombe Hill Canal SSSI to the west of the Site means that this receptor could be impacted by surface water or drainage released to the west of the A38. This risk will be assessed at Stage 3.

14.5.20. Flooding can also occur when the sewerage infrastructure becomes overwhelmed by heavy rainfall (due to inadequate capacity) or blockages in drainage systems (as a result of sediment or debris accumulation). Works above or adjacent to existing sewer networks along the A38 and A4019 may also damage buried pipelines (to the extent that it causes flooding), through damage during excavations or through damage causing below ground blockages. This risk will be reassessed at Stage 3.

Operation

14.5.21. Flood Risk;

- The Site is not located in an area with fluvial flood risk issues. Therefore, the Scheme is unlikely to exacerbate long term fluvial flood risk.

14.5.22. Surface water impacts;

- The existing overland flow paths should be taken into account in the design of the A4019 spur off the new Coombe Hill junction. The Scheme should seek to avoid changes to the level of the road at its low spot. Similarly, if any culverts passing under the A4019 require extension, then surface water flood risk may be increased here.
- Potential flow paths for road drainage to the Coombe Hill Canal SSSI should be considered. It is likely that the mitigation measures outlined below will be sufficient to satisfy the needs of the Scheme. It is noted however, that the Environment Agency/Natural England may need to be a consultee beyond the LLFA because of the potential to outfall to this designated receptor.
- Any new culverts passing under the A4019 would need to remain clear during the life of the Scheme. Blockage of those culverts would increase flood risk in the area, particularly to The Bellows property.

- Surface water flooding can be exacerbated if developments increase the percentage of impermeable area, so generating more runoff. The existing highway junction is fully paved, yet the widening work to increase junction capacity will increase the paved area. As such there is a risk of an increase in surface water flooding from the operating site.
- Without appropriate mitigation, the potential overall effect on surface water flood risk has been assessed as large and is considered to be significant.

14.5.23. Sewers;

- The design of the Scheme will likely increase the impermeable area draining to the existing surface water sewers. This could increase the amount of surface water runoff to be conveyed to the receiving watercourse, if not using SuDS methods.
- Without appropriate mitigation, the potential overall effect on sewer flooding has been assessed as moderate and is considered to be significant.

Potential mitigation measures

14.5.24. No specific construction stage mitigation measures are identified for the Scheme. The measures described in section 21.9 of the main TAR report will apply.

- If the Option is designed and constructed having gained appropriate consents from the LLFA, and taking into account climate change, such that flood risk issues have been identified and mitigated in the design, then it is not considered that there will be adverse flood risk issues associated with the construction of the Scheme. Subject to the implementation of all mitigation measures, the overall residual effect on flood risk during construction has been assessed as neutral.

14.5.25. To mitigate operational stage impacts a Drainage Strategy should be developed to ensure there is minimum/no change in surface water runoff with mitigation measures to ensure that there is no increase in surface water flood risk. It will be important to ensure that the overland flow path to the east of Coombe Hill junction is not obstructed by the Scheme.

- Subject to the implementation of all mitigation measures, and the operation and management of them, then the overall residual effect on flood risk during site operation has been assessed as neutral.

15. Programme

15.1. Scheme Level Programme

15.1.1. The project programme is included within section 23 of the M5 J10 TAR.

16. Cost Estimates

16.1. Option Cost Comparison

16.1.1. Table 16.1 below provides an approximate cost estimate for each option.

16.1.2. Cost estimates for the scheme will be subject to change in future stages, when more detailed assessments and design developments are undertaken

Table 16.1 – Summary of Cost Estimates for Each Options

Description	A4019 Dualling	Coombe Hill Option 1	Coombe Hill Option 2	Coombe Hill Option 3
Approx. Total Scheme Cost	**£20-25M**	**£5M**	**£4M**	**£3.5-4M**

All figures shown in pounds, in 2018 prices

17. Conclusion and Recommendations

17.1. Options for Public Consultation

17.1.1. Of the three options for the A4019 dualling, it is concluded that Options 2 and 3 should be sifted out as they would have greater safety risks associated with lack of physical segregation of opposing traffic flows, but only provide marginal improvement to the land impacts of Option 1. Therefore the A4019 Option 1 and the three options for the Coombe Hill junction presented in this report have been assessed and a summary of the main outcomes is provided below.

17.2. Brief summary description of each option

A4019 – Option 1

- On-line widening of the existing A4019 between the proposed gyratory roundabout for the West Cheltenham Link Road and the Fire Station to provide a standard two-lane dual carriageway with 3.65m lane widths and a 1.80m wide central reservation.
- A new signalised junction is proposed at the existing staggered crossroad junction between The Green and Moat Lane in Uckington.
- A two-way 4 m wide cycle track and 2 m wide footway is proposed on the northern side of the A4019 for the extents of the proposed dualling section between the new roundabout and the Fire Station.
- There would be a significant impact on land immediately to the north of the A4019, including the requirement for demolition of two houses and significant loss of boundaries and frontage for a number of other properties.
- Generally, utilities located within the existing northern verge of the A4019 would likely either need to be diverted or protected due to the proposed carriageway widening which is largely into the northern verge. Some carriageway widening into the southern verge is also proposed, particularly at the new signalised junction at Uckington, so some diversion/protection works would also likely be required at these locations.
- Approximate total scheme cost is £20 – 25 million.
- On the basis of the assessment undertaken to date, environmental impacts are expected to be limited changes in noise and air quality levels as a result of the changes in the road layout (although the effects incurred will depend on traffic numbers and speeds); and also from land take and the demolition of the buildings to the north of the A4019 leading to ecological impacts and potential loss of agricultural land (depending on the extent of the land take beyond the existing road and highway boundary).
- The introduction of a new roundabout linking the A4019 to the West Cheltenham Link Road and the new signal-controlled junction at The Green /Moat Lane may increase the potential for future collisions but will also make turning manoeuvres easier. The dualling of the route may lead to an increase in vehicle speeds which could increase the severity of a collision. Opposing traffic flows would be segregated by a central reserve with a VRS.

Coombe Hill Option 1

- Option 1 was developed on the same concept as the Amey Consulting signalised junction option but the approach lanes on the A4019 and A38 southern arm were amended to suit forecast demand. This resulted in the proposed three lane approach on the A4019 reducing to two lanes as the existing layout. The proposed two lane exit on the A38 southern arm also reduced to one lane as the existing layout.
- There would be a free flow left turn lane connecting the A38 northern arm to the A4019 via an axillary lane. Due to the length of the proposed auxiliary lane the existing A4019 bus stop would need to be relocated to the east.
- Pedestrian facilities would be provided across the A4019, The Wharf and the A38 Eastern arm. Additionally, a crossing across the left turn (A38 to A4019) would be provided, which would run independently of the rest of the junction.
- Cycling facilities in the form of Advanced Stop Lines and lead in cycle lanes would be provided on all arms except for The Wharf, where they have been omitted due to the low traffic flows.
- Land would be required outside the existing highway boundary in several areas but most significantly to the east side of the A38 northern arm and south east of the existing filling station. There are submitted planning applications for housing developments in both of the fields. This option would also significantly impact the frontage of the property The Bellows.
- The proposed left turning auxiliary lane would require the diversion of a medium pressure gas main, underground high and low voltage electricity, BT and telecommunication services currently running in the footway/verge on the northern side of the A4019 continuing through the north-east corner of the junction to the eastern side of the A38. An existing overhead low voltage pylon would also need to need to be moved to accommodate the auxiliary lane. A low pressure gas main, low voltage underground electricity and a telecommunication service would also likely need to be diverted to accommodate the widening of the A38 southern arm into the western verge.
- Approximate total scheme cost is £5 million.
- The environmental assessment undertaken to date indicates that environmental impacts are likely to be limited to those caused by land take outside of the alignment of the highway; assuming that surface water drainage is to the east and not to the west of the Scheme, and that the overland flow path to the east of Coombe Hill junction is not obstructed by the Scheme. Changes in traffic numbers and speeds from the Scheme will also impact on noise and air quality, although these are expected to be broadly similar across the three options. Ecological habitats within the Scheme boundary include hardstanding associated with the A4019 and A38, adjacent hedgerows and field boundaries, such as grass margins. Hardstanding is of negligible ecological value but hedgerows are a priority habitat. Environmental impacts will therefore be minimised where land take (outside the highway) and vegetation loss can be avoided.
- The proposed junction layout would provide a safer environment for pedestrians and cyclists and may provide improved clarity of junction operation particularly at the petrol station access off the northern arm. The location of the relocated bus lay-by at the end of the merge on the free flow left turn exit may increase the risk of conflict between buses slowing to enter the lay-by and vehicles completing the merge manoeuvre.

Coombe Hill - Option 2

- Option 2 was developed with the aim of removing the auxiliary lane from the free flow left turn lane, included in Option 1, in order to minimise scheme land impacts and costs. The auxiliary lane is replaced in this option by a give-way arrangement for left turning traffic.
- Apart from the removal of the auxiliary lane, the lane arrangement on each of the arms is the same as Option 1 and would also provide pedestrian facilities. However, rather than an A4019 crossing, which would no longer be possible due to the reduced length of the left turn refuge island, both A38 arms would have pedestrian facilities.
- Cycling facilities would also be provided as described in Option 1.
- Land impacts would be less than Option 1 as the scheme ties into the existing A38 north arm and the A4019 earlier, so therefore the improvement extents are reduced. The removal of the auxiliary lane also results in reduced impact to the field south east of the existing filling station and no impact on the property The Bellows.
- The reduced extent of works for Option 2, compared to Option 1, means that there is a reduced impact on existing statutory utility plant particularly in the footway/verge on the northern side of the A4019. As such, the extent of diversionary works is likely to be less, particularly for the medium pressure gas main, underground high and low voltage electricity and telecommunication service running through the north-east corner of the junction. The overhead low voltage electricity pylon would also be unaffected, unlike Option 1. Diversionary works required for the widening of the A38 southern arm would be the same as for Option 1.
- Approximate total scheme cost is £4 million.
- The smaller land take outside of the highway for Option 2, compared to Option 1, means that overall this option is expected to incur a smaller environmental impact than Option 1. Improved facilities for cyclists (in all three options) and pedestrians in Option 2 provides a positive environmental impact.
- The safety benefits would be similar to Option 1. However, the removal of the auxiliary lane would mean that the existing bus stop could remain and the increased risk of conflict associated with merging left turning traffic and buses for Option 1, would be avoided with this option.

Coombe Hill - Option 3

- Option 3 was developed with the aim of further minimising scheme land impacts and costs with the left turn lane from the A38 to the A4019 being signalised alongside the straight-ahead lane.
- Apart from the amendment to the left turn lane, the lane arrangement on each of the arms is the same as Options 1 and 2 and would also provide pedestrian facilities at similar locations to Option 2.
- Cycling facilities would also be provided as Options 1 and 2.
- Land impacts would be less than both Option 1 and 2 with only minimal areas of widening required.
- The reduced extent of works and reduced widening on the A38 northern arm for Option 3, compared to Option 1 and 2, means that there is a reduced impact on existing statutory utility plant particularly in the footway/verge on the northern side of the A4019. As such, the extent of diversionary works is likely to be less, particularly for the medium pressure gas main, underground high and low voltage electricity and telecommunication service running through the north-east corner of the junction. The overhead low voltage electricity pylon would also be unaffected, unlike Option 1. Diversionary works required for the widening of the A38 southern arm would be the same as for Option 1 and 2.
- Approximate total scheme cost is £3.5 - 4 million.

- The smaller land take outside of the highway for Option 3, compared to Options 1 and 2, means that overall, this option is expected to incur a smaller environmental impact than the other two options. The positive environmental impacts arising through improvements for pedestrians and cyclists are the same as for Option 2 and Option 1 respectively.
- The safety benefits would be similar to Option 1 and Option 2.

17.3. Options to be taken forward

17.3.1. It is recommended that the A4019 Option 1 is taken forward for further development.

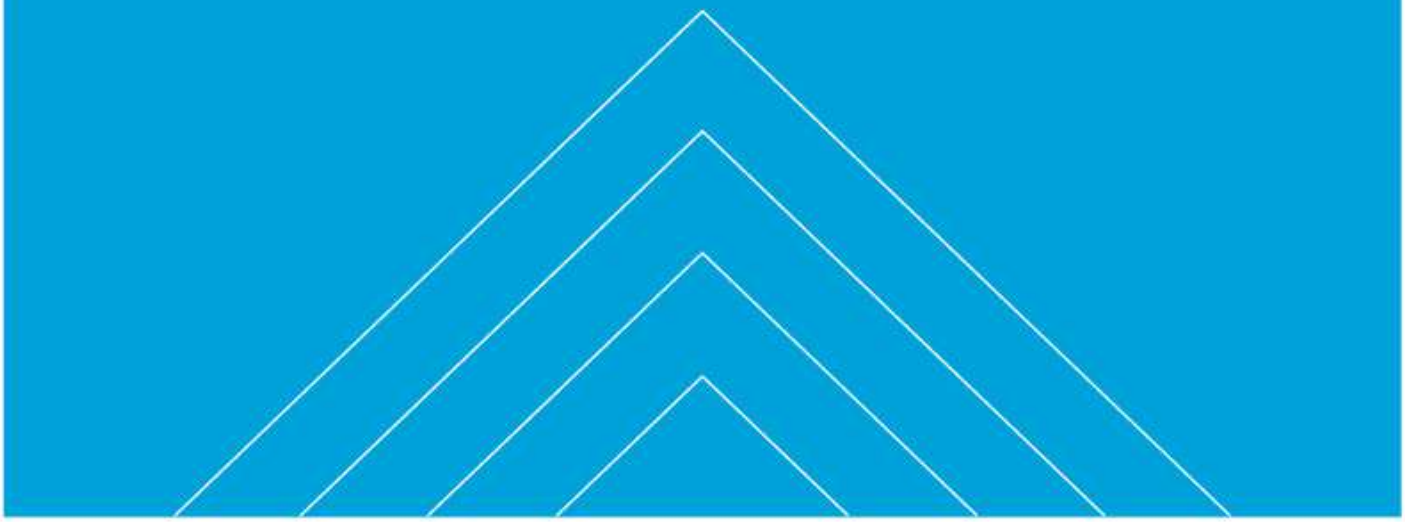
17.3.2. Out of the three options for the Coombe Hill junction improvements, Options 2 and 3 are assessed as offering the greatest operational benefits, while Option 3 would have the least land and environmental impacts, as well as having the lowest construction costs of the three options. It is therefore recommended that Option 3 is taken forward for further development.

18. Glossary

Abbreviation	Term
AADT	Annual Average Daily Traffic
ALC	Agricultural Land Classification
AONB	Area of Outstanding Natural Beauty
AQMA	Air Quality Management Area
ARN	Affected Road Network
ASR	Appraisal Specification Report
AST	Appraisal Summary Table
BCR	Benefit/Cost Ratio
BMV	Best and Most Versatile
CBC	Cheltenham Borough Council
CCTV	Close Circuit Television
CDM	Construction Design Management
CEMP	Construction Environmental Management Plan
CFHN	Colman's Farm Habitat Network
CO2e	Carbon Dioxide Equivalent
CSV	Central Severn Vale
DCO	Development Consent Order
DEFRA	Department for Environment Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Road and Bridges
EA	Environmental Agency
ELPV	Enhanced Longitudinal Profile Variance
ERTs	Emergency Response Telephones
ES	Environmental Statement
ESR	Environmental Study Report
GCC	Gloucestershire County Council
GHG	Green House Gases
HE DDMS	Highways England Drainage Data Management System
HAPMS	Highways Agency Pavement Management System
HE	Highways England
HIF	Housing Infrastructure Fund
INNS	Invasive Non-native Species
IP	Inter-Peak
IPPC	Integrated Pollution Prevention and Control
ITS	Intelligent Transport Systems

Abbreviation	Term
JCS	Joint Core Strategy
LAPPC	Local Authority Pollution Prevention and Control
LCA	Landscape Character Area
LGF	Local Growth Fund
LWS	Local Wildlife Site
MIDAS	Motorway Incident Detection and Automatic Signalling
NIA	Noise Important Area
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NRSWA	New Roads and Streetworks Act
NPV	Net Present Value
NTM	National Transport Model
OEMP	Operational Environmental Management Plan
PEAOR	Preliminary Environmental Assessment of Options Report
PICs	Personal Injury Collisions
PRoW	Public Right of Way
PVB	Present Value of Benefits
PVC	Present Value of Costs
RofSW	Risk of Flooding from Surface Water
SAC	Special Area of Conservation
SCOOT	Split Cycletime Offset Optimisation Technique
SGAR	Stage Gate Assessment Review
SPA	Special Protection Area
SRN	Strategic Road Network
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage System
SWMP	Site Waste Management Plan
TAR	Technical Appraisal Report
TBC	Tewkesbury Borough Council
TEE	Transport Economic Efficiency
TS	Transport System
TTM	Temporary Traffic Management
VfM	Value for Money
WebTAG	WebTAG (DfT's on line) Transport Analysis Guidance
WEEE	Waste Electrical and Electronic Equipment
WFD	Water Framework Directive

Appendices



Appendix A. A4019 Option Drawings

A.1. A4019 Layout (Sheet 1 of 2) - GCCM5J10-ATK-HML-L1_SR-SK-CH-000001_C01.pdf

A.2. A4019 Layout (Sheet 2 of 2) - GCCM5J10-ATK-HML-L1_SR-SK-CH-000002_C01.pdf

A.3. A4019 Typical Cross Section Option 1 - GCCM5J10-ATK-HML-L1_SR-SK-CH-000004_C01.pdf

A.4. A4019 Typical Cross Section Option 2 and 3 - GCCM5J10-ATK-HML-L1_SR-SK-CH-000005_C01.pdf

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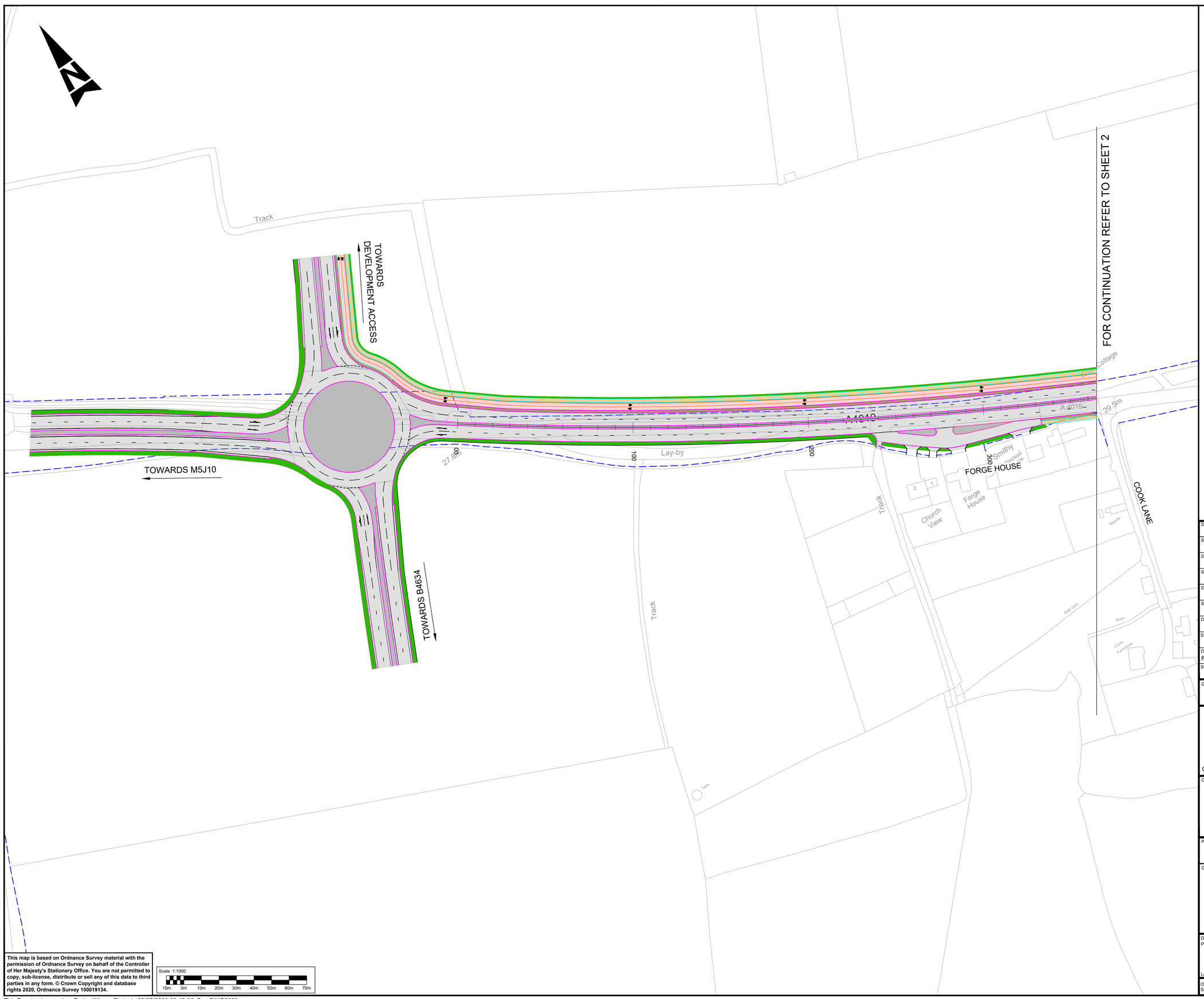

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. REFER DRAWING NO GCCM5J10-ATK-HML-L1_SR-SK-CH-000004 & GCCM5J10-ATK-HML-L1_SR-SK-CH-000005 FOR CROSS SECTIONS OPTIONS.

KEY:

- EXISTING HIGHWAY BOUNDARY
- PROPOSED KERB EDGE
- PROPOSED SEPARATOR
- PROPOSED CARRIAGEWAY
- PROPOSED VERGE
- PROPOSED ISLAND
- PROPOSED FOOTPATH
- PROPOSED CYCLE WAY
- PLOT ACCESS LINE WITH PRIORITY TO NMU
- PLOT ACCESS LINE WITH PRIORITY TO PLOT

Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description	First Issue					
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
A1	---	HS	CJ	AM	LJ	17/07/20

Drawing Suitability: APPROVED - PUBLISHED

Status: A1

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Client: Gloucestershire County Council

Project Title: M5 J10 Improvements Scheme

Drawing Title: A4019 Standard Dual Carriageway (D2UAP)

Drawing Number
Project: GCCM5J10 - Originator: ATK - Volume: HML -
L1_SR - SK - CH - 000001
Location | Type | Role | Number

Original Size: A1 | Scale: 1:1000 | Project Ref. No: 5197035 | Sheet: 1 of 2 | Rev: C01

Scale 1:1000
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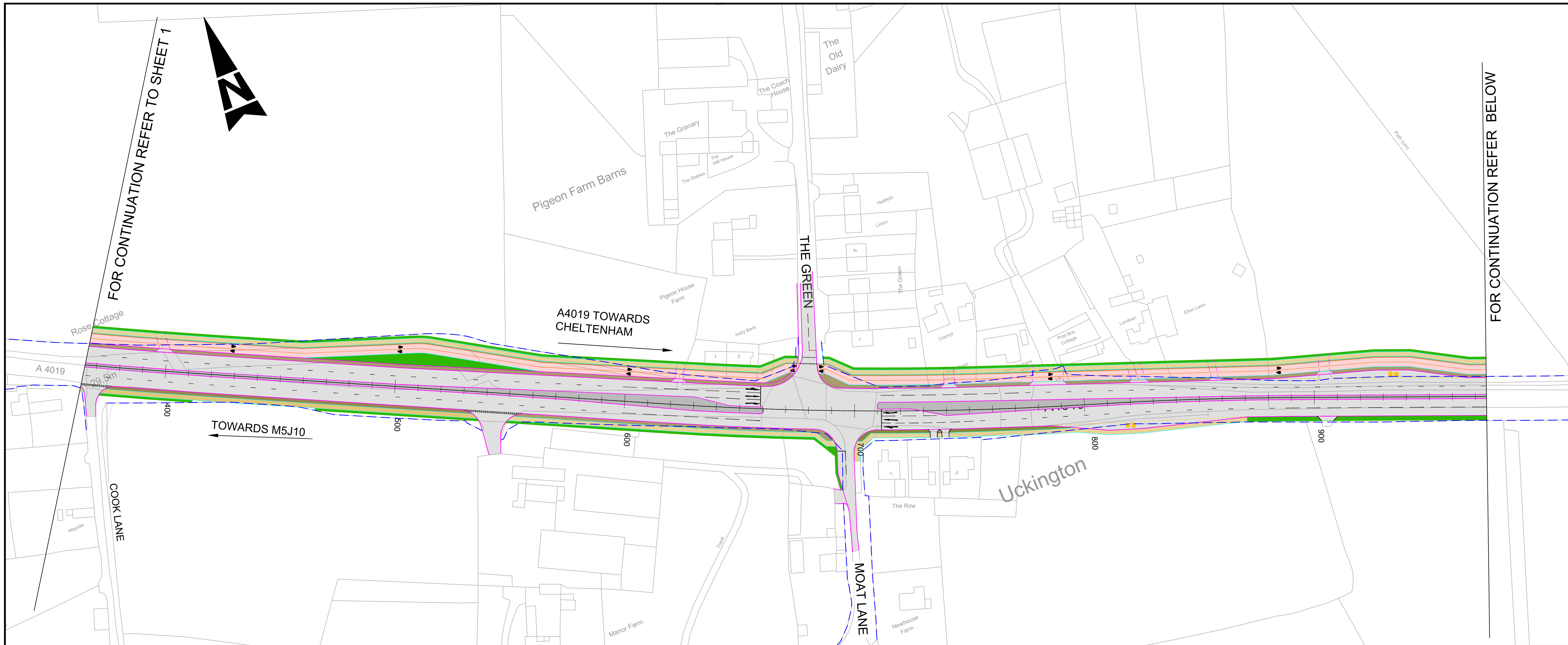

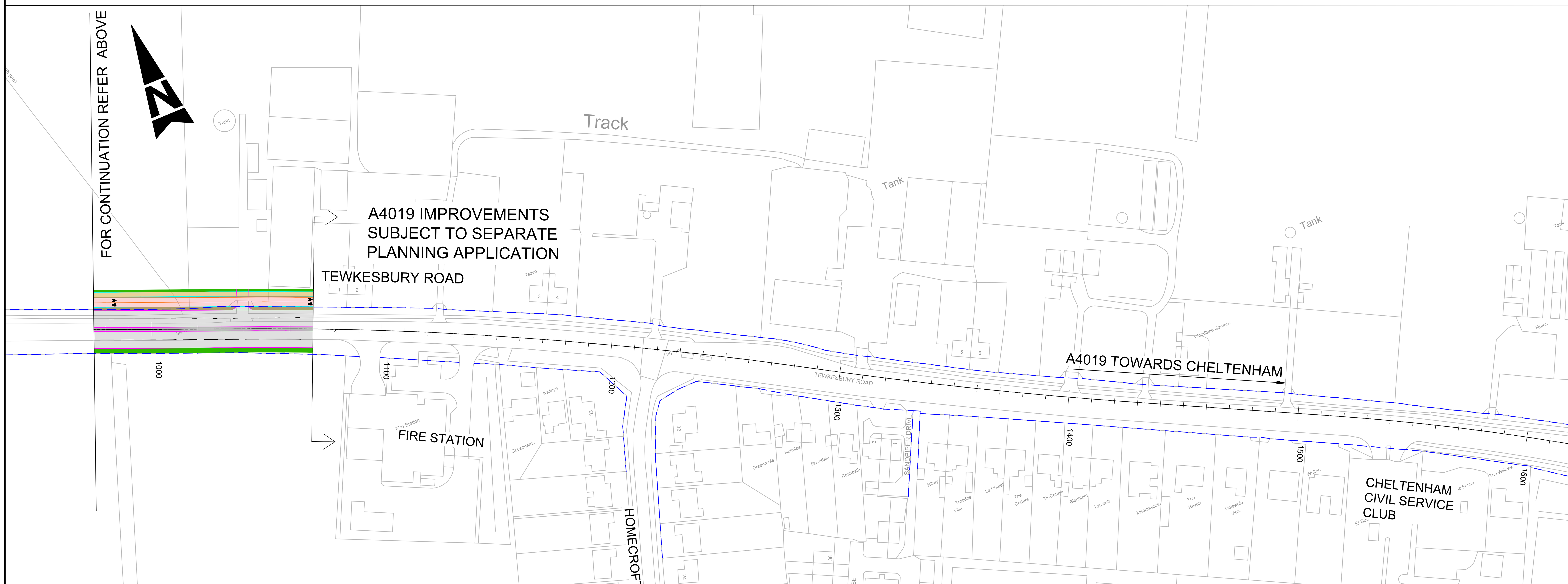

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1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. REFER DRAWING NO GCCM5J10-ATK-HML-L1_SR-SK-CH-000004 & GCCM5J10-ATK-HML-L1_SR-SK-CH-000005 FOR CROSS SECTIONS OPTIONS.

KEY:

- EXISTING HIGHWAY BOUNDARY
- PROPOSED KERB EDGE
- PROPOSED SEPARATOR
- PROPOSED CARRIAGEWAY
- PROPOSED VERGE
- PROPOSED ISLAND
- PROPOSED FOOTPATH
- PROPOSED CYCLE WAY
- PLOT ACCESS LINE WITH PRIORITY TO NMU
- PLOT ACCESS LINE WITH PRIORITY TO PLOT

Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description: First Issue						
A1	---	HS	CJ	AM	LJ	17/07/20

Drawing Suitability: APPROVED - PUBLISHED | Status: A1

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Project Title: M5 J10 Improvements Scheme

Drawing Title: A4019 Standard Dual Carriageway (D2UAP)

Drawing Number: GCCM5J10 - ATK - HML - L1_SR - SK - CH - 000002

Original Size: A1 | Scale: 1:1000 | Project Ref. No: 5197035 | Sheet: 2 of 2 | Rev: C01

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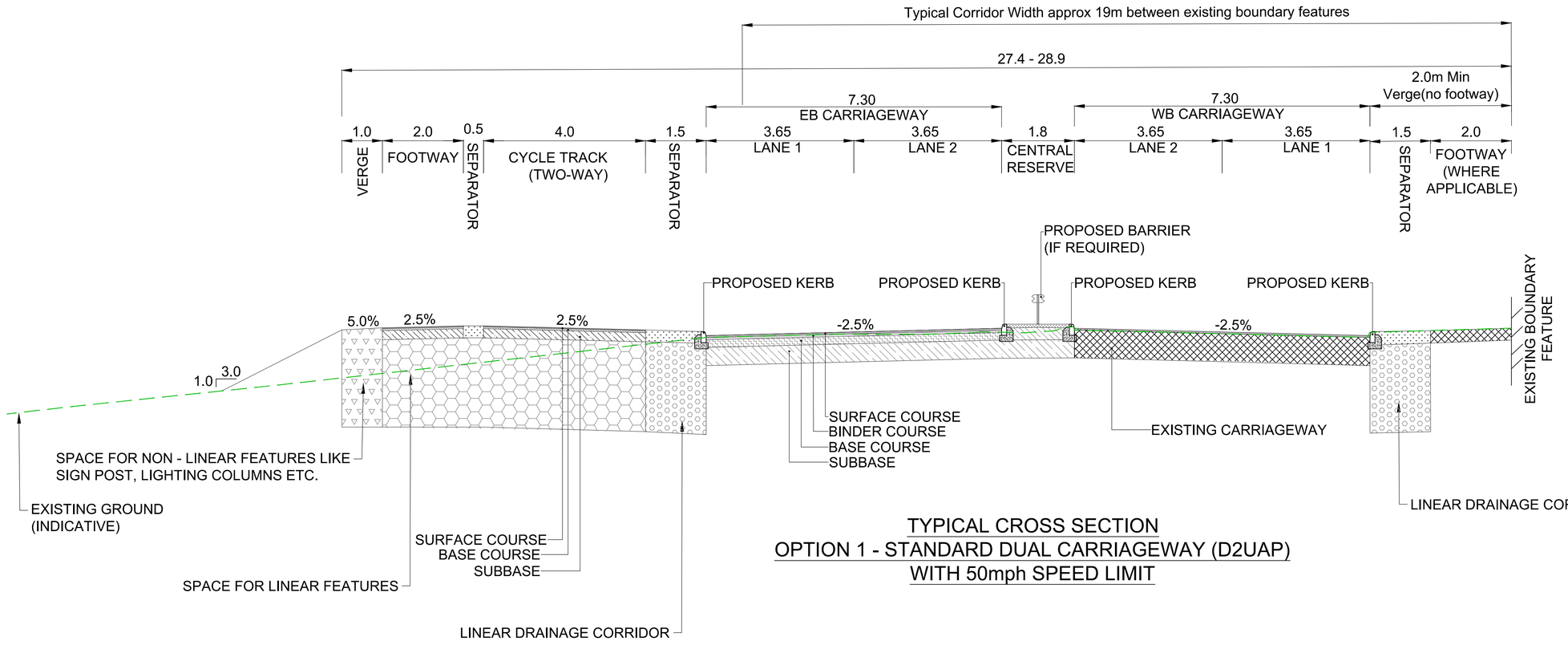

TYPICAL CROSS SECTION
OPTION 1 - STANDARD DUAL CARRIAGEWAY (D2UAP) WITH 50mph SPEED LIMIT

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. BASED ON TAG UNIT A5.4 - MARGINAL EXTERNAL COSTS, TABLE A6, THESE OPTIONS WOULD HAVE A SUGGESTED AVERAGE CAPACITY OF 1100 PCU PER LANE KM, MAKING OVERALL CAPACITY 2200 PCU PER LANE KM IN EITHER DIRECTION.

Description	Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
First Issue	A1	---	HS	CJ	AM	LJ	17/07/20

Drawing Suitability: APPROVED - PUBLISHED
Status: A1

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Client: Gloucestershire COUNTY COUNCIL

Project Title: M5 J10 Improvements Scheme

Drawing Title: A4019 Typical Cross Section Option 1- Standard Dual Carriageway (D2UAP) with 50mph Speed Limit

Drawing Number: GCCM5J10 - ATK - HML - L1_SR - SK - CH - 000004
(Project - Originator - Volume - Location - Type - Role - Number)

Original Size: A1 | Scale: NTS | Project Ref. No: 5197035 | Sheet: 1 of 1 | Rev: C01

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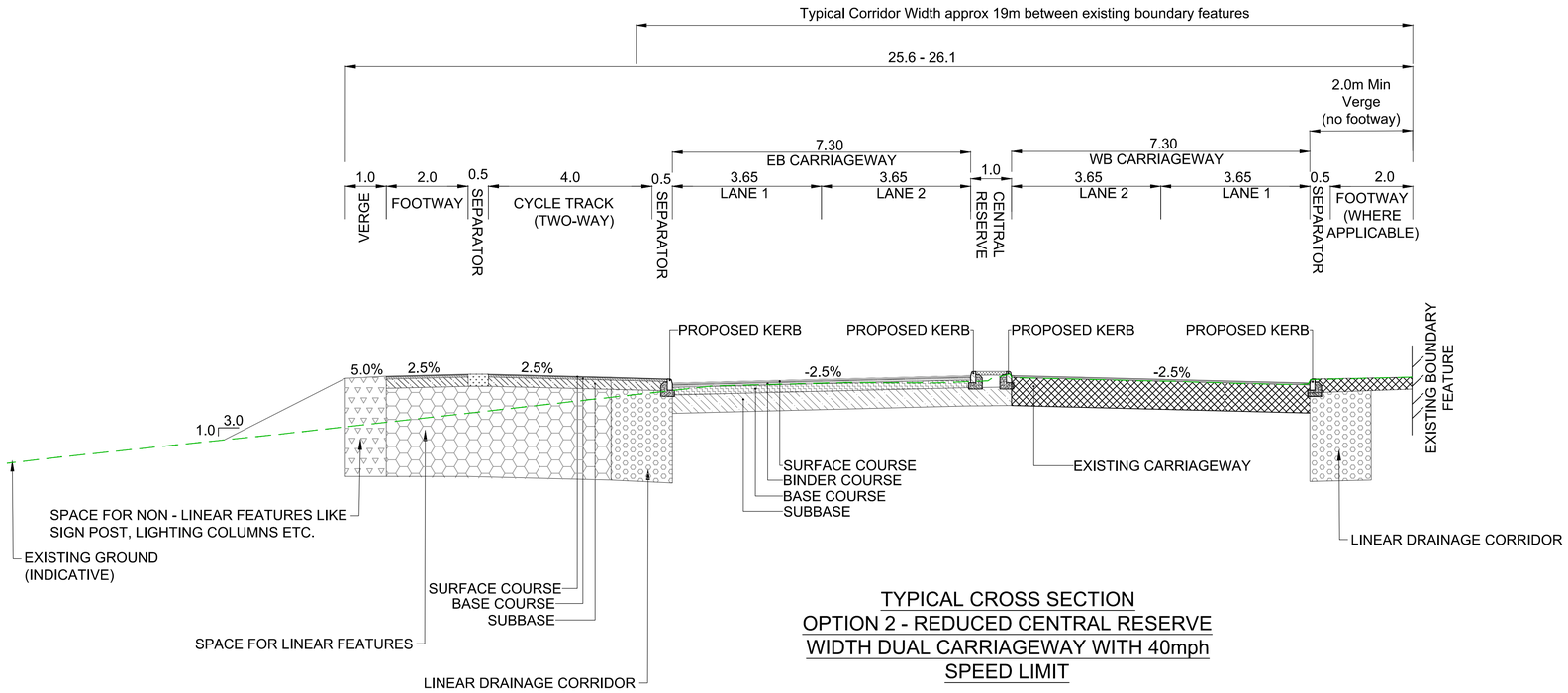
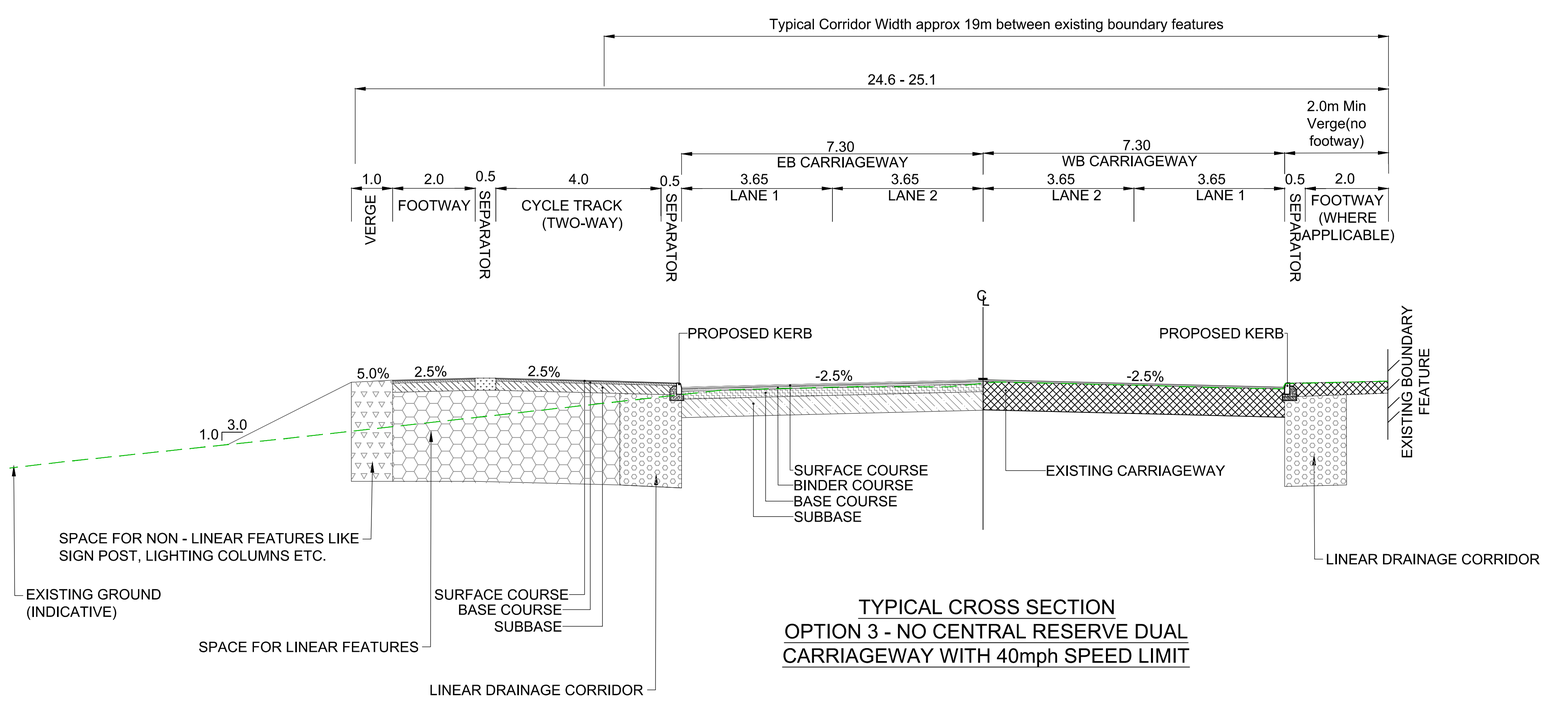


TYPICAL CROSS SECTION
OPTION 2 - REDUCED CENTRAL RESERVE WIDTH DUAL CARRIAGEWAY WITH 40mph SPEED LIMIT



TYPICAL CROSS SECTION
OPTION 3 - NO CENTRAL RESERVE DUAL CARRIAGEWAY WITH 40mph SPEED LIMIT

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. BASED ON TAG UNIT A5.4 - MARGINAL EXTERNAL COSTS, TABLE A6, THESE OPTIONS WOULD HAVE A SUGGESTED AVERAGE CAPACITY OF 1100 PCU PER LANE KM, MAKING OVERALL CAPACITY 2200 PCU PER LANE KM IN EITHER DIRECTION.

Description	Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
First Issue	A1	---	HS	CJ	AM	LJ	17/07/20

Drawing Suitability: APPROVED - PUBLISHED — Status: A1

ATKINS
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Tel : 08000 514514

Client: Gloucestershire County Council

Project Title: M5 J10 Improvements Scheme

Drawing Title: A4019 Typical Cross Section Option 2 & 3

Drawing Number: Project GCCM5J10 - Originator ATK - Volume HML - Location L1_SR - Type SK - Role CH - Number 000005

Original Size: A1 | Scale: NTS | Project Ref. No: 5197035 | Sheet: 1 of 1 | Rev: C01

This Drawing is saved on ProjectWise. Plotted: 20/07/2020 09:57:00 By: SING5990

Appendix B. Coombe Hill Option Drawings

B.1. Option 1 - GCCM5J10-ATK-HML-J5_JN-SK-CH-000001_C01.pdf

B.2. Option 2 - GCCM5J10-ATK-HML-J5_JN-SK-CH-000002_C01.pdf

B.3. Option 3 - GCCM5J10-ATK-HML-J5_JN-SK-CH-000003_C01.pdf

DO NOT SCALE

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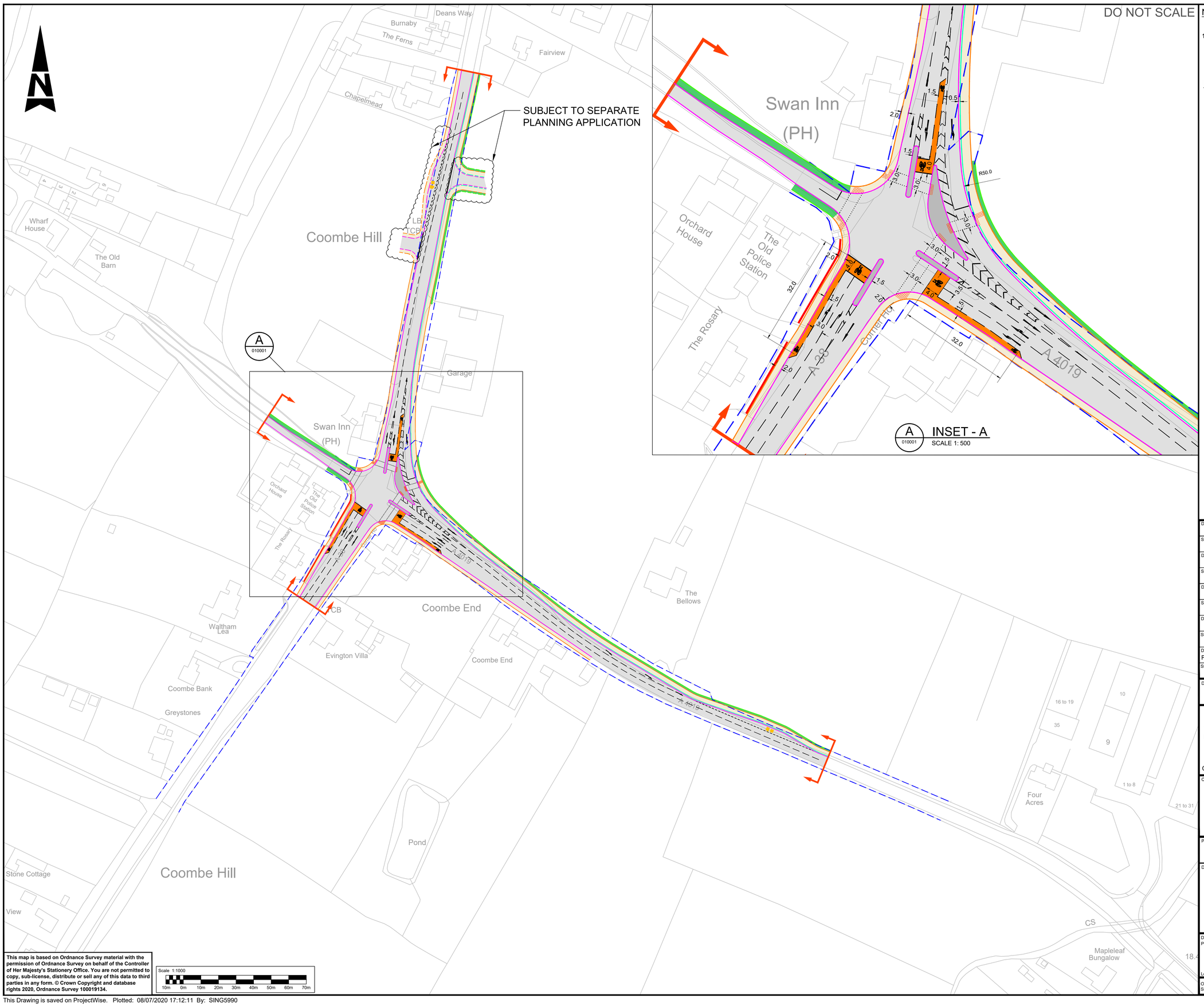

DO NOT SCALE

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.

KEY:

- EXISTING BOUNDARY (TENTATIVE)
- PROPOSED KERB EDGE
- PROPOSED SEPARATOR
- PROPOSED CARRIAGEWAY
- PROPOSED VERGE
- PROPOSED ISLAND
- PROPOSED FOOTPATH
- PROPOSED TACTILE PAVING
- LEAD IN CYCLE LANES
- PROPOSED RETAINING FEATURE
- SITE EXTENTS

Scale 1:1000
10m 0m 10m 20m 30m 40m 50m 60m 70m

Description	Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
First Issue	A1	C01	HS	CJ	AM	LJ	07/07/20

Drawing Suitability: APPROVED - PUBLISHED — Status: A1

ATKINS
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Client: Gloucestershire County Council

Project Title: M5 J10 Improvements Scheme

Drawing Title: COOMBE HILL JUNCTION OPTION -1

Drawing Number
Project: GCCM5J10 - Originator: ATK - Volume: HML -
Location: J5_JN - Type: SK - Role: CH - Number: 000001

Original Size:	Scale:	Project Ref. No:	Sheet:	Rev:
A1	1:1000	5197035	1 of 1	C01

This Drawing is saved on ProjectWise. Plotted: 08/07/2020 17:12:11 By: SING5990

DO NOT SCALE

Millimetres 100 0 10

DO NOT SCALE

Burnaby
Deans Way
The Ferns
Fairview
Chapelmead
Wharf House
The Old Barn
Coombe Hill
LB
TCB
Garage
Swan Inn (PH)
Orchard House
The Old Police Station
The Rosary
Waltham Lea
TCB
Coombe End
Evington Villa
Coombe End
Coombe Bank
Greystones
The Bellows
A 4019
16 to 19
35
10
9
1 to 8
Four Acres
21 to 31
Pond
Coombe Hill
Stone Cottage
View
CS
Mapleleaf Bungalow

A 010001

Swan Inn (PH)
Garage
Orchard House
The Old Police Station
The Rosary
A 4019
Coombe Hill
18.0
1:5 TAPER
43.0
32.0
32.0
15
A 010001 INSET - A
SCALE 1: 500

Scale 1:1000
10m 0m 10m 20m 30m 40m 50m 60m 70m

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.

KEY:

- EXISTING BOUNDARY (TENTATIVE)
- PROPOSED KERB EDGE
- PROPOSED SEPARATOR
- PROPOSED CARRIAGEWAY
- PROPOSED VERGE
- PROPOSED ISLAND
- PROPOSED FOOTPATH
- PROPOSED TACTILE PAVING
- LEAD IN CYCLE LANES
- PROPOSED RETAINING FEATURE
- SITE EXTENTS

Description	Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
First Issue	A1	C01	HS	CJ	AM	LJ	07/07/20

Drawing Suitability: APPROVED - PUBLISHED — Status: A1

ATKINS
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Client: Gloucestershire County Council

Project Title: M5 J10 Improvements Scheme

Drawing Title: COOMBE HILL JUNCTION OPTION -2

Drawing Number: Project GCCM5J10 - Originator ATK - Volume HML - Location J5_JN - Type SK - Role CH - Number 000002

Original Size:	Scale:	Project Ref. No:	Sheet:	Rev:
A1	1:1000	5197035	1 of 1	C01

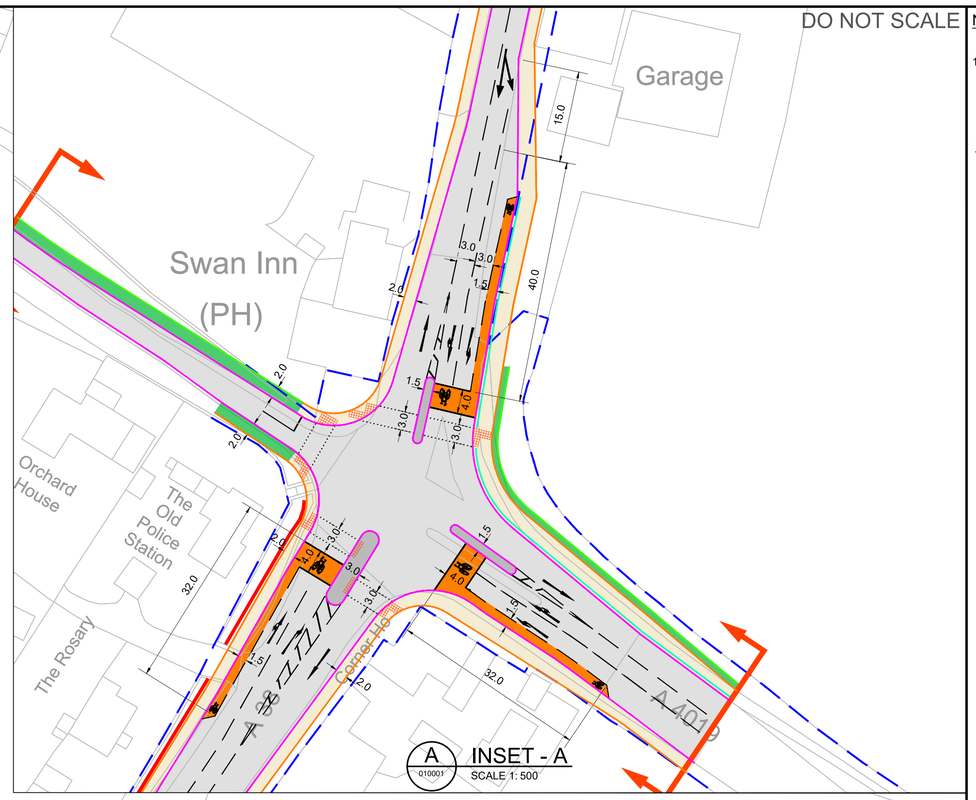
This Drawing is saved on ProjectWise. Plotted: 08/07/2020 17:12:04 By: SING5990

DO NOT SCALE

Millimetres 100 0 10

DO NOT SCALE

Burnaby
Deans Way
The Ferns
Fairview
Chapelmead
Wharf House
The Old Barn
Coombe Hill
LB
TCB
Garage
Swan Inn (PH)
Orchard House
The Old Police Station
The Rosary
Corner Hd
A 4019
A 010001
Waltham Lea
Evington Villa
Coombe End
Coombe Bank
Greystones
The Bellows
Four Acres
16 to 19
35
10
9
1 to 8
21 to 31
Pond
Stone Cottage
View
CS
Mapleleaf Bungalow



NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.

KEY:

- EXISTING BOUNDARY (TENTATIVE)
- PROPOSED KERB EDGE
- PROPOSED SEPARATOR
- PROPOSED CARRIAGEWAY
- PROPOSED VERGE
- PROPOSED ISLAND
- PROPOSED FOOTPATH
- PROPOSED TACTILE PAVING
- LEAD IN CYCLE LANES
- PROPOSED RETAINING FEATURE
- SITE EXTENTS

Scale 1:1000
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This Drawing is saved on ProjectWise. Plotted: 08/07/2020 17:12:25 By: SING5990

Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description	First Issue					
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
A1	C01	HS	CJ	AM	LJ	07/07/20

Drawing Suitability: APPROVED - PUBLISHED
Status: A1

ATKINS
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Client: Gloucestershire County Council

Project Title: M5 J10 Improvements Scheme

Drawing Title: COOMBE HILL JUNCTION OPTION -3

Drawing Number
Project: GCCM5J10 - ATK - HML - J5_JN - SK - CH - 000003
Originator | Volume | Location | Type | Role | Number

Original Size:	Scale:	Project Ref. No:	Sheet:	Rev:
A1	1:1000	5197035	1 of 1	C01

Appendix C. Existing Statutory Utilities Plans

C.1. A4019 – GCCM5J10-ATK-VUT-ZZ-DR-CH-000002_C01.pdf & GCCM5J10-ATK-VUT-ZZ-DR-CH-000005_C01.pdf

C.2. Coombe Hill – GCCM5J10-ATK-VUT-J5_JN-DR-CH-000002_C01.pdf

DO NOT SCALE

Millimetres 0 10 100

FOR CONTINUATION REFER TO SHEET 3

SHELDON NURSERIES

PIFFS ELM INTERCHANGE BRIDGE

PIFFS ELM SERVICE CULVERT

M5 JUNCTION 10

A4019

M5

WITHYBRIDGE LANE

TEWKESBURY ROAD

RIVER CHELT

RIVER CHELT CULVERT

BUTLER'S COURT

FOR CONTINUATION REFER TO SHEET 5

FOR CONTINUATION REFER TO SHEET 1

NOTES:

1. UTILITIES SHOWN ARE DRAWN BASED ON UTILITY SEARCH REPORT (ORDER REFERENCE : 85361)
2. UTILITIES ARE ONLY SHOWN WITHIN THE C2 SEARCH BOUNDARY AREA.

KEY:

TELECOM

- BT OVERHEAD
- BT UNDERGROUND
- TELECOMMUNICATION (ZAYO.)
- CITY FIBRE
- GIGACLEAR ROUTE
- NRTS DUCT OR CABLE ROUTE (NRTS)
- TELECOMMUNICATION (VIRGIN MEDIA)

WATER

- SEVERN TRENT WATER DISTRIBUTION MAIN
- SEVERN TRENT PUBLIC FOUL GRAVITY SEWER

GAS

- GAS HIGH PRESSURE UNDERGROUND (W&WU)
- GAS MEDIUM PRESSURE UNDERGROUND (W&WU)
- GAS LOW PRESSURE UNDERGROUND (W&WU)

POWER

- WPD HV 132KV OVERHEAD LINES
- WPD HV 11KV OVERHEAD LINES
- WPD LOW VOLTAGE SUPPLY UNDERGROUND
- WPD SERVICE LINE OVERHEAD
- WPD SERVICE LINE UNDERGROUND
- WPD HV 11KV SUPPLY UNDERGROUND
- WPD LOW VOLTAGE SUPPLY OVERHEAD LINES

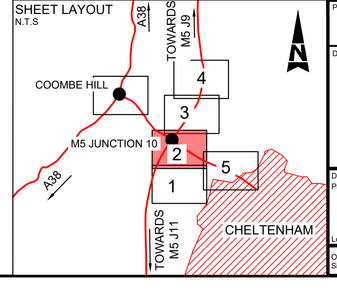
OTHER

- C2 SEARCH BOUNDARY EXTENT

Scale 1:2500

50m 0m 50m 100m 150m

SHEET LAYOUT
N.T.S



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks (Reference shall also be made to the design hazard log).

Construction

Maintenance / Cleaning

Use

Decommissioning / Demolition

Description	Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
First Issue	A1	C01	HS	CG	AM	LJ	24/07/20

Drawing Suitability: APPROVED - PUBLISHED

Status: A1

ATKINS
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Shire Hall
Bearland
Gloucester
GL1 2TH
Tel : 08000 514514

Client: Gloucestershire County Council

Project Title: M5 J10 Improvements Scheme

Drawing Title: M5 J10 & A4019
EXISTING UTILITES PLAN

Drawing Number
Project: GCCM5J10 - ATK - VUT - ZZ - DR - CH - 000002
Originator | Volume | Location | Type | Role | Number

Original Size: A1 | Scale: 1:2500 | Project Ref. No: 5197035 | Sheet: 2 of 5 | Rev: C01

This Drawing is saved on ProjectWise. Plotted: 24/07/2020 19:00:56 By: LATA7335

Millimetres 0 10 100

DO NOT SCALE

FOR CONTINUATION REFER TO SHEET 2

UCKINGTON

A4019

TEWKESBURY ROAD

RIVER CHELT

ARLE NURSERY

OLD GLOUCESTER ROAD

B4634

Uckington

Track

Chestnut Farm

Uckington Baptist Church

Uckington Farm

Pigeon Farm

Hall

Old Cart Barn

The Stables

The Grange

The Old Dairy

Little Orchard

Sports Facility

Balancing Pond

Gallagher Retail Park

Scale 1:2500

50m 0m 50m 100m 150m

KEY:

TELECOM

- BT-OH — BT OVERHEAD
- BT-UG — BT UNDERGROUND
- COMMS — TELECOMMUNICATION (ZAYO.)
- CF — CITY FIBRE
- GIGA — GIGACLEAR ROUTE
- NRTS DUCT OR CABLE ROUTE (NRTS)
- VG — TELECOMMUNICATION (VIRGIN MEDIA)

WATER

- WATER — SEVERN TRENT WATER DISTRIBUTION MAIN
- SEWER — SEVERN TRENT PUBLIC FOUL GRAVITY SEWER

GAS

- GAS-HP — GAS HIGH PRESSURE UNDERGROUND (W&WU)
- GAS-MP — GAS MEDIUM PRESSURE UNDERGROUND (W&WU)
- GAS-LP — GAS LOW PRESSURE UNDERGROUND (W&WU)

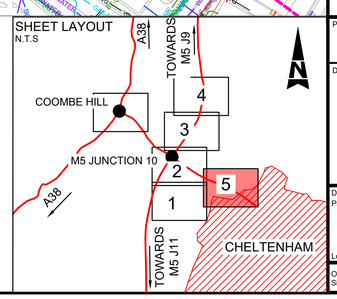
POWER

- 132KV-OH — WPD HV 132KV OVERHEAD LINES
- 11KV-OH — WPD HV 11KV OVERHEAD LINES
- LV-UG — WPD LOW VOLTAGE SUPPLY UNDERGROUND
- WPD SERVICE LINE OVERHEAD
- WPD SERVICE LINE UNDERGROUND
- 11KV-UG — WPD HV 11KV SUPPLY UNDERGROUND
- LV-OH — WPD LOW VOLTAGE SUPPLY OVERHEAD LINES

OTHER

- C2 SEARCH BOUNDARY EXTENT

SHEET LAYOUT
N.T.S



NOTES:

1. UTILITIES SHOWN ARE DRAWN BASED ON UTILITY SEARCH REPORT (ORDER REFERENCE : 85361)
2. UTILITIES ARE ONLY SHOWN WITHIN THE C2 SEARCH BOUNDARY AREA.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks (Reference shall also be made to the design hazard log).

Construction

Maintenance / Cleaning

Use

Decommissioning / Demolition

Description	Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
First Issue	A1	C01	HS	CG	AM	LJ	24/07/20

Drawing Suitability: APPROVED - PUBLISHED — Status: A1

ATKINS
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Gloucester
GL1 2TH
Tel : 08000 514514

Client: Gloucestershire County Council

Project Title: M5 J10 Improvements Scheme

Drawing Title: M5 J10 & A4019
EXISTING UTILITES PLAN

Drawing Number
Project: GCCM5J10 - ATK - VUT - ZZ - DR - CH - 000005
Originator | Volume | Location | Type | Role | Number

Original Size: A1 | Scale: 1:2500 | Project Ref. No: 5197035 | Sheet: 5 of 5 | Rev: C01

DO NOT SCALE

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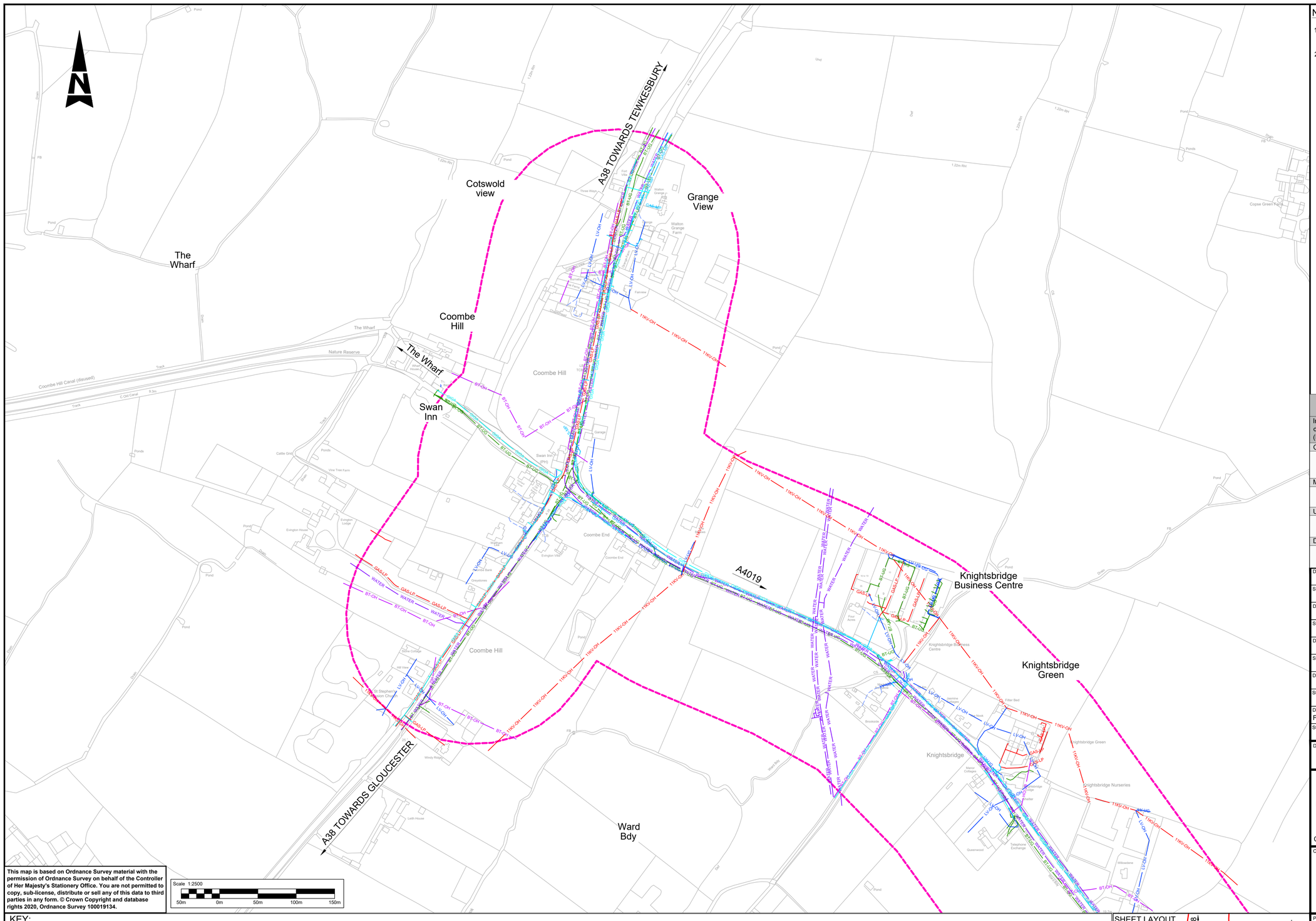

NOTES:

1. UTILITIES SHOWN ARE DRAWN BASED ON UTILITY SEARCH REPORT (ORDER REFERENCE : 85360)
2. UTILITIES ARE ONLY SHOWN WITHIN THE C2 SEARCH BOUNDARY AREA.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks (Reference shall also be made to the design hazard log).

Construction

Maintenance / Cleaning

Use

Decommissioning / Demolition

Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
First Issue						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
A1	C01	HS	CG	AM	LJ	24/07/20

Drawing Suitability: APPROVED - PUBLISHED — Status: A1

ATKINS
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Bearland
Gloucester
GL1 2TH
Tel : 08000 514514

Client: Gloucestershire County Council

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Scale 1:2500
50m 0m 50m 100m 150m

KEY:

TELECOM

- BT-OH BT-OH — BT OVERHEAD
- BT-UG BT-UG — BT UNDERGROUND
- GIGA GIGA — GIGACLEAR ROUTE

WATER

- WATER WATER — SEVERN TRENT WATER DISTRIBUTION MAIN

GAS

- GAS-MP — GAS MEDIUM PRESSURE UNDERGROUND (W&WU)
- GAS-LP GAS-LP — GAS LOW PRESSURE UNDERGROUND (W&WU)

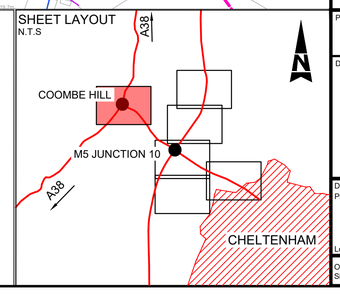
POWER

- 11KV-OH — WPD HV 11KV OVERHEAD LINES
- LV-UG LV-UG — WPD LOW VOLTAGE SUPPLY UNDERGROUND
- WPD SERVICE LINE UNDERGROUND
- 11KV-UG — WPD HV 11KV SUPPLY UNDERGROUND
- LV-OH LV-OH — WPD LOW VOLTAGE SUPPLY OVERHEAD LINES

OTHER

- C2 SEARCH BOUNDARY EXTENT

SHEET LAYOUT N.T.S



Project Title: M5 J10 Improvements Scheme

Drawing Title: COOMBE HILL EXISTING UTILITES PLAN

Drawing Number

Project	Originator	Volume	Location	Type	Role	Number
GCCM5J10	ATK	VUT	J5_JN	DR	CH	000002

Original Size:	Scale:	Project Ref. No:	Sheet:	Rev:
A1	1:2500	5197035	1 of 1	C01

This Drawing is saved on ProjectWise. Plotted: 24/07/2020 18:50:46 Bv: LATA7335

Appendix D. Technical Note – A4019/A38: Coombe Hill Junction Traffic Signal Model

D.1. GCCM5J10-ATK-HTS-CHJNC-TN-CH-000001

Technical Note

Project:	M5 J10 Improvements		
Subject:	A4019/A38: Coombe Hill Junction		
Author:	Jake Lettin		
Date:	17/07/2020	Project No.:	5197035
Distribution:	Lars Jorgensen Christopher Roberts	Representing:	Atkins Atkins

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	For Information	JL	MT			26/06/20
Rev 1.1	For Information	JL	MT			07/07/20
Rev 1.2	For information	JL	MT	AEM	LJ	17/07/20

Introduction

This technical note details the work undertaken to create a traffic signal model of A4019/A38 "Coombe Hill" junction, Cheltenham, and analyses the outputs to inform on junction arrangements. Various junction arrangements were evaluated to determine the best plan going forwards.

Junction Turning Count Calculation

Surveyed flows for the junction were provided by Tracsis, as measured on 30/04/2019. The data was supplied as Origin/Destination flows in 15-minute intervals from 07:00 – 19:00. To determine the AM and PM peak flows to be used for modelling, hourly flows were calculated across the entire time period (07:00-08:00, 07:15-08:15 etc), and the highest total flows were used for the **'Surveyed'** AM and PM peaks.

Flows and turning counts were also taken from Atkins' Saturn model. These flows included 2013 base model flows, 2041 Do-Minimum flows and 2041 Option 2 Flows. Since Saturn is a strategic model and works on a much larger scale than individual junctions, it is assumed that the surveyed flows are a more accurate representation of the current conditions than the base model. However, the base model flows **'Model 2013 Flows'** are also considered as a sensitivity analysis, to ensure that the junction can effectively operate under a range of scenarios.

The flows for the **'2041 DM'** and **'2041 Option 2'** scenarios were calculated by scaling the surveyed flows, relative to the base flows:

$$2041\ Flow = Surveyed\ Flow \times \frac{2041\ Model\ Flow}{Base\ Model\ Flow}$$

These flows were then converted to turning counts using the turning count ratios provided in the Saturn model.

Altogether, this led to the development of 4 different scenarios, each with AM and PM peak flows:

- Surveyed (2019) Flows
- Base Model (2013) Flows
- 2041 Do Minimum (DM) Flows
- 2041 Option 2 (Opt 2) Flows

The resulting flow matrices are listed below. Values in green are reductions from the surveyed flows, where red values are increased:

Surveyed (2019) Flows

AM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	576	266	0
A4019 (B)	258	0	188	2
A38 Westbound (C)	325	457	0	0
The Wharf (D)	0	0	0	0

PM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	271	313	2
A4019 (B)	472	0	333	5
A38 Westbound (C)	314	312	0	0
The Wharf (D)	0	0	0	0

Base Model (2013) Flows

AM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	321	404	0
A4019 (B)	225	0	234	0
A38 Westbound (C)	397	413	0	0
The Wharf (D)	0	0	0	0

PM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	256	447	0
A4019 (B)	396	0	355	0
A38 Westbound (C)	335	254	0	0
The Wharf (D)	0	0	0	0

2041 Do Minimum Model Flows

AM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	439	455	0
A4019 (B)	234	0	184	0
A38 Westbound (C)	191	354	0	0
The Wharf (D)	0	0	0	0

PM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	213	335	0
A4019 (B)	407	0	395	0
A38 Westbound (C)	184	306	0	0
The Wharf (D)	0	0	0	0

2041 Option 2 Model Flows

AM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	353	582	0
A4019 (B)	214	0	219	0
A38 Westbound (C)	207	410	0	0
The Wharf (D)	0	0	0	0

PM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	181	298	0
A4019 (B)	403	0	413	0
A38 Westbound (C)	214	425	0	0
The Wharf (D)	0	0	0	0

Since traffic flows in and out of The Wharf are in single figures, all scenarios have been modelled without The Wharf approach receiving a green light.

Listed below are the traffic flows associated with 2041 Option 1 Model Flows, which are not modelled as Option 1 is no longer being considered.

2041 Option 1 Model Flows

AM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	266	227	0
A4019 (B)	456	0	422	0
A38 Westbound (C)	473	210	0	0
The Wharf (D)	0	0	0	0

PM Peak				
Origin \ Destination	A	B	C	D
A38 Eastbound (A)	0	447	210	0
A4019 (B)	260	0	348	0
A38 Westbound (C)	408	434	0	0
The Wharf (D)	0	0	0	0

Junction Layouts

All flow scenarios detailed above were incorporated into Linsig models representing Coombe Hill junction. The models investigated were as follows:

- Existing junction layout
- Layout 1 – Based on Drawing **GCCM5J10-ATK-HGN-J5_JN-SK-CH-000002**
- Layout 2 – Based on Drawing **GCCM5J10-ATK-HGN-J5_JN-SK-CH-000003**
- Layout 3 – Based on Drawing **GCCM5J10-ATK-HGN-J5_JN-SK-CH-000004**

Existing junction layout

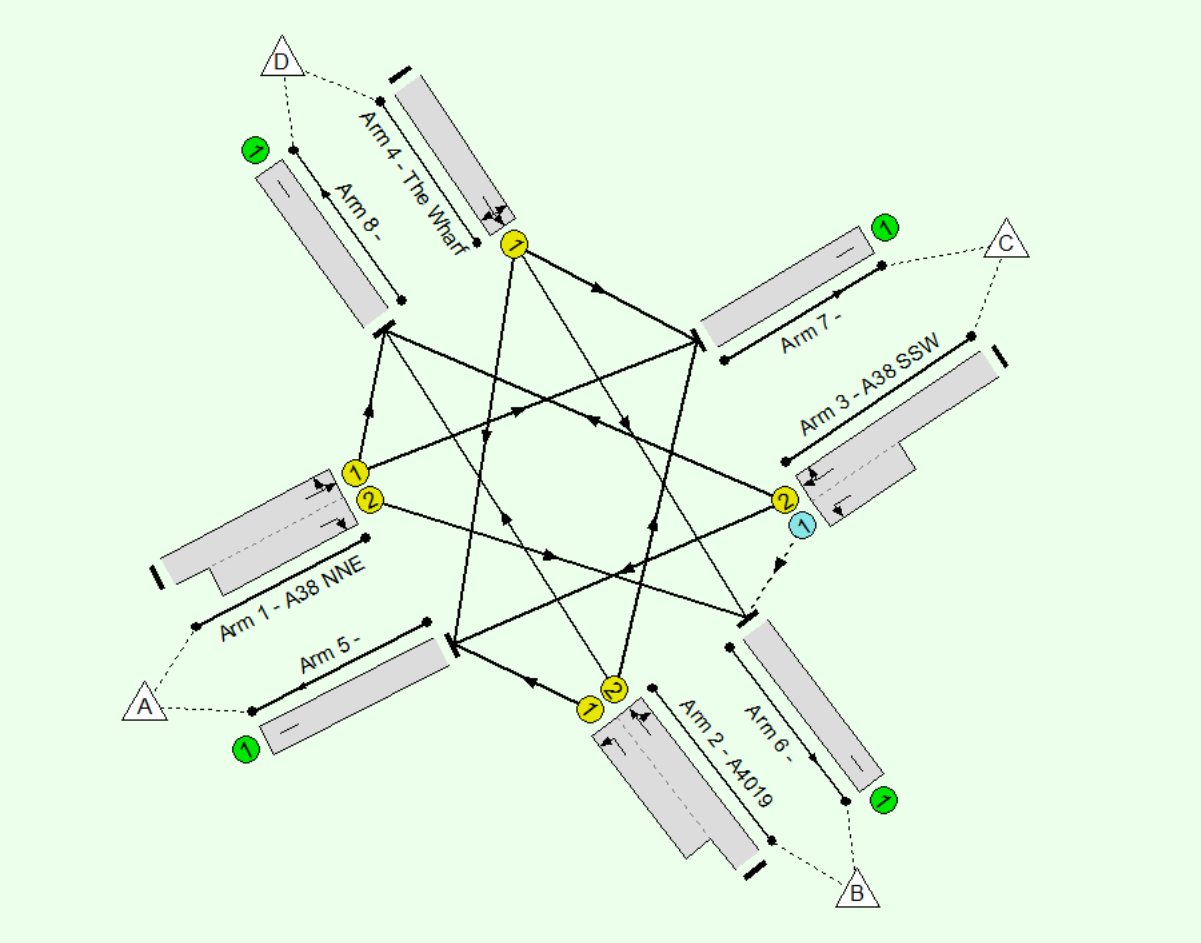


Figure 1 - Linsig model layout of existing junction

As can be seen above, the existing junction has been modelled with the lane allocations as they currently are. Approaching the junction from the south west (Zone A), Arm 1 Lane 1 is used for ahead and left movements, and Arm 1 Lane 2 is used to turn right. From the A4019 (Zone B), Arm 2 Lane 1 is used to turn left, and Arm 2 Lane 2 is used for ahead and right movements. Approaching from the north east (Zone C), Arm 3 Lane 1 is used to turn left and is not signalised. Arm 3 Lane 2 is used for ahead and right movements. From The Wharf (Zone D), all movements originate from a single lane.

The junction currently operates using 4 stages, as shown below:

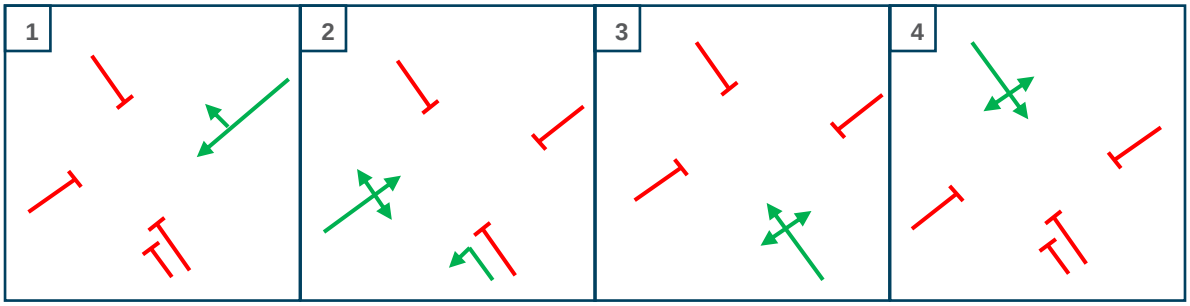


Figure 2 - Staging Diagram for existing junction layout

Layout 1

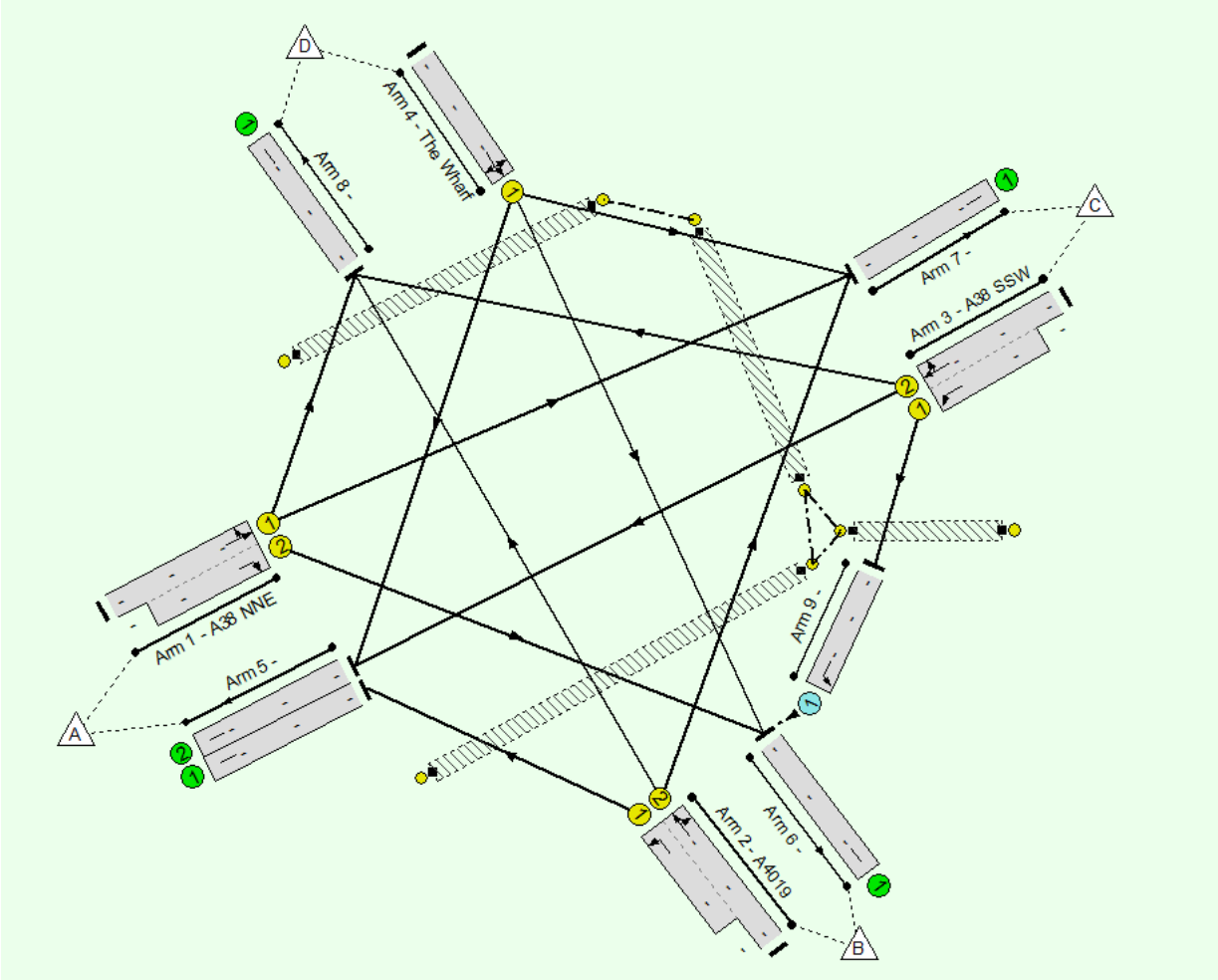
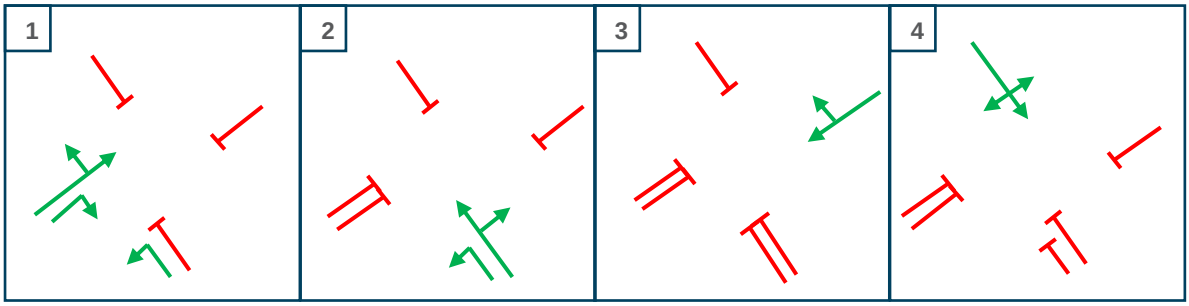


Figure 3 - Linsig model of Layout 1

Layout 1 has the same lane allocations as the existing layout. However, pedestrian facilities are provided across the A4019, The Wharf and the A38 Eastern arm. Additionally, a crossing across the left turn (A38 to A4019) is provided, which runs independently of the rest of the junction. The junction would operate differently depending on whether pedestrian demand exists. The junction has therefore been modelled with demands for all pedestrian movements, as well as for none, providing a 'best case' and 'worst case' scenario from a capacity perspective.

Without pedestrian demands



With pedestrian demands

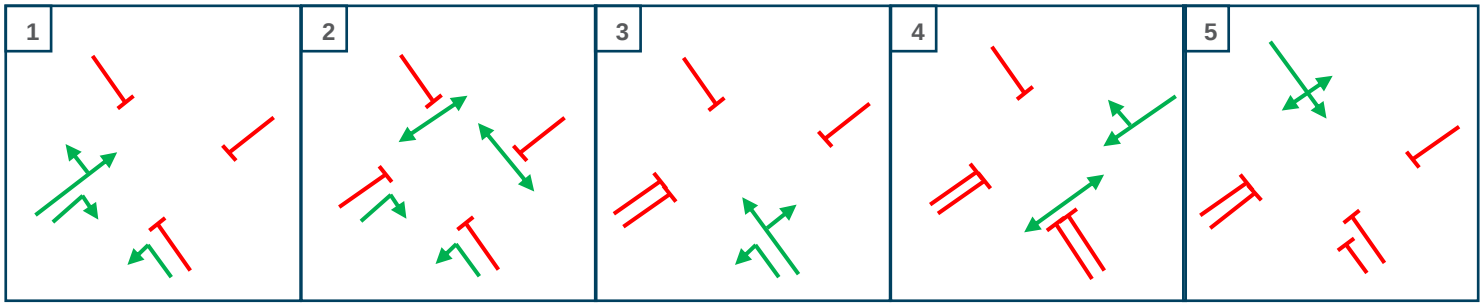


Figure 4 - Staging Diagrams for Layout 1

Layout 2

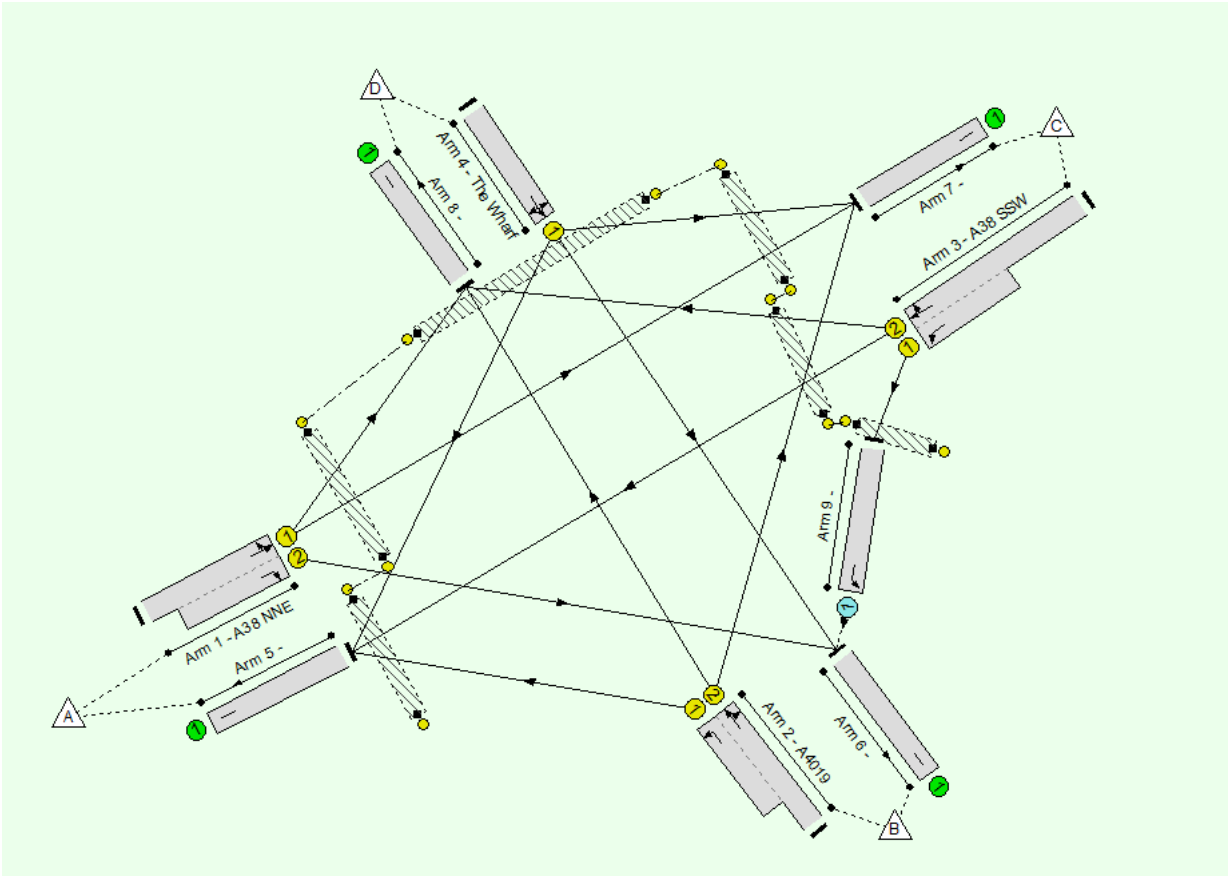
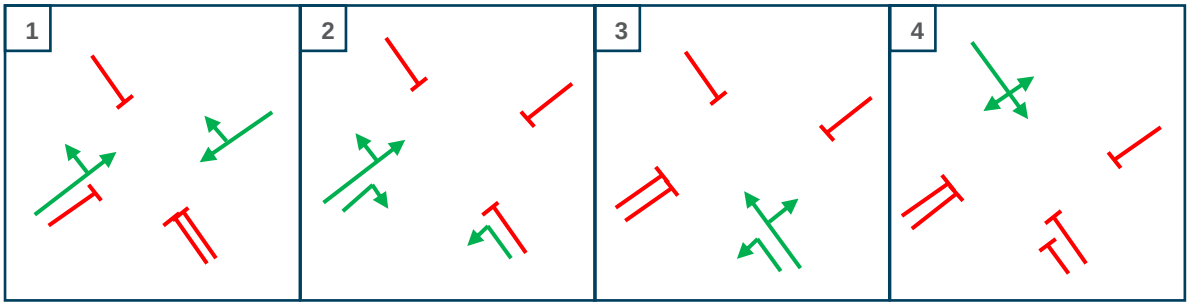


Figure 5 - Linsig model of Layout 2

Layout 2 also uses the same lane allocations as the existing layout, and also provides pedestrian facilities. However, rather than an A4019 crossing, both A38 arms have pedestrian facilities. These facilities are staggered crossings whereas Layout 1 utilises 'straight across' crossings. The staggered crossings have significant advantages; the pedestrians can be run separately for the entry and exits of each arm, and the time required for pedestrians to cross is shorter meaning that more green time can be given to vehicular traffic. As with Layout 1, the staging of this layout will depend on whether pedestrian demand exists:

Without pedestrian demands



With pedestrian demands

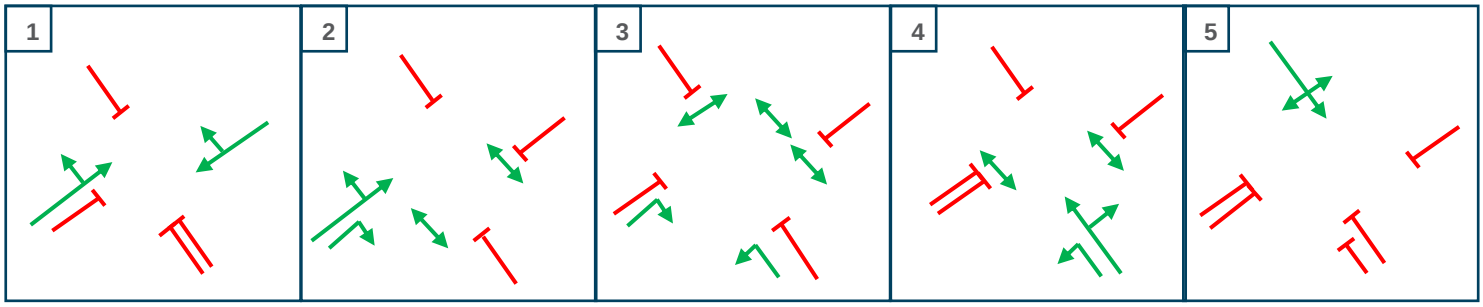


Figure 6 – Staging Diagrams for Layout 2

Layout 3

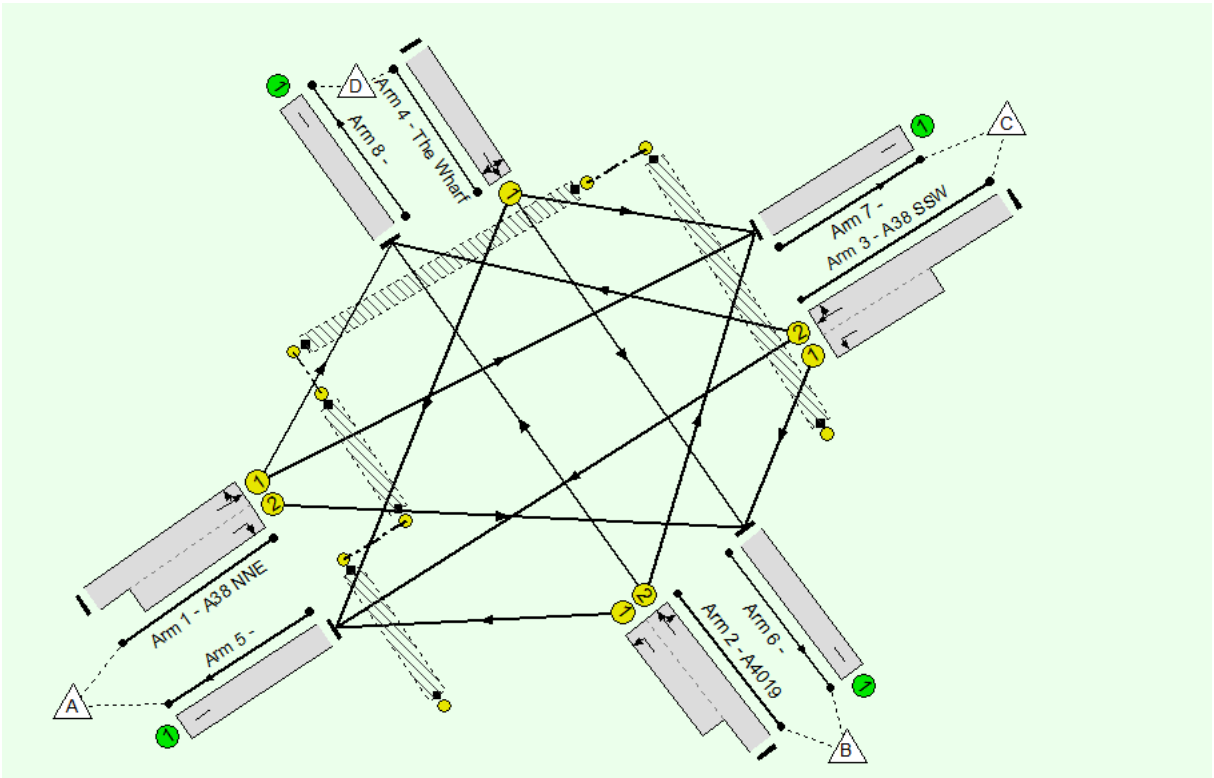
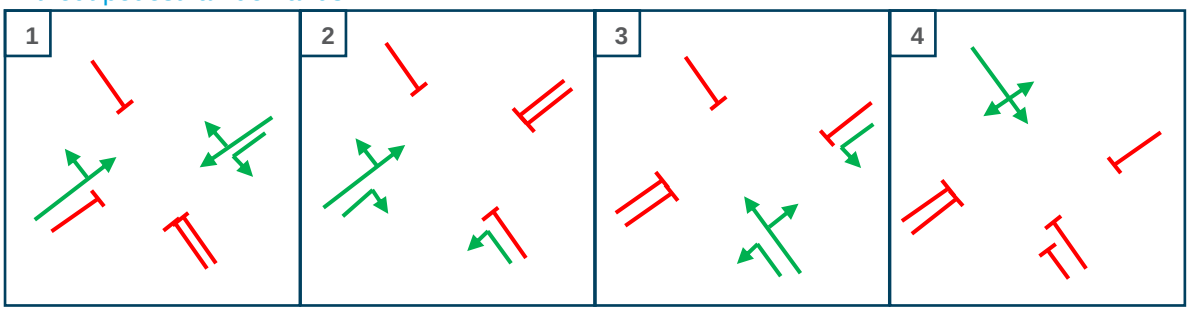


Figure 7 – Linsig model of Layout 3

Layout 3 is more like a traditional crossroad layout, with the left turn from the A38 onto the A4019 being signalised. This option would require the least space, potentially unlocking areas currently being used as road space for footpaths and landscaping, therefore reducing the carbon footprint and biodiversity net loss of the junction. It also has potential to facilitate pedestrian facilities across the A38 on the Western arm, though the current staging arrangement for this layout does not have provisions for crossing the A4019.

As with the previous layouts, the staging of this junction will depend on whether pedestrian demand exists. The staging arrangements for both scenarios are shown below:

Without pedestrian demands



With pedestrian demands

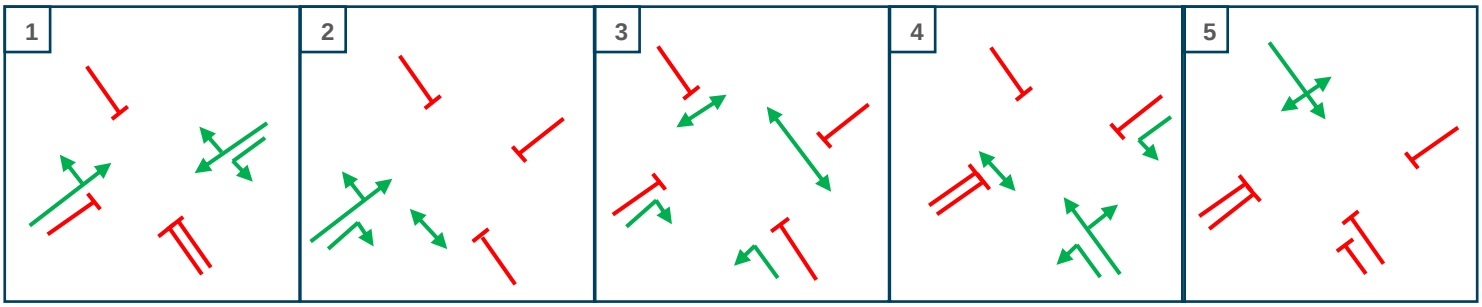


Figure 8 – Staging Diagrams for Layout 3

Results and Analysis

The outputs of the Linsig modelling are listed below. The measurables are:

- Passenger Reserve Capacity (PRC): A measure of how much spare capacity the junction has, as a percentage. If the junction has a PRC **above 0,** the junction is within capacity and has room for an increase in vehicles. If the PRC is **below 0,** the junction cannot operate without causing major delays.
- Delay: A measure of how much delay is expected at the junction. This is measured as PCU hours per hour and should be minimised. Delay is best employed to compare junction options against each other but can provide an average delay per vehicle. This is calculated by dividing the delay by the total number of vehicular flows. For example, if the delay was 10 PCUhr/hr and the total number of flows was 2000 vehicles per hour, the average delay per vehicle would be 0.005 hours, or 18 seconds.

Where the modelling suggests that there is lots of spare capacity, this suggests that the delay would in reality be less than the model suggests as the junction would run a reduced cycle time. In each scenario, and with each flow group, the same cycle time of 70 seconds has been used, in order to effectively compare the layouts. Results are given below for each flow group and each layout **without any pedestrian demands:**

Surveyed (2019) Flows

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	9.3	14.58	25.5	12.67
Layout 1 (without pedestrians)	5.0	16.84	19.7	13.25
Layout 2 (without pedestrians)	15.6	**13.05**	26.7	11.43
Layout 3 (without pedestrians)	**18.2**	13.17	**28.9**	**11.18**

Base Model (2013) Flows

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	16.8	13.98	13.2	14.98
Layout 1 (without pedestrians)	25.2	12.75	14.5	14.97
Layout 2 (without pedestrians)	24.7	10.91	24.5	11.46
Layout 3 (without pedestrians)	**27.9**	**10.78**	**26.7**	**11.12**

2041 DM Model Flows

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	44.1	8.71	36.0	9.72
Layout 1 (without pedestrians)	33.3	9.60	28.8	10.62
Layout 2 (without pedestrians)	54.4	**7.62**	41.1	8.63
Layout 3 (without pedestrians)	**57.2**	8.40	**47.3**	**8.55**

2041 Option 2 Model Flows

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	23.9	10.48	28.2	10.45
Layout 1 (without pedestrians)	25.3	10.80	27.4	10.75
Layout 2 (without pedestrians)	56.8	**8.20**	39.6	8.78
Layout 3 (without pedestrians)	**59.5**	8.70	**42.6**	**8.53**

Without pedestrian demands, all junction layouts run within capacity with all flow scenarios. Additionally, all flow scenarios indicate that the best performance is seen with Layouts 2 and 3, whereas performance with Layout 1 is comparable to the existing layout.

Listed below are the results for Layouts 1-3 when pedestrian movements occur every cycle. This represents the 'worst case scenario' in terms of vehicular capacity. The results are compared with the existing arrangement for reference; note that the **existing junction layout does not have pedestrian facilities** and for this reason the best performing option from Layouts 1-3 is highlighted.

Surveyed Flows

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	9.3	14.58	25.5	12.67
Layout 1 (with pedestrians)	-8.6	33.85	2.0	20.52
Layout 2 (with pedestrians)	9.3	15.79	8.2	14.58
Layout 3 (with pedestrians)	**12.5**	**15.78**	**11.3**	**14.03**

Base Model (2013) Flows

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	16.8	13.98	13.2	14.98
Layout 1 (with pedestrians)	-4.2	24.97	-12.0	50.98
Layout 2 (with pedestrians)	6.6	14.45	4.6	16.81
Layout 3 (with pedestrians)	**12.4**	**13.45**	**7.9**	**16.75**

2041 DM Model Flows

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	44.1	8.71	36.0	9.72
Layout 1 (with pedestrians)	12.9	13.71	0.7	18.15
Layout 2 (with pedestrians)	46.2	**10.19**	13.1	12.19
Layout 3 (with pedestrians)	**49.1**	10.82	**19.3**	**12.01**

2041 Option 2 Model Flows

Layout	AM Peak		PM Peak	
	PRC (%)	Delay (PCUhr/hr)	PRC (%)	Delay (PCUhr/hr)
Existing junction layout (without pedestrians)	23.9	10.48	28.2	10.45
Layout 1 (with pedestrians)	-7.7	28.09	-0.2	19.98
Layout 2 (with pedestrians)	24.8	**11.75**	6.0	13.26
Layout 3 (with pedestrians)	**25.3**	11.93	**12.1**	**12.95**

When pedestrian stages are included in the staging arrangement, there is a slight increase in delay when compared with the existing layout. However, it is worth noting that the junction still runs with spare capacity in all of these scenarios for Layouts 2 and 3, and that the existing junction provides no facilities for pedestrians. Layout 1, however, has a negative PRC in several scenarios and as such should be discounted.

The modelling above suggests a 'worst case' scenario, in which pedestrian demands exist during every cycle. This would suggest a pedestrian would use the push button every 70 seconds. In reality, it is more likely that the PRC and delay of the junction would lie somewhere between the 'pedestrian' and 'no pedestrian' scenarios for the proposed layouts, depending on the frequency of pedestrian demands.

For all layouts, the length of Arm 3, Lane 1 is represented in the Linsig model as 40m, as shown in the drawing. However, increased performance can be seen when increasing this length to 50m.

A comparison between Layouts 2 and 3 identifies that there is slightly better performance for Layout 3 in the 2041 scenarios. Layout 2, however, has the benefit of providing staggered pedestrian crossings on the Eastern A38 arm. Additionally, the crossing across the A38 to A4019 left turn lane runs independently of the rest of the junction, so left turning traffic would only be halted when pedestrian demands existed. With Layout 3, the left turning traffic shares a stop line with the ahead/right traffic and will be held back more often. There are also other considerations that should be taken into account. Some factors are listed below:

- Construction costs: Layout 2 would most likely have a higher construction cost, as the area of the junction is larger.
- Futureproofing: Since it has a larger area, Layout 2 would have more scope for modifications in the future, if traffic conditions were to deviate greatly from the modelled flows.
- Land Take: Since the area of Layout 3 is smaller, the required land take would be smaller. The left turn from the A38 onto the A4019 is also much closer to the junction with Layout 3, where Layout 2 would require more land take for this movement.
- Environmental Impact: The environmental impact of all potential layouts should be assessed. The layout with the least impact would be to retain the current layout, as the production of concrete is an energy intensive process. However, this benefit may well be offset since the current junction layout does not provide opportunities for pedestrians. Layout 3 could also provide opportunities for improved biodiversity due to the smaller junction footprint freeing up land.
- Walking/Cycling: Layout 2 provides the best crossing facilities, with staggered crossings on both arms of the A38. Layout 3, however, does still provide facilities, which could be staggered. In addition, it potentially frees up space for better footways. Demand for pedestrians and cyclists should be investigated to determine the best layout. The pedestrian facilities across the Western arm of the A38 should have particular attention, as there is possibility for intervisibility issues between stop lines. A more appropriate solution could be to provide pedestrian facilities across the A4019 instead.

Conclusion

Layouts 2 and 3 provide improved performance on the current layout when there is an absence of pedestrian demands. When pedestrian demands are introduced each cycle, the performance drops, and there is slightly more delay than the current layout. In reality, the junction performance will lie somewhere between these limits depending on the frequency of demands. Overall this indicates that Layouts 2 and 3 will provide comparable performance to the current arrangement, while also providing pedestrian facilities.

Layout 3 provides the best performance from a traffic perspective. However, as mentioned above there are many factors that should be considered and prioritised. It is recommended that either junction be carried forward to be further developed. Assessment of public opinion and pedestrian demand could further inform on the preferred option, as well as preference from GCC and local stakeholders.

The proposed layout provides formal crossing facilities, enabling pedestrians to access all sides of the junction. Subject to consultation the pedestrian crossings on the southern side of the A38 could be removed. This would increase the efficiency of the junction for vehicular traffic and provide improved junction inter-visibility.

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