

A428 Black Cat to Caxton Gibbet improvements

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9.10 Junction Modelling Technical Note

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Author	A428 Black Cat to Caxton Gibbet Improvements Project Team, Highways England

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6 Background

- 6.1.1 At the Local Technical Review Group (LTRG) meeting on 10 June 2021, Cambridgeshire County Council (CCC) requested clarification regarding the junction modelling approach undertaken to support the Development Consent Order (DCO) application. This is also referred to in CCC's Relevant Representation [RR-013].
- 6.1.2 CCC has questioned why base models were not developed for all of the junctions assessed and why all the junction models were not calibrated and validated for the base year; and instead, all traffic flows were taken directly from the forecast strategic model.
- 6.1.3 This note sets out the reasons for the approach taken in the local junction modelling to assess the impacts of the Scheme, which are described in the Transport Assessment [APP-241 to APP-242]/ Transport Assessment Annex [APP-243], and have been submitted as part of the DCO application.

6.2 Classification of Junctions

- 6.2.1 This Technical Note provides a response to the questions from CCC regarding the junction modelling methodology. The reasons for base models not being developed as part of the assessment of some junctions, and why existing survey data was not considered in the process of deriving forecast demand for some locations are outlined, and the implications of this approach are analysed.
- 6.2.2 The junctions have been separated into three categories for the purposes of this Technical Note:
- Junctions which do not exist in the base year, or where there are fundamental changes in layout: referred to as '**Scheme junctions**'.
 - Junctions which do exist in the base year and are not significantly changed by the Scheme, but where no base models were developed: referred to as '**existing junctions with no calibrated/ validated base models**'.
 - Junctions which do exist in the base year and are not significantly changed by the Scheme, but where observed data was available and base models were developed: referred to as '**existing junctions with calibrated/ validated base models**'.
- 6.2.3 The junctions discussed in this Technical Note are shown on a map in **Figure 6-1**.

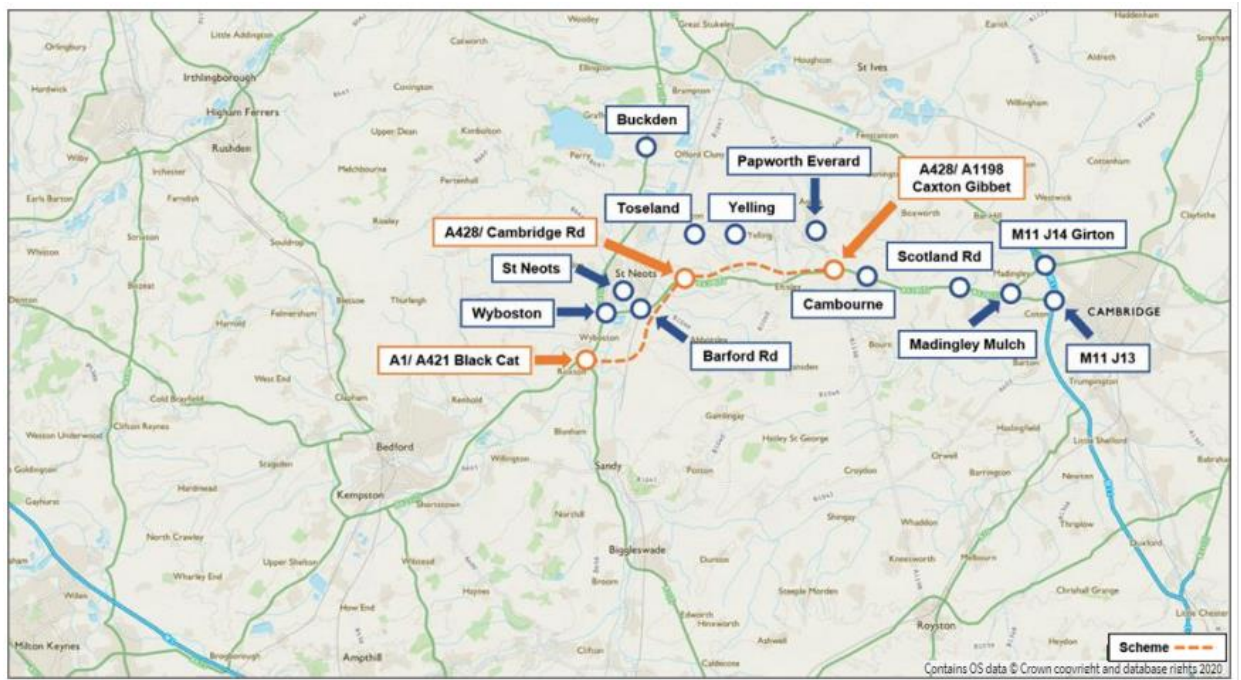


Figure 6-1 –Junction Models - Cambridgeshire

6.3 Scheme junctions

6.3.1 The Scheme includes design improvements at five main junctions:

- a. Black Cat (A1/A421/New dual carriageway) – Vissim model developed.
- b. Caxton Gibbet (A428/A1198 Ermine Street) – Vissim model developed.
- c. Cambridge Road (A428/Cambridge Road) – Vissim model developed.
- d. B1046/ Potton Road junction - PICADY model developed.
- e. The two proposed roundabouts collectively known as the Eltisley Link - ARCADY models developed.

6.3.2 Microsimulation (Vissim) modelling has been carried out to assess the proposed layouts for the three key Scheme junctions (Black Cat, Caxton Gibbet and Cambridge Road junctions) and assessed the operational performance of the Scheme design in the AM and PM peak hours for the 2025 opening and 2040 design years. Vissim models were developed for these junctions, as the complexity of the layouts and importance of these junctions required a detailed assessment.

- 6.3.3 The approach to developing the Vissim models for these junctions is documented in Technical Note 44 – Vissim Modelling - Stage 3 Scheme Junctions (included as an appendix to the Transport Assessment [APP-241 to APP-242]). Part 2 of the Transport Assessment and TN 44 [APP-242] formed part of Highways England's Stage 3 process for preparation of the Development Consent Order (DCO) application for the proposed Scheme.
- 6.3.4 The B1046/Potton Road and Eltisle Link junctions were modelled in PICADY and ARCADY respectively and the modelled approach is documented in the Transport Assessment [APP-241 to APP-242].
- 6.3.5 The base year models were not developed for these five locations, as the junction layouts will change fundamentally between the base year (i.e. its current form) and what has been proposed for the Scheme; which will completely change the traffic operations at these junctions.
- 6.3.6 These junctions were tested, using a standard approach with forecast flows extracted directly from SATURN, as the Scheme led to significant re-routing, and fundamental changes to the layouts meant that the existing traffic flow characteristics at these junctions are not relevant in the forecast years.
- 6.3.7 CCC has also questioned why survey data was not used in the process of deriving the forecast year demand, rather than this being directly taken from SATURN. CCC also noted that HGV flows in the models were taken directly from the SATURN models. The fundamental changes in junction layout at these locations, means that a large proportion of the traffic movements are newly created by the Scheme, so there is no alternative to using traffic flows directly from SATURN for these movements; traffic flow changes for existing movements that remain will be complex and relate to wider area rerouting.
- 6.3.8 Therefore, the approach where forecast flows were directly entered from SATURN was adopted for consistency. However, a comparison has been undertaken between the SATURN base year turning movements and available survey data – which shows that the SATURN base flows (including HGV flows) are sufficiently aligned with the surveyed flows such that this will not change the conclusions of the analysis, supporting direct use of the SATURN forecast flows.

6.4 Existing junctions with no calibrated/ validated base models

- 6.4.1 The following junctions were modelled using ARCADY, PICADY or LinSIG to assess the impacts of the proposed Scheme where the junction is not proposed to change, but the flow changes resulting from the Scheme are expected to have an impact:
- a. A428/Toseland Road/Abbotsley Road junction (PICADY).
 - b. Yelling and Toseland Crossroads (PICADY).

- c. Cambourne Junction (LinSig).
 - d. Scotland Road junction, Hardwick (ARCADY).
 - e. Madingley Mulch junction (ARCADY) – this junction also forms part of the area covered by the Vissim model assessment of M11 Junction 13.
 - f. Wyboston roundabout (ARCADY).
 - g. Barford Road roundabout (ARCADY).
- 6.4.2 The details of the approach to developing these junction models are documented in the Transport Assessment [APP-241 to APP-242] and Transport Assessment Annex [APP-243] which were part of the Stage 3 process for preparing the DCO application for the proposed Scheme. The junction modelling did include base year models, but the flows used were extracted from the 2015 base year SATURN model.
- 6.4.3 The traffic flows input to the future year models were based on SATURN output flows from the 2025 and 2040 Do Minimum and Do Something SATURN models.
- 6.4.4 CCC has requested clarity regarding the reasons for not developing calibrated base year junction models at these locations using survey data and why the forecast models were developed by using the flows from the SATURN model directly.
- 6.4.5 The initial modelling analysis indicated that the Scheme would result in either a significant capacity improvement at junctions with existing capacity issues or, where the Scheme increases traffic flows, the junctions were predicted to operate under capacity by a large margin. The Madingley Mulch roundabout, where the Scheme is predicted to increase traffic flows, is also covered by the M11 J13 Vissim model.
- 6.4.6 It was therefore not considered necessary to obtain and use survey data to calibrate/validate junction models, and the direct use of SATURN flows is considered to be a proportionate/reasonable approach to assessing the effects of the Scheme in the wider area. In any case, further data collection would not have been appropriate at the time, since traffic conditions would have been affected by restrictions imposed during the Covid19 pandemic.

6.5 Existing junctions with calibrated/validated base models

- 6.5.1 Vissim models were developed for two junctions in the wider Cambridgeshire area, at M11 Junction 13 and Buckden, where the strategic model flow changes indicated further assessment was necessary and where a standalone junction assessment would not have provided sufficient information. The modelling approach and assessment is described in the Transport Assessment Annex [APP-243].

6.5.2 As there were no significant network changes in the wider area locations where Vissim models were developed, it was considered appropriate to develop and calibrate/validate base models to assess the impact of flow changes predicted due to the Scheme. These Vissim models are not discussed further in this Technical Note, since base models/survey information was used in the modelling assessments.

7 Scheme Junctions

7.1 Introduction

7.1.1 Vissim microsimulation models were developed at the key Scheme junctions, where the complexity of the proposed layouts meant that a standalone junction modelling based assessment would not be capable of fully assessing the performance of the junctions.

7.1.2 PICADY and ARCADY models were developed of the B1046/Potton Road and Eltisley Link junctions respectively.

7.2 Junction Layout Comparison

7.2.1 The comparison of the geometric layouts at the five Scheme junctions indicates that there are significant changes to the existing layout, summarised as follows:

- a. The Black Cat junction is completely replaced with no retention of any part of the existing junction. A Vissim base model would therefore not be appropriate as none of the Base model coding would be carried forward to the forecast model and direct comparison will not be possible due to fundamentally different layouts.
- b. A new Cambridge Road/A428 junction is proposed in a different location; the existing junction would be for local access to the St Neots area with a significant reduction in traffic. A comparison to a Vissim base model is not required, as there will clearly be a benefit that will be realised at the existing roundabout. In terms of the proposed new junction to the east, a comparison with a base model is not appropriate as the junction does not exist at present.
- c. The Caxton Gibbet junction is a new junction, which incorporates the existing roundabout as part of the junction. However, the configuration is proposed to change fundamentally and the geometry/lane configuration will be updated. The development of a Vissim base model of the existing roundabout would not provide a useful comparison, as the model coding would be almost completely replaced in a forecast model; the comparison of results between the existing and proposed junction would not be appropriate or informative, due to the fundamental reconfiguration of the junction.
- d. The B1046/Potton Road junction is a new junction, since Potton Road is realigned to join the B1046 in a different location, with different junction geometry to the existing layout. Therefore, it was not appropriate or relevant to develop a base model of the existing junction.

- e. The Eltislely link junction is a new junction with two roundabouts which do not exist in the current layout. The existing layout comprises two staggered priority junctions and no part of the existing junction is proposed to be retained. Therefore, developing a base model would not provide a useful comparison at this location.
- 7.2.2 It was concluded that the development of base models for these locations would not provide comparable results to that of the forecast year models developed for the proposed design layouts; hence the approach adopted is reasonable and proportionate to the Scheme assessment.

7.3 Forecast Traffic Flows

- 7.3.1 In addition to questioning why base models have not been developed in some locations, CCC has noted that, since the SATURN model is not calibrated to observed turning count information the SATURN model may not reflect existing turning volumes/proportions sufficiently closely, which may mean future year flows are impacted by any discrepancies.
- 7.3.2 As described in Section 7.2 above, the layouts of the three key Scheme junctions are proposed to change significantly with new movements introduced by the Scheme. A standard approach has therefore been adopted where the strategic SATURN model future year flows were entered directly into the future year Vissim models. This is appropriate since the base year SATURN models are calibrated/validated to observed traffic flows in the Scheme area following TAG guidance and the future year SATURN models are capable of assessing re-routing changes due to the Scheme, which have an effect over a wider area.
- 7.3.3 The Potton Road/B1046 junction changes fundamentally in geometric layout, but the overall movements do not change fundamentally, while for the Eltislely junction, the junction layout changes significantly and the flows are fundamentally different because the former A428 loses all of its through traffic. A comparison has been made between available survey information and the SATURN base flows, to establish if taking these into account would change the conclusions of the modelling analysis.
- 7.3.4 The different layouts for the three key junctions are shown in Figure 7-1, Figure 7-2 and **Figure 7-3**. The layouts significantly change the pattern of traffic movements and introduce movements which did not previously exist:
- a. Black Cat - there are 20 key traffic movements in the proposed layout at Black Cat junction. Out of these, eight traffic movements (40%) were not present in the base situation.
 - b. Cambridge Road - there are 20 traffic movements at the proposed Cambridge Road junction, compared to the six existing movements. The new dual carriageway passing through the junction introduces an additional 14 traffic movements (70%).

- c. Caxton Gibbet - there are 20 traffic movements at the proposed Caxton Gibbet junction. Of these, eight of the traffic movements (40%) are introduced due to the new dual carriageway.

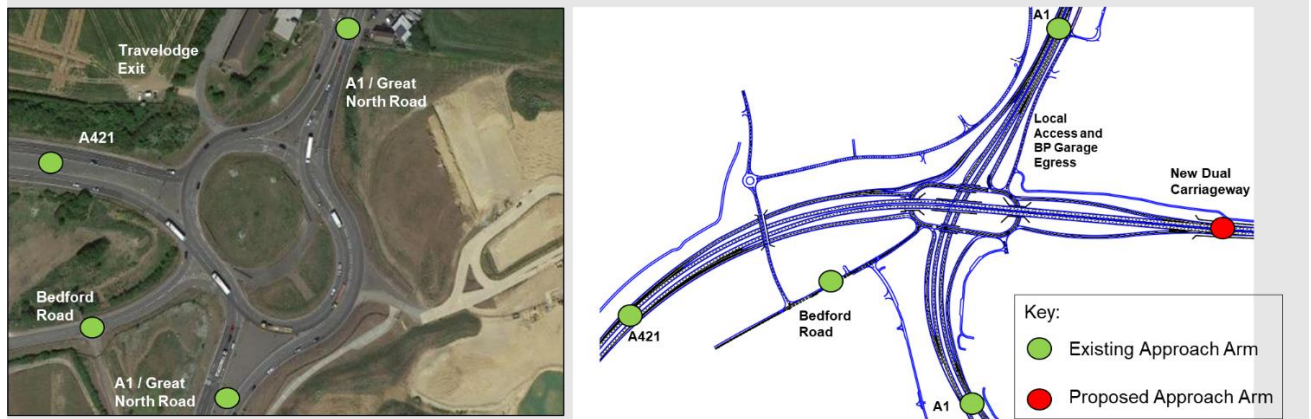


Figure 7-1 – Origin/ Destinations at existing and proposed Black Cat junction

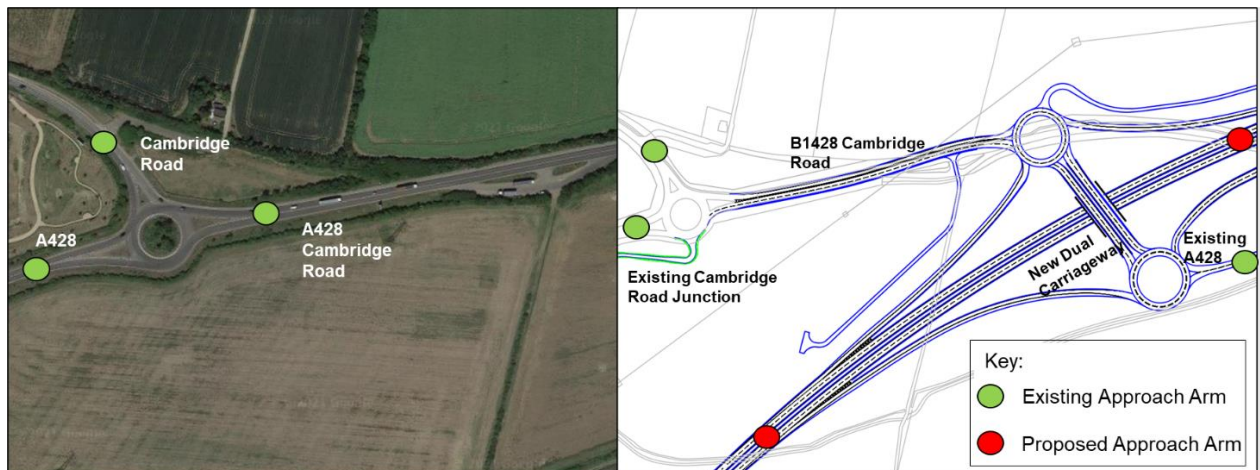


Figure 7-2 – Origin/ Destinations at existing and proposed Cambridge Road Junction

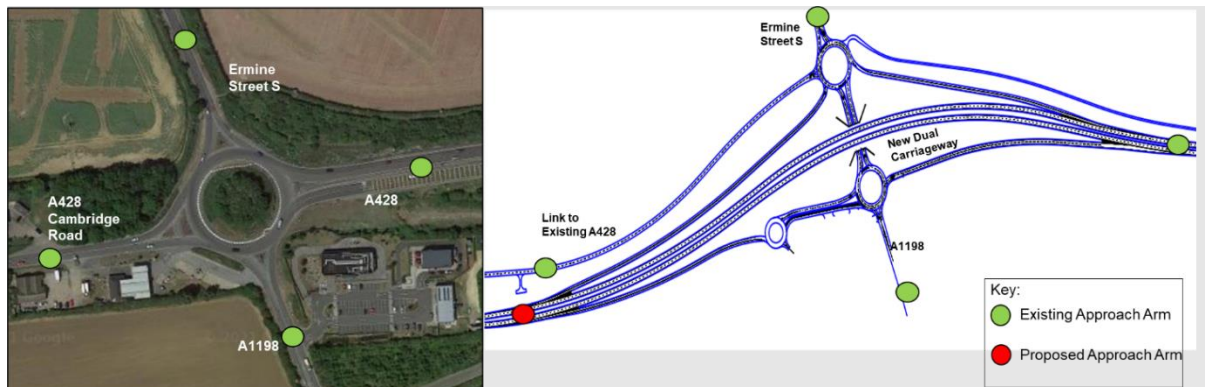


Figure 7-3 – Origin/ Destinations at existing and proposed Caxton Gibbet Junction

- 7.3.5 A comparison of the turning flows extracted from the 2015 SATURN models and the surveyed data has been undertaken
- 7.3.6 The analysis has shown that the majority of forecast traffic flows at the Cambridge Road and Caxton Gibbet junctions, and a significant proportion of the flows at the Black Cat junction, would need to be taken directly from the forecast SATURN models. An alternative approach, where survey data was used in the process of deriving forecast demand, would therefore have a limited impact on results.
- 7.3.7 The analysis has also shown that the total 2015 base year SATURN turning flows and surveyed turning flows (data compared is from 2016 and 2017) are a good match at the Black Cat junction and match reasonably well at the Cambridge Road and Caxton Gibbet junctions. The HGV flows in the SATURN models reflect the surveyed turning patterns well and the SATURN flows are slightly higher than surveyed, so are robust for use in the junction models. The SATURN model therefore forms a suitable basis from which to forecast both the future year flows and changes due to the Scheme at these locations.
- 7.3.8 There are some differences between the survey information and the 2015 base SATURN flows at the Potton Road/ B1046 and B1040/A428 junctions. However, these differences are not sufficient to change the conclusions of the analysis, since the junction models indicate a large amount of spare capacity is available.
- 7.3.9 Based on the above, it can be robustly concluded that the SATURN model is the only source of flow information that could be used to forecast the demand for the new movements in the forecast Vissim models.

8 Existing Junctions with no calibrated base models

8.1.1 The following Cambridgeshire junctions (listed in Table 8-1) were modelled for the assessment of the Scheme impacts and were reported in the Transport Assessment [APP-241 to APP-242] and Transport Assessment Annex [APP-243].

Table 8-1 – Summary of Existing Junctions without calibrated base models

Junction	Model Type	Data Available?	Survey data used?	Scheme improves operation	Capacity Prediction
A428/ Toseland Road/ Abbotsley Road junction	PICADY	Yes - Sept 2017 (Toseland Road junction only)	No	Yes	The junctions operate significantly overcapacity in the 2025 and 2040 Do Minimum scenarios. The Do Something scenarios work well within capacity due to a predicted reduction in traffic flows.
Yelling- Toseland crossroads	PICADY	Yes - Nov 2019	No	No – overall flow reduction but increase on north-south movement	Junction remains well within capacity (maximum RFC of 0.27) with minimal queues and delays.
A428/Cambourne Junction	LinSIG	No	No	No – minor flow increases	The junction is predicted to operate well within its capacity across all scenarios (the highest Degree of Saturation is 38.2%).
A428/Scotland Road Hardwick	ARCADY	No	No	Yes	The results show that there is a maximum RFC of 0.53 in the 2040 DM scenario and 0.42 in the 2040 DS scenario. The Do Something scenarios work well within capacity due to a predicted reduction in traffic flows.

Junction	Model Type	Data Available?	Survey data used?	Scheme improves operation	Capacity Prediction
A428/A1303 Madingley Mulch Roundabout	ARCADY	Yes - Nov 2019	No	No – flow increases	The results show that there is a maximum RFC of 0.62 in the 2025 DS PM scenario and RFC of 0.72 in the 2040 DS PM scenario, both for the A1303 approach. This junction will operate within capacity across all scenarios.
Wyboston Roundabout	ARCADY	Yes - April 2016	Yes (base year models only)	Yes	The introduction of the Scheme significantly improves the junction performance. The junction is predicted to operate within capacity as a result of the Scheme in both the forecast years (max RFC is 0.85 in the 2040 DS PM peak).
Barford Road Roundabout	ARCADY	Yes - Nov 2017	Yes (base year models only)	Yes	The introduction of the Scheme significantly improves the junction performance, as the DM scenarios are predicted to be over capacity. The junction is predicted to operate within capacity as a result of the Scheme in both the forecast years (max RFC is 0.80 in the 2040 DS AM peak).

8.1.2 The above junctions currently exist and are not proposed to change due to the Scheme. For most of these junctions, AECOM ran the model for the 2015 base case using flows from the 2015 SATURN model and compared the output with typical traffic conditions sourced from pre-Covid Google Maps imagery. In the case of Wyboston and Barford Road roundabouts, the 2016/2017 survey data was used in the base model runs, but the base models were not validated.

- 8.1.3 A formal validation of the performance of junctions, where the base model layouts and traffic flows were available, was not carried out. The key reason for this is the text contained in section 13.13 of the Junction9 manual, which states that *'if proper validation of an ARCADY/PICADY model is required, the junction operation will need to be observed on many occasions and the observed queue lengths averaged. Only then can the queue lengths predicted by the model be compared with those found on site.'* The manual goes on to state: *'In general, for any use of the program, you should check wherever possible that the results approximately match observed behaviour at the junction before modelling other scenarios'*.
- 8.1.4 Survey data was not used in the development of forecast demand: initial analysis indicated that these junctions would either operate well within capacity or there was an overall flow reduction due to the Scheme. A proportionate approach was therefore followed where SATURN flows were used directly in the models.
- 8.1.5 The traffic flows which have been input into the future year models were extracted from the SATURN model for all four modelled scenarios (Do Minimum and Do Something 2025 AM and PM, 2040 AM and PM). Traffic flows have been included for all movements at the junctions.
- 8.1.6 The flows were extracted from the A428 SATURN model as average hour across the peak period flows and these were converted to peak hour flows for the AM and PM using the factors 1.086 and 1.076 respectively.
- 8.1.7 The analysis has demonstrated that the Scheme results in a capacity improvement in the locations listed below; if survey data was incorporated into the analysis and/or base models were validated, this conclusion would not change, so, it is not proportionate or necessary to undertake this assessment:
- a. A428/Toseland Road/Abbotsley Road junction.
 - b. Scotland Road junction, Hardwick.
 - c. Wyboston roundabout.
 - d. Barford Road roundabout.
- 8.1.8 As summarised in the table above, the modelling has shown that although there is a slight impact from the Scheme, the following junctions will operate well within capacity. If survey data was incorporated into the analysis and/or base models were validated, there are not likely to be capacity issues, since there is predicted to be a significant amount of spare capacity. It is therefore considered that the relative assessment of the impact in the locations below is proportionate:
- a. Yelling and Toseland Crossroads.
 - b. Cambourne Junction.

- 8.1.9 There is predicted to be an increase in traffic flows at the Madingley Mulch junction due to the Scheme. This junction forms part of the Vissim model of M11 Junction 13, which was calibrated to MCTC data from November 2019; the Vissim model provides an assessment of the roundabout as part of the A1303 corridor, as queues along this route impact the operation of the roundabout. The standalone ARCADY model shows the impact of the Scheme flow changes in isolation and is supplementary to the Vissim model. It is therefore considered that the modelling submitted in the DCO application is sufficient to demonstrate the impact of the Scheme in this location.
- 8.1.10 The above analysis has shown that the Scheme has a beneficial impact on junctions with existing capacity issues and the junctions where flows increase, are predicted to operate well within capacity. Since these junctions do not form part of the Scheme, and they are therefore not fundamental to the design and operation of the Scheme, it is considered that the approach taken is proportionate and reasonable in understanding the wider impacts of the Scheme.