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A30 Chiverton to Carland Cross

Combined Modelling and Appraisal (ComMA) Report

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Foreword

The section of the A30 in Cornwall from Chiverton to Carland Cross, north of Truro, experiences congestion and delays throughout the year, with poor journey time reliability. The construction of an upgraded dual carriageway will help meet Highways England's objectives of maintaining the smooth flow of traffic, making the network safer and supporting economic growth.

The scope of the scheme is to upgrade 12.5km of single carriageway to dual carriageway on the A30 between Chiverton Cross and Carland Cross.

The specific Transport Objectives are:

- to contribute to regeneration and sustainable economic growth;
  - to support employment & residential development opportunities;
- to improve the safety, operation & efficiency of the transport network;
- improve network reliability and reduce journey times;
  - to deliver capacity enhancements to the SRN;
- supporting the use of sustainable modes of transport;
- delivering better environmental outcomes, and;
- to improve local and strategic connectivity.

This report details the development of the traffic model that has been used in the appraisal of the scheme in terms of impact on the highway network and the economic benefits of the scheme for Highways England Project Control Framework (PCF) Stage 3 in support of the Development Consent Order.

This report covers the development and calibration/validation of the base year model, the development of the forecast matrices and network and the economic appraisal of the scheme.

Executive Summary

The section of the A30 in Cornwall from Chiverton to Carland Cross, experiences congestion and delays throughout the year, with poor journey time reliability. The construction of an upgraded dual carriageway will help meet Highways England's objectives of maintaining the smooth flow of traffic, making the network safer and supporting economic growth.

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This report covers the development and calibration/validation of the base year model, the development of the forecast matrices and network and the economic appraisal of the scheme.

The model was based on the Truro model which had a base year of 2009. From this base the network and matrices have been extended and updated to a base year of 2015 to cover an area more representative of the area the scheme will impact on. The model has then been calibrated and validated to meet the criteria set out in WebTAG. The model achieves these criteria and as such is believed to provide a robust representation of the interactions of the highway network.

From the base model, forecast matrices for 2023 (scheme opening year) and 2038 (scheme design year) were developed based on local development plans. The model networks were updated to include any infrastructure upgrades planned between the 2015 base year and the forecast years. For the forecast years Variable Demand Modelling (VDM) was undertaken using the software DIADEM.

The economic appraisal was undertaken using the prescribed methodology set you in WebTAG and used the latest version of TUBA to ensure the latest costs were used. In addition to assessing the transport economics of the scheme, the impact on the wider area and the environmental and reliability impacts were all assessed to provide an adjusted BCR of 4.61. The BCR for the scheme therefore represents Very High Value for Money.

Summary of content

The report has been produced in accordance with the guidance set out in with Highways England's PCF product description for the Combined Modelling and Appraisal (ComMA) report.

1 Introduction

1.1 Background

1.1.1 The section of the A30 in Cornwall between Chiverton Cross and Carland Cross, north of Truro, is currently a winding single carriageway route. Following the completion of the dualling scheme to upgrade the A30 between Temple and Higher Carblake near Bodmin in 2017, the A30 Chiverton Cross to Carland Cross section is the only remaining single carriageway section of the A30 route between the M5 at Exeter and Camborne in west Cornwall.

1.1.2 Due to the single carriageway standard, this section of the A30 experiences congestion and delays throughout the year, with poor journey time reliability. These problems are exacerbated in summer months, when traffic flows increase due to tourist traffic.

1.1.3 The construction of an upgraded dual carriageway will help meet Highways England's objectives of maintaining the smooth flow of traffic, making the network safer and supporting economic growth. The desire for enhancements to this route is strongly supported by local and regional strategies from Cornwall Council, the Cornwall and Isles of Scilly Local Enterprise Partnership, businesses and local stakeholders.

1.1.4 The scheme will have a significant impact on travel on the A30 within Cornwall; it will significantly reduce current journey times on the route and congestion at key junctions. Due to these improvements in performance, travel patterns in the area will be affected and the improved route will be likely to attract traffic from other routes. Truro is a major attractor of trips within Cornwall, and travel patterns for traffic using routes across the existing A30, such as from Newquay, Perranporth and other towns to Truro, will be affected. The traffic model has therefore been designed to be able to model the impact of travel patterns across a wide area.

1.2 The Scheme

1.2.1 In 2014, it was announced as part of the Roads Investment Strategy (RIS) that a scheme to upgrade the last single carriageway gap on the A30 in Cornwall to expressway standard would receive funding.

1.2.2 The scope of the scheme is to upgrade 12.5km of single carriageway to dual carriageway on the A30 between Chiverton Cross Roundabout and Carland Cross roundabout.

1.3 Objectives

1.3.1 The scheme will:

- contribute to economic growth by supporting employment and residential development opportunities;
- contribute to regeneration by enhancing the opportunities for previous, existing and future regeneration projects to realise their full potential; and

- minimise the environmental impact of operating, maintaining and improving the network and seek to protect and enhance the quality of its surrounding environment while conforming to the principles of sustainable transport.

Scheme objectives

- Improve the safety, operation & efficiency of the transport network;
- Contribute to regeneration and sustainable economic growth;
- Support employment & residential development opportunities;
- Improve network reliability and reduce journey times;
- Deliver capacity enhancements to the Strategic Road Network (SRN);
- Support the use of sustainable modes of transport;
- deliver better environmental outcomes; and
- to improve local and strategic connectivity.

1.4 Description of the Scheme

1.4.1 The key elements of the scheme consist of:

- The construction of a new A30 dual carriageway road approximately 14 kilometres between Chiverton and Carland Cross.
- The re-alignment and detrunking of the existing A30.
- The construction of a new grade separated junction at Chiverton.
- The construction of a new grade separated dumbbell junction at Chybucca.
- The construction of a new grade separated junction at Carland Cross.
- Works to Allet Road for access across the new A30 at Trewsawsen.
- The demolition and replacement of the existing bridge at Tolgroggan Farm.
- The construction of an underbridge under the main carriageway of the new A30 and the existing A30 at Trevalso.
- The construction of an underbridge at Pennycomequick.

1.4.2 These features were identified as meeting the current and future needs of road users, as well as achieving the high-level Government, Highways England and local objectives for the SRN.

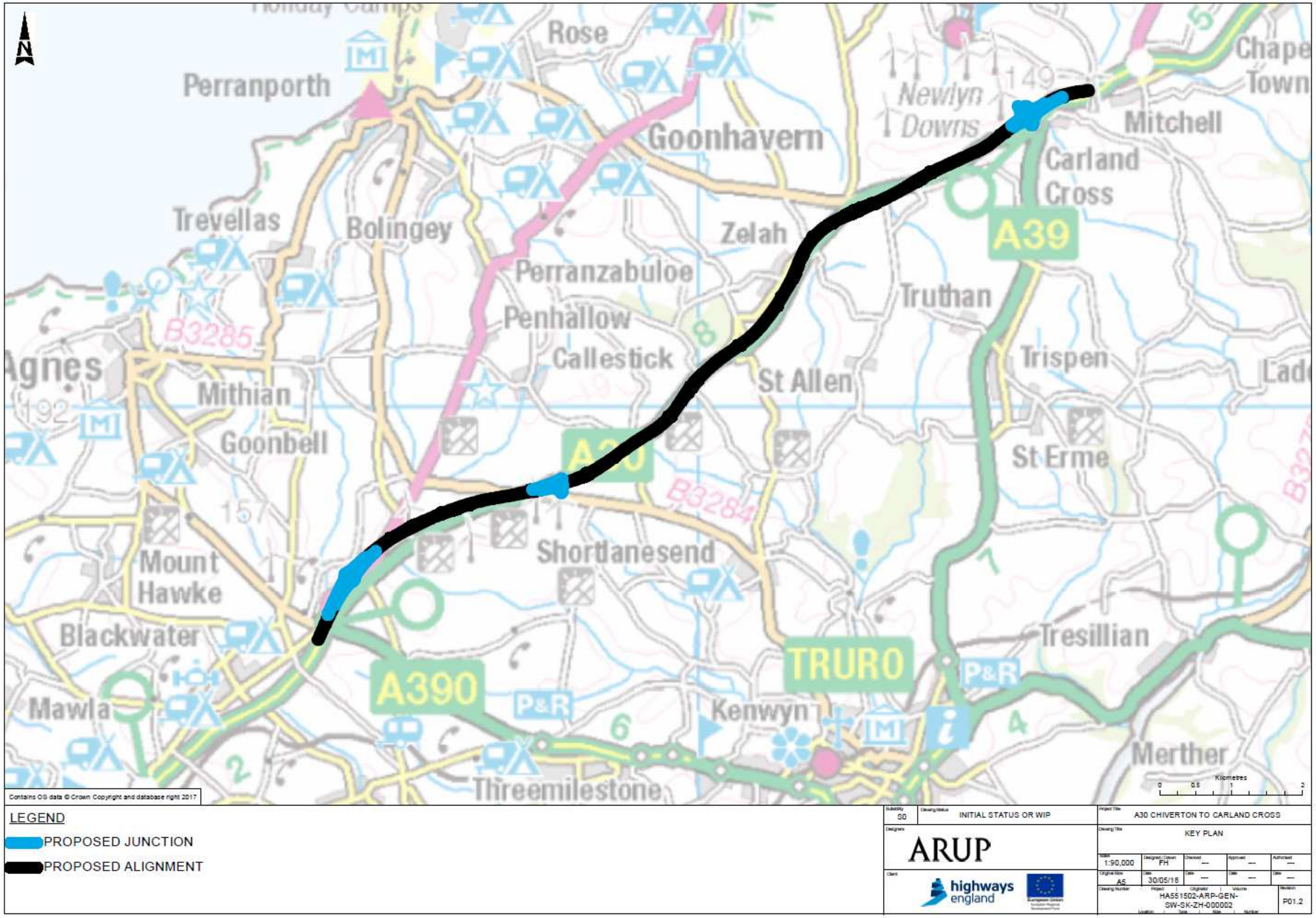

Figure 1-1 Scheme area

1.5 Previous Analysis

PCF Stage 0

1.5.1 The basis of the assessment, for all PCF stages, is the 2009 Truro Model that was designed to assess the impact of developments and highway improvement schemes in the vicinity of the City of Truro, Cornwall.

1.5.2 The Truro 2009 demand matrices were built using RSI data from six sites on the key routes into Truro. Two of the sites, on the A390 near Highertown and the B3284 near Shortlanesend were surveyed in 2009; the other sites were surveyed in 2003. A gravity model was then used to estimate unobserved trips. A30 through trips were added from an older model matrix, and updated to 2009 volumes.

1.5.3 The 2009 Truro model covered the time periods listed below and carried forward to this study:

- AM Peak Hour – 08:00 to 09:00
- PM Peak Hour – 17:00 to 18:00

1.5.4 An additional interpeak hour model (average interpeak hour from 10:00 to 16:00) was constructed during the development of the PCF Stage 1 model, which has also been updated for PCF Stages 2 and 3.

1.5.5 Whilst the 2009 Truro SATURN model contains sufficient detail on the A30 between Chiverton Cross and Carland Cross to allow a robust appraisal of scheme benefits, the validation of the existing 2009 model focussed on Truro City Centre and the key routes into the City, and did not include detailed calibration and validation of links on the A30. It was therefore considered that the validation of the model should be updated to incorporate both more detailed validation of the A30 and to update the model base year.

1.5.6 This revalidation was carried out for the PCF Stage 0 appraisal. The model base year was updated from 2009 to 2015 by applying TEMPRO growth factors to the 2009 base year matrices. TEMPRO growth factors were used to forecast demand for the scheme opening (2022) and scheme design (2037) years.

1.5.7 The A30 Chiverton to Carland Cross PCF Stage 0 - Scheme Review Report (v5.1, July 2015) also details the economic studies of this section of the A30 that were previously carried out; the 2003 Economic Assessment Report produced by Hyder and the 2006 Eddington Study Evidence Base. The reported Benefit to Cost Ratios (BCRs) from these two studies were between 1.9 and 3.8 dependant on the growth scenario used (Low, Core or High).

1.5.8 An economic assessment was carried out for PCF Stage 0 using the modified Truro SATURN model. This was detailed in the A30 Chiverton to Carland Cross PCF Stage 0 - Scheme Review Report (v5.1, July 2015) and is summarised below. TUBA was used to calculate the economic impact of the proposed scheme.

1.5.9 The results of the PCF Stage 0 economic assessment are shown in Table 1-1.

Table 1-1 PCF Stage 0 Economic assessment results

Item	Value
Noise	Not assessed
Local Air Quality	Not assessed
Greenhouse Gases	-£3.65m
Journey Quality	Not assessed
Physical Activity	Not assessed
Accidents	Not assessed
Economic Efficiency (Commuting)	£130.85m
Economic Efficiency (Other)	£196.07m
Economic Efficiency (Business Users)	£285.26m
Indirect Tax Revenues	£8.75m
Present Value of Benefits (PVB)	**£617.27m**
Present Value of Costs (PVC)	**£200.31m**
Benefit-to-Cost Ratio (BCR)	**3.1**

PCF Stage 1

1.5.10 Following on from PCF Stage 0 the traffic model was further updated to improve the traffic network near the scheme resulting in improved modelling of the impact that the scheme will have on the local road network.

1.5.11 An economic assessment was carried out for PCF Stage 1 using the PCF Stage 1 SATURN model. This was detailed in the PCF Stage 1 A30 Chiverton to Carland Cross Economic Assessment Report (May 2016) (HA551502-WSP-GEN-0000-RE-TR-00005-P02) and PCF Stage 1 A30 Chiverton to Carland Cross Economic Assessment Report Addendum (June 2016) (HA551502-WSP-GEN-0000-RE-TR-00008-P02). These reports assessed two alignments for the scheme with the addendum assessing the economic impacts of the scheme including west facing slips at Chybucca.

1.5.12 The results of the PCF Stage 1 economic assessment for Option 6B which included west facing slips at Chybucca (detailed in the PCF Stage 1 A30 Chiverton to Carland Cross Economic Assessment Report Addendum HA551502-WSP-GEN-0000-RE-TR-00008-P02) are shown in Table 1-2.

Table 1-2 PCF Stage 1 economic assessment results - Option 6B with west facing slips at Chybucca

Item	Value
Noise	Not assessed
Local Air Quality	Not assessed
Greenhouse Gases	-£10.93m
Journey Quality	Not assessed
Physical Activity	Not assessed
Accidents	£16.79
Economic Efficiency (Commuting)	£155.71m
Economic Efficiency (Other)	£298.97m
Economic Efficiency (Business Users)	£557.07m
Indirect Tax Revenues	£21.40m
Present Value of Benefits (PVB)	**£1,039.00m**
Present Value of Costs (PVC)	**£200.17m**
Benefit-to-Cost Ratio (BCR)	**5.2**

PCF Stage 2

1.5.13 For PCF Stage 2 the PCF Stage 1 model formed the basis from which to work. The PCF Stage 1 model was deemed appropriate to use at PCF Stage 2 as the model provides good coverage in the area of interest and was developed in accordance with WebTAG guidance. Utilising the PCF Stage 1 model as the basis for PCF Stage 2 is a more robust and time efficient approach than to develop a new model from scratch.

1.5.14 For PCF Stage 2 the SATURN model has been updated to include Variable Demand Modelling (VDM) and NTEM 7.0 for developing the 2022 and 2037 forecast matrices.

1.5.15 The results show that the Present Value Benefits (PVB) decreased when compared to the PCF Stage 1 assessment. The reduction can be attributed to changes to the values of time and the incorporation of variable demand modelling, both of which reduce the benefits compared to the earlier assessment at PCF Stage 1. The PCF Stage 2 appraisal uses TUBA 1.9.8 and values from WebTAG Data Book Forthcoming Change November 2016, which enables appraisal to be undertaken with values of time that vary by distance.

1.5.16 An adjusted BCR was calculated incorporating reliability benefits, landscape impacts and Wider Impacts.

1.5.17 Landscape impacts were calculated based on the on the methodology in accordance with the Value for Money Assessment: Advice Note for Local Transport Decision Makers (DfT, December 2013).

1.5.18 Reliability benefits were monetised by assessing whether the impacts are slight, moderate or large and applying a factor of 5%, 10% or 20% to the time savings calculated in TUBA.

1.5.19 The Wider Impact described as ‘output in imperfectly competitive markets’ WI2, consisting of a 10% uplift of business user benefits in line with guidance.

1.5.20 The results of the PCF Stage 1 economic assessment for Option 6B are shown in Table 1-3.

Table 1-3 PCF Stage 2 Economic assessment results - Do something (option 7A)

Item	Value
Noise	-£0.27m
Local Air Quality	-£0.05m
Greenhouse Gases	-£34.67m
Journey Quality	
Physical Activity	
Accidents	£41.55m
Economic Efficiency (Commuting)	£146.37m
Economic Efficiency (Other)	£145.65m
Economic Efficiency (Business Users)	£204.96
Indirect Tax Revenues	£61.02m
Present Value of Benefits (PVB)	£564.56
Present Value of Costs (PVC)	£379.95m
Benefit-to-Cost Ratio (BCR)	3.1
Reliability	£30.18m
Landscape	-£81.60m
Wider Impacts	**£20.50m**
Adjusted BCR	**2.9**

2 Local Transport Situation

2.1.1 As the only main route to western Cornwall, the A30 is crucial to the resilience and performance of transport infrastructure in the region, and the connectivity of western Cornwall to the rest of the South West and wider UK. With increasing traffic flows predicted in the future years; congestion, queuing, and journey time unreliability will increase. Improvements to traffic flow, and increased north–south permeability, will provide better journey reliability, and a better connected local network, supporting regeneration and development of the region.

2.1.2 The single carriageway A30 between Chiverton Cross and Carland Cross operates close to capacity during neutral month peak hours, and is forecast to operate over capacity by 2022, the opening year of the scheme. As such, this section experiences heavy congestion at both junctions and their approaches, due to capacity constraints, and on the mainline itself, where vehicles experience delays behind slow moving vehicles. This can be seen in the journey time data for Chiverton to Carland Cross, where journey times are higher than 150% of the free flow journey times in the AM and PM peaks, and are still above 125% of the free flow journey time in the interpeak periods (full analysis of the journey time data is presented in Section 7.4).

2.1.3 Journey times show that the A30 currently operates over capacity in the summer period due to the significantly increased traffic flows during these periods. When incidents occur, that impede or block flow on the A30, there is no alternative direct route, forcing traffic to queue on the main road or divert to minor roads which are not capable of sustaining substantial traffic flows or movements.

2.1.4 Current congestion on the existing A30 between Chiverton Cross and Carland Cross forms a bottleneck in the trunk road network in Cornwall, preventing reliable east – west journeys and stifling growth in Cornwall. If not improved, the existing infrastructure will continue to contribute to growing congestion, poor reliability and efficiency, and poor journey times – all of which fail to meet HE’s business strategy and the Government’s strategic vision outlined in the RIS.

2.1.5 Road safety is also a concern. The current poor alignment, limited overtaking opportunities, side road junctions and private accesses have caused numerous accidents on this section of the A30. According to a summary of traffic personal injury accidents, between 1 January 2012 and 31 December 2016, there was 1 fatality, 17 serious collisions and 93 slight collisions between Chiverton and Carland Cross. Accidents were more frequent in the vicinity of Chiverton Cross, Carland Cross, Zelah Hill, Chybucca and Callestick/Allet Cross Junction.

3 Summary and Review of Existing Data

3.1 Review of Existing Volumetric Data

3.1.1 Automatic Traffic Count (ATC) data was collected from various locations along the A30 from Highways England's TRADS database. Cornwall Council have also provided ATC data for a number of key local roads. The average hourly flow at each count location between 07:00 and 19:00 was extracted. A summary of the average flow over each peak period has been used in the calibration of the 2015 base year model. A plot of the locations of the ATC counts can be found in Section 5 of this report. All ATC data collected was from 2014 or 2015. This data is considered of high quality given the availability of almost entire years at all TRADS sites. The local CC ATC sites are also considered to be of good quality as they provide at least an entire neutral month of data.

3.1.2 Manual Classified Counts (MCC) data, collected in October 2014, was also provided by Cornwall Council, providing detailed turning movements for all side road junctions with the A30 within the scheme area. The location of these counts is detailed in Section 5. The MCC's were undertaken in October 2014 and March 2015. The MCC at Chiverton Cross was undertaken in March 2015 and so was well after the improvement scheme was implemented at this junction.

3.2 Review of Existing Trip Data

3.2.1 Some origin-destination data is available within the vicinity of the A30 Chiverton to Carland Cross scheme; this data was collected through Roadside Interviews (RSI). The locations and sources of this data are detailed in the table below.

Table 3-1 Existing origin-destination data

Ref	Type	Location	Date	Source
1	Roadside Interview	A30 at Temple	Tuesday 22nd November 2011 Friday 13th July 2012	Cornwall Council
2	Roadside Interview	Truro – A390 Truro	September 2009	Cornwall Council

3.2.2 Data from other RSIs conducted within Cornwall is available. However, these locations are more remote from the scheme and therefore it is not considered necessary to make use of these datasets.

3.3 Review of Existing Journey Time Data

3.3.1 Journey Time data was collected from the HATRIS JTDB (Journey Time Database) on the A30 trunk road. The JTDB is a national dataset of average vehicle journey times between fixed points on the trunk road network. The dataset contains average speeds of all vehicles passing between two points. The list below details the location of the surveys on the A30:

- A3074 Hayle and Penzance (Westbound only)
- A3074 Nut Lane, Lelant and Tolvaddon Interchange;
- Tolvaddon Interchange and Scorrier Interchange;
- Scorrier Interchange and Chiverton Cross roundabout;

- Chiverton Cross roundabout and Carland Cross roundabout;
- Carland Cross roundabout and Mitchell Interchange;
- Mitchell Interchange and Chapel Town;
- Chapel Town and St Enoder;
- St Enoder and Indian Queens;
- Indian Queens and junction with A389/A391;
- Junction with A389/ A391 and Carminnow Cross;
- Carminnow Cross and Launceston Rd, Bodmin; and,
- A30 Entry Slip and A395, Tregadillett (Eastbound only)

3.3.2 These routes cover the A30 in detail between Lelant, near Hayle and Bodmin. The journey time corridor provided by this model extends outside of the proposed simulation network. The location of the journey time routes is shown in Section 7.

3.3.3 Traffic Master journey time data has been supplied by Cornwall Council which covers the following routes:

- A390 between Chiverton Cross roundabout and County Hall, Truro;
- A39 between Carland Cross and Union Hill junction, Truro;
- A3075 between Chiverton Cross roundabout and Newquay;
- B3284 between Chybucca and Truro via Shortlanesend;
- A39 between Arch Hill, Truro and Carnon Gate, Devoran;
- B3285 between the A30 and the A3075;
- B3277 between Chiverton Cross and St. Agnes; and,
- A30 between Chiverton Cross and Carland Cross.

3.3.4 This data supplements the TRADS data to provide a wider coverage and the combined dataset is considered to have a sufficiently wide coverage.

3.3.5 The journey time data will be used as part of the base model validation process.

3.4 Review of Existing Mapping, Geometric and Operational Data

Mapping

3.4.1 Google Maps and aerial photography from Google Street View were used as a reference when building the network. No further data had to be collected for the model network build as Google Maps and Street View proved adequate in obtaining knowledge of the highway layout.

3.4.2 Detailed OS Mapping is available for the scheme corridor and has been used in the plotting of data collection data.

Accident data

3.4.3 According to a summary of traffic personal injury accidents, between 1 January 2012 and 31 December 2016, there was 1 fatality, 17 serious collisions and 93 slight collisions between Chiverton Cross and Carland Cross. Accidents were more frequent in the vicinity of Chiverton Cross, Carland Cross, Zelah Hill, Chybucca and Callestick/Allet Cross Junction.

3.4.4 The data will be used in the scheme appraisal to determine the impact of the scheme on the number of accidents and their severity.

Queue length data

3.4.5 Queue length data is available for Chybucca and Carland Cross junctions. This has been described further in Sections 5.1.6 to 5.1.7 of this report.

4 Data Collection

4.1 Additional Data Obtained

4.1.1 Mott MacDonald Grontmij commissioned Nationwide Data Collection Ltd (NDC) to undertake a series of RSI surveys at key locations on the A30 and on other key roads in the vicinity of the scheme area to aid the development of the base year A30 Chiverton to Carland traffic assignment model. ATC and MCC counts were also undertaken by NDC at these locations.

4.1.2 Figure 4-1 shows the location of these surveys with regards to the study area.

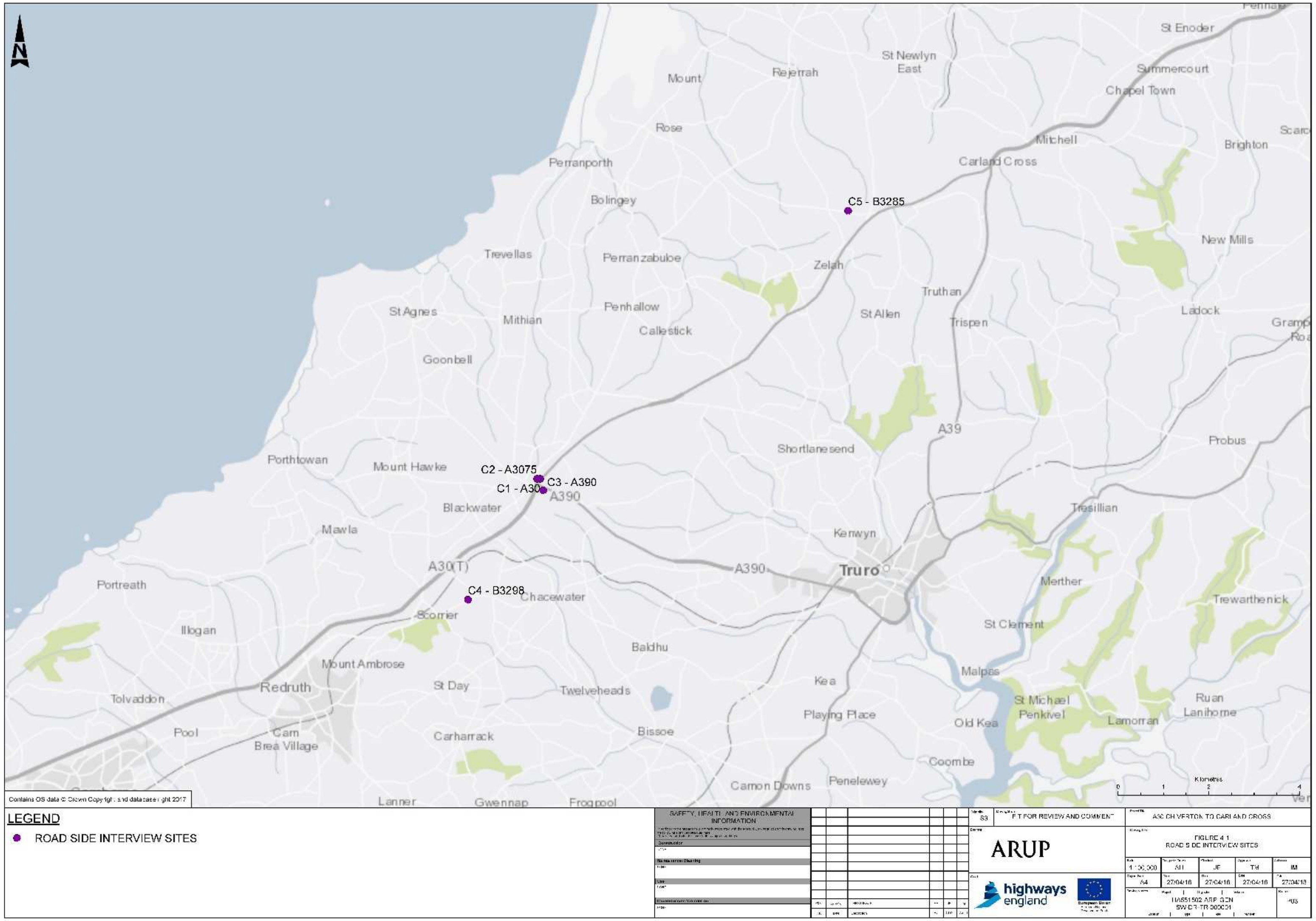

Figure 4-1 Roadside interview locations

4.2 Survey Programme

4.2.1 Two survey methods were used as part of the data collection exercise with three of the surveys being undertaken through direct face to face interviews, and the remaining two surveys conducted by issuing postcards to be filled in and returned to NDC.

4.2.2 All RSI's were undertaken on the 20th and 21st October 2015 at the following locations:

4.2.3 Wednesday 21st October 2015

- C1 – A30 westbound approaching Chiverton Cross roundabout – RSI
- C2 – A3075 southbound approaching Chiverton Cross roundabout – Postcard Survey
- C3 – A390 northbound approaching Chiverton Cross Roundabout– Postcard Survey

Thursday 22nd October 2015

- C4 – B3298 eastbound towards Truro – RSI
- C5 – B3285 eastbound towards A30 – RSI

4.3 Representative Basis of Surveys

4.3.1 All surveys were conducted during a neutral month on a neutral weekday to obtain a dataset representative of typical conditions and to align with the time periods being modelled. The survey dates of Wednesday 21st October and Thursday 22nd October are outside of the late summer holiday season but are before the school autumn half term holiday, which took place from 26th to 30th October in 2015.[1] It should be noted that school half term holidays can differ in other parts of the country.

4.3.2 All surveys covered a 12-hour time period (0700-1900), this allowed for the surveys to include all peak periods.

4.3.3 Several drivers reported that interview sites on the 21st October were being mentioned on local traffic reports, advising drivers to avoid the area. It was noted that Highways England published the locations and dates of all upcoming South West RSI surveys on the gov.uk webpage on the 9th of October 2015[2], in advance of the surveys. Intense pressure from motorists was reported on the 21st October to inform locals about the following day's survey locations due to the extensive queuing on the morning of the 21st. These were reluctantly provided in in the interest of transparency.

4.4 Outcome and Quality of Surveys

4.4.1 Purpose cleaning was undertaken by NDC as part of their checks before issuing the data to WSP | PB. This process removed purposes where both origin and destinations were illogical such as both being listed as 'Usual place of work' or 'Home'. More details are found in Appendix C of the NDC 'Mott MacDonald South

[1] Source: http://www.cornwall.gov.uk/media/3625817/Cornwall-Term-Dates-2015-20160-FINAL.pdf)
[2] Source: https://www.gov.uk/government/news/traffic-surveys-taking-place-on-south-west-main-roads)

West Traffic Survey – Survey Report October & November 2015' (December 2015).

4.4.2 Table 4-1 shows the number of surveys completed at each site. Note this sample rate is before any data was removed as part of the NDC cleaning process.

Table 4-1 RSI and postcard survey sample rates

Ref	Location	Total	MCC	Sample Rate
C1	A30 between Chiverton Cross roundabout and Chybucca	1090	9101	12.0%
C2	A3075 North of Chiverton Cross roundabout	242	4367	5.5%
C3	A390 East of Chiverton Cross roundabout	833	9160	9.6%
C4	B3298 Near Chacewater	916	2859	32.0%
C5	B3285 Between Goonhavern and A30	560	1348	41.5%

4.4.3 Table 4-1 shows that both postcard surveys recorded a sample rate of below 10%. While low, this type of survey does not generally produce high sample rates due to the nature of the survey distribution and returns process.

RSI Data collection issues

4.4.4 The following issues were encountered whilst conducting the RSIs:

- The survey caused the traffic to slow through the site causing the associated ATC at each site to miscount on day of the respective survey.

4.4.5 Site C1

- Several survey participants mentioned that the site was being mentioned on local traffic reports with drivers advised to avoid the area where possible.

4.4.6 Site C2

- Postcard distribution did not commence until 08:00 due to the late arrival of the Police Traffic Officer.
- Traffic management was relocated further north at 12:00 to allow three lanes at the stop line of the junction. Postcard distribution restarted at 13:45.
- Postcard distribution was then restricted to 5 minutes in every 15 after this time.
- Surveying was suspended at 17:15 to clear a ½ mile queue caused by 2 tractors passing through the vicinity of the site.
- Several survey participants mentioned that the site was being mentioned on local traffic reports with drivers advised to avoid the area where possible.
- The site showed a low return rate with only 5.5% of total traffic on the route sampled. This is sample rate is before NDC cleaned the data.

4.4.7 Site C3

- Postcard distribution did not commence until 08:00 due to the late arrival of the Police Traffic Officer.
- From 12:30 there were frequent suspensions to clear queuing traffic.

- The site was temporarily suspended from 14:15 to 14:45, postcard distribution was then restricted to 5 minutes in every 15 after this time.
- Several survey participants mentioned that the site was being mentioned on local traffic reports with drivers advised to avoid the area where possible.

4.4.8 Site C4

- No specific issues reported.

4.4.9 Site C5

- No specific issues reported.

5 Final Volumetric Dataset

5.1 Location of Existing Data Sites

Traffic count data

5.1.1 Manual Classified Count (MCC) data was collected by Cornwall Council in October 2014 at all the junctions on the A30 section from Chiverton Cross to Carland Cross, as well as at other key junctions in the area. The locations of these counts are shown in Figure 5-1.

5.1.2 The figures showing the average peak hour turning movements at 20 junctions within, and surrounding, the A30 Chiverton to Carland Cross study area can be found in the PCF Stage 3 Traffic Data Collection Report (HA551505-WSP-GEN-0000-RE-TR-0012-P02). These diagrams show a trend in the traffic movements between the AM and PM peak periods; during the AM it is clear to see the major flows of traffic are heading from the A30 and north of the A30 to Truro. In the PM peak this trend is reversed with a larger proportion of trips heading northbound from Truro back towards the A30.

5.1.3 The MCC data has been used to calibrate the base model turning flows at the key junctions on the A30 in the vicinity of the scheme area including Chiverton Cross roundabout, Chybucca roundabout and Carland Cross roundabout. Data for the minor junctions between Chiverton Cross and Carland Cross roundabouts has also been extracted and with the key junctions providing viable routes into Truro used for calibration purposes at these locations.

5.1.4 Automatic Traffic Count (ATC) data is available on the A30 from Highways England's TRADS database and count data for key routes on the local highways network is available from Cornwall Council. The locations of these counts are shown in Figure 5-2.

5.1.5 Analysis of ATC and TRADS counts is conducted in Section 5.3 of this report.

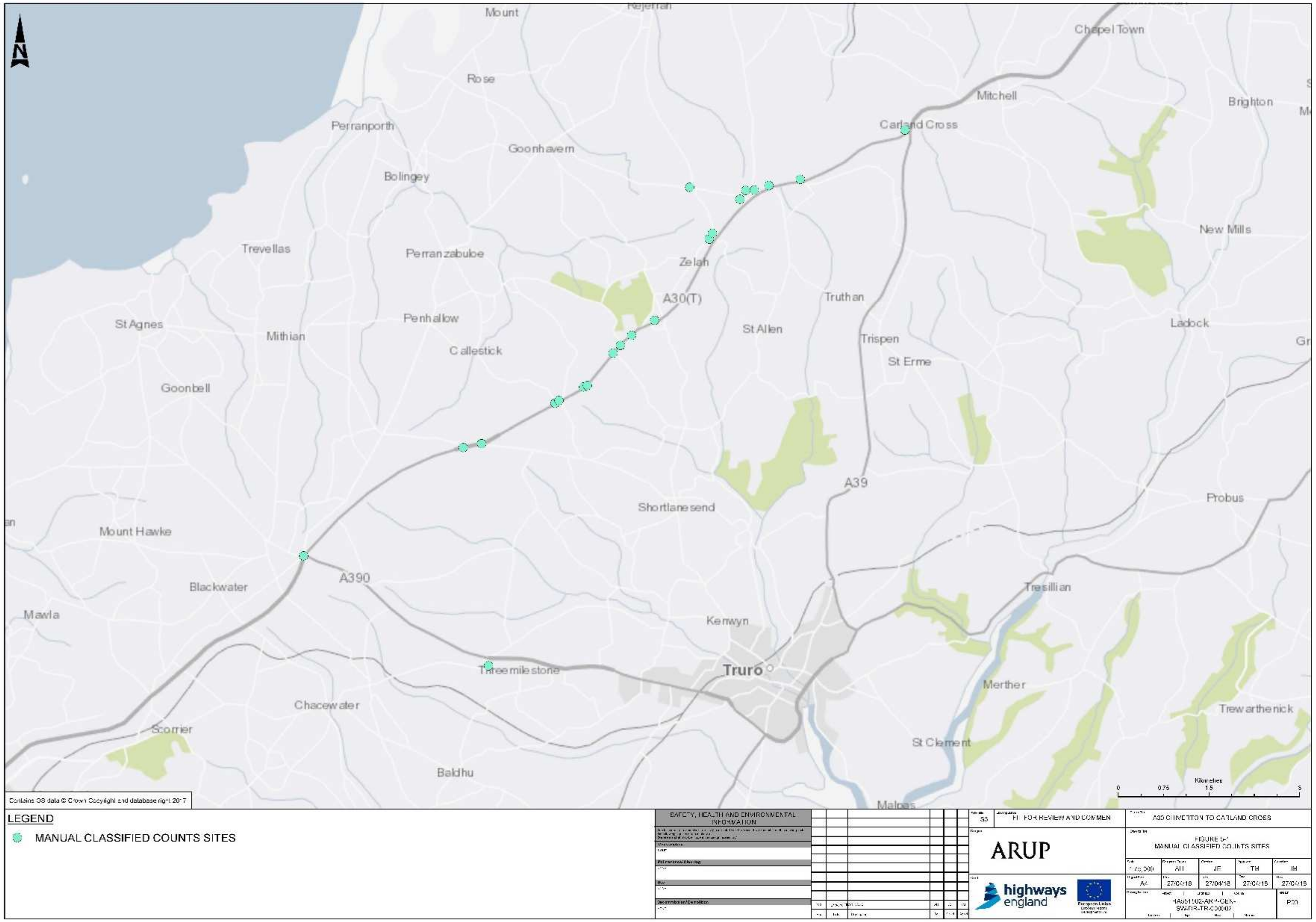

Figure 5-1 Location of available manual classified counts

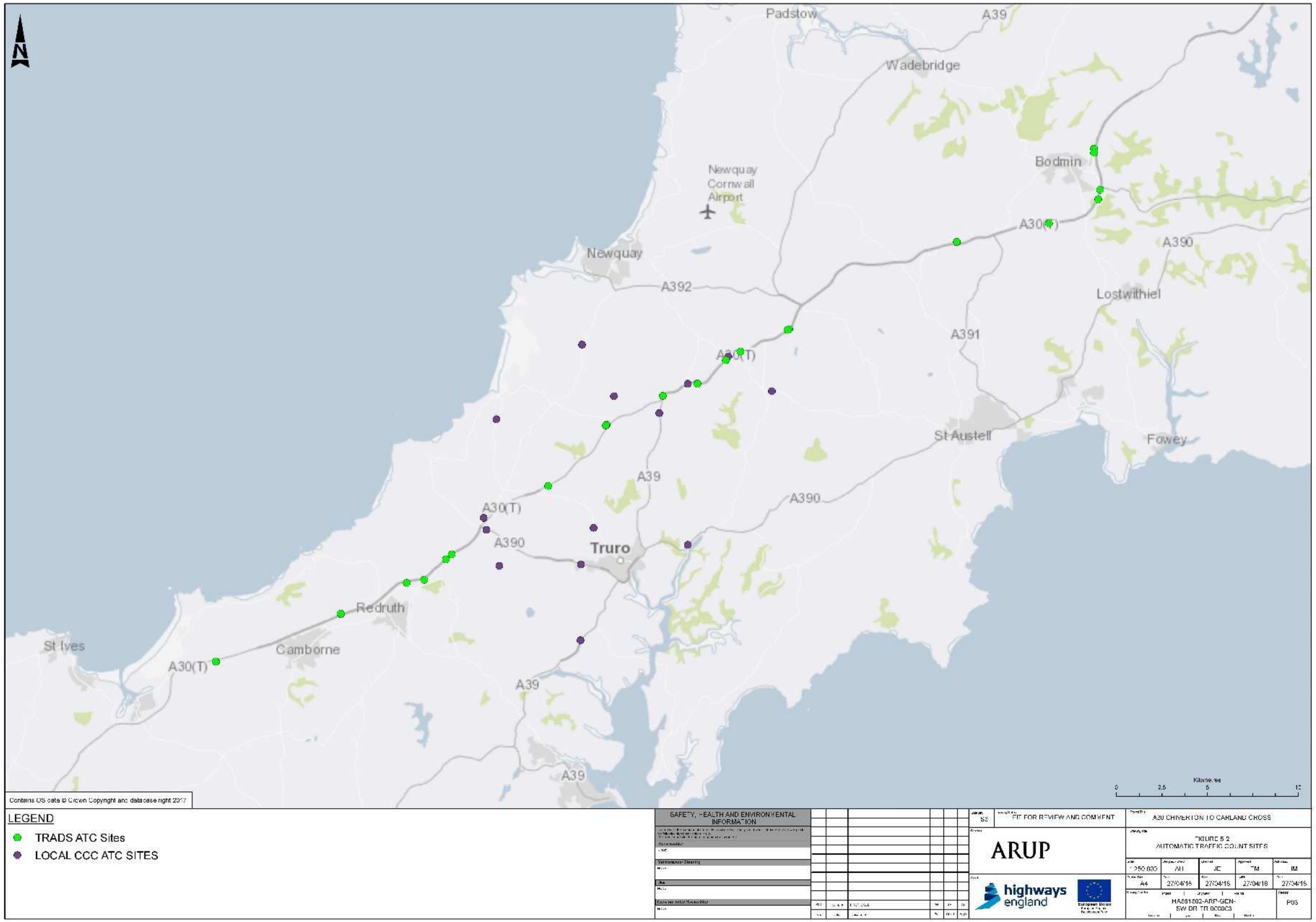

Figure 5-2 Location of available automatic traffic count data

Queue length data

5.1.6 Queue data at a number of key locations on the A30 was also collected by Cornwall Council in February 2013. This data covered the junctions in the figure below but will not be used for the key Carland Cross and Chybucca junctions as more up-to-date data is available (22nd/23rd October 2014). Surveys of queuing on minor arms on the A30 were also undertaken by CC during October 2014.

5.1.7 Figure 5-3 and Figure 5-4 show the locations of the surveys conducted.

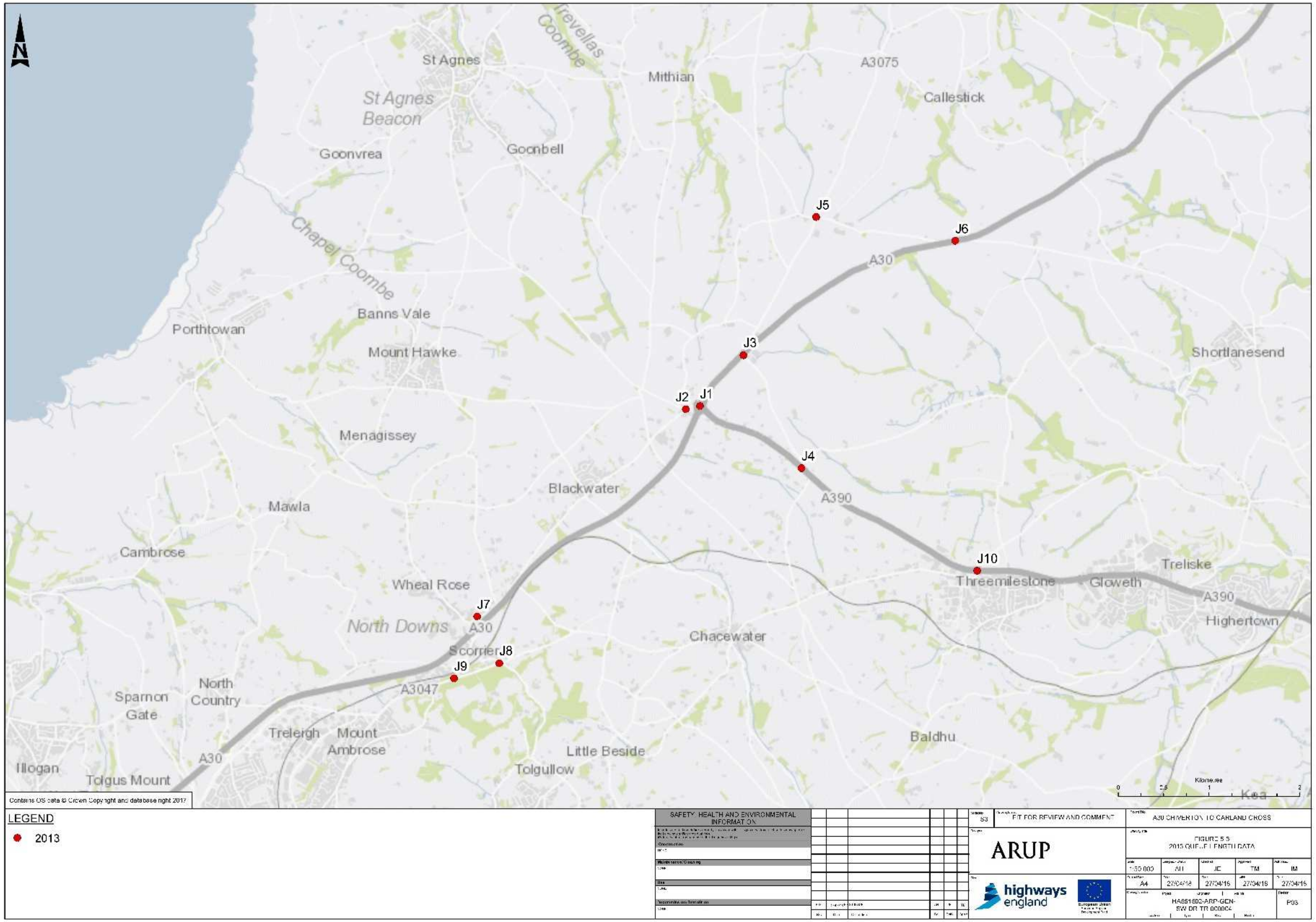

Figure 5-3 Location of available 2013 queue length data

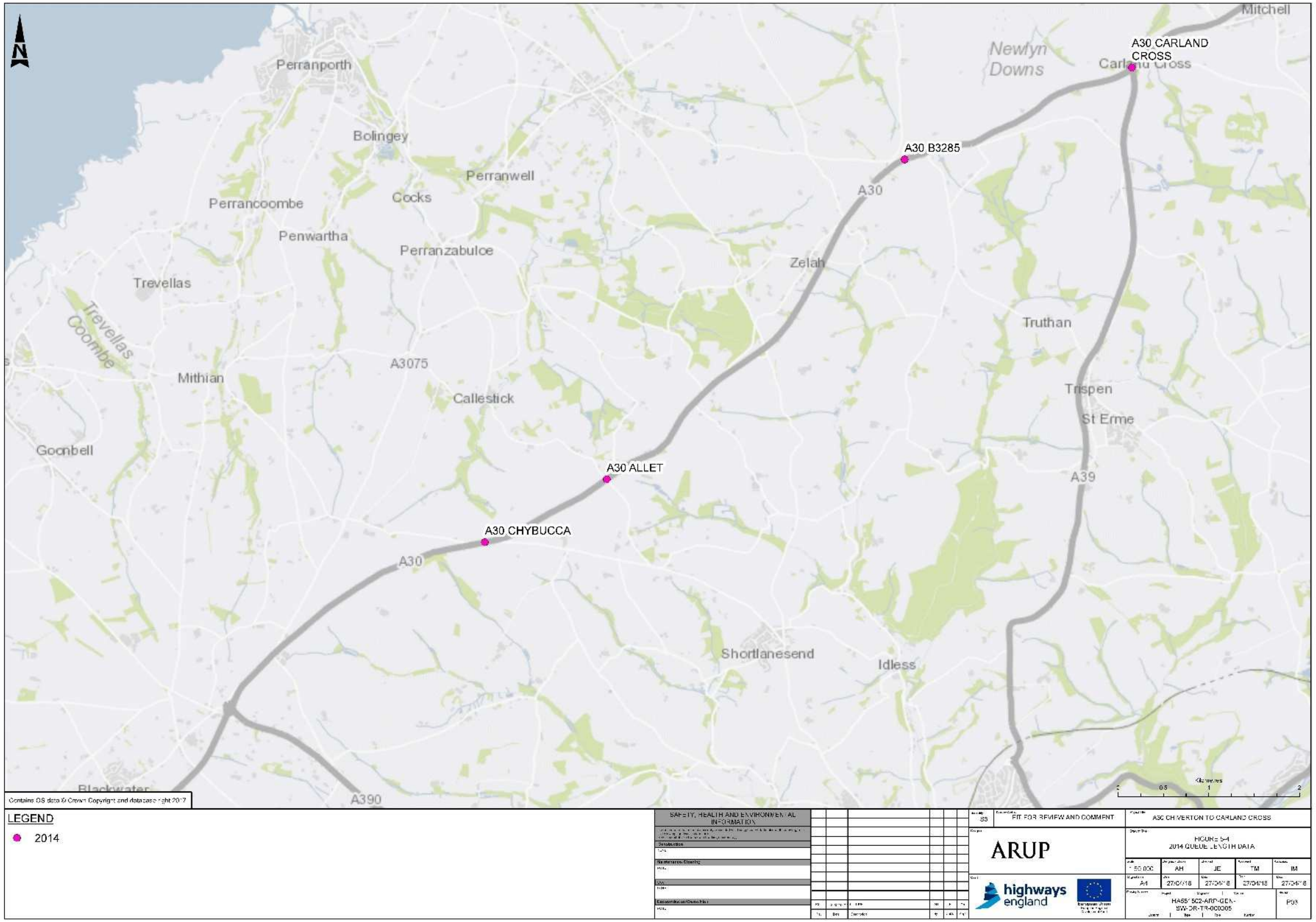

Figure 5-4 Location of available 2014 queue length data

5.1.8 Table 5-1 and Table 5-2 show a summary of the queuing at Chybucca Junction and at Carland Cross Roundabout using the data gathered in 2014. The data was reported as the maximum queue observed in 1 minute intervals. The other junctions that were surveyed in 2014 show limited queuing with very low average queuing at these junctions over the course of the peak periods. Each of the junctions were surveyed on one day only:

- Chybucca Junction – Wednesday 22nd October 2014
- Carland Cross Roundabout – Thursday 23rd October 2014

Table 5-1 2014 Queue summaries at Chybucca junction

Junction	Queue Type	Peak Period	B3284 Northbound		A30 Eastbound		A30 Westbound	
			Lane 1	**Lane 2**	**Lane 1**	**Lane 2**	**Lane 1**	**Lane 2**
Chybucca	Average over the Period (no. Vehicles)	AM	1	1	1	1	1	1
		PM	5	5	5	5	5	5
	Maximum (no. Vehicles)	AM	6	2	0	38	0	27
		PM	22	3	0	10	0	27

Table 5-2 2014 Queue summaries at Carland Cross (excluding windfarm)

Junction	Queue Type	Peak Period	B3284 Northbound		A30 Eastbound		A30 Westbound		Services Northbound
			Lane 1	**Lane 2**	**Lane 1**	**Lane 2**	**Lane 1**	**Lane 2**	**Lane 1**
Carland Cross	Average over the Period (no. Vehicles)	AM	0	2	0	13	0	0	1
		PM	0	0	1	20	0	0	1
	Maximum (no. Vehicles)	AM	3	26	2	35	0	2	4
		PM	4	19	15	35	0	3	4

5.1.9 HGV proportions have been calculated for the peak periods for both the MCC and ATC data. HGV data for both count types has been further separated into OGV1 and OGV2 vehicle classifications in addition to a combined HGV value.

5.1.10 The MCC counts provided OGV1 and OGV2 proportions on a 15-minute basis. These proportions were organised into a series of hourly proportions for each site. The vehicle breakdown for the average peak hour was then calculated from these hourly values. Table 5-3 shows the MCC average peak hour vehicle breakdowns at each count site.

Table 5-3 Manual classified count vehicle proportions

Junction Number from Plan	Site Name	Veh % (12hr Entry Flows)				
		Car	LGV	OGV1	OGV2	HGV
1	**Chybucca**	83%	15%	2%	1%	3%
		73%	18%	5%	3%	8%
		70%	19%	7%	4%	10%
2	**Allet Junction**	73%	19%	8%	0%	8%
		80%	13%	3%	4%	7%
		74%	17%	4%	6%	9%
		75%	20%	5%	0%	5%
3	**Lower Ventongimps Junction**	77%	18%	5%	0%	5%
		0%	0%	100%*	0%	0%
		77%	23%	0%	0%	0%
5	**Shortlanesend Junction, Marazanvose**	58%	37%	0%	5%	5%
		45%	55%	0%	0%	0%
		83%	17%	0%	0%	0%
6	**Perranzabuloe Junction**	94%	6%	0%	0%	0%
		71%	29%	0%	0%	0%
		83%	17%	0%	0%	0%
		67%	33%	0%	0%	0%
7	**Western Slip Road, to Zelah**	0%	0%	0%	0%	0%
		0%	0%	0%	0%	0%
		72%	17%	10%	1%	11%
8	**Shortlanesend/ Zelah Junction**	81%	12%	2%	5%	8%
		0%	0%	0%	0%	0%
		81%	14%	3%	3%	6%
9	**Zelah Hill Slip Road**	84%	14%	2%	0%	2%
		67%	26%	7%	0%	7%
		89%	10%	1%	0%	1%
10	**St Allen Junction**	58%	32%	11%	0%	11%
		100%	0%	0%	0%	0%
		71%	14%	14%	0%	14%
11	**Boxheater (W) Junction**	80%	19%	2%	0%	2%
		75%	25%	0%	0%	0%
		79%	18%	3%	0%	3%
12	**Boxheater (E) Junction**	77%	18%	4%	1%	5%
		71%	20%	5%	3%	9%
		70%	20%	5%	4%	10%
13	**Trispen Junction**	76%	21%	1%	1%	3%
		97%	3%	0%	0%	0%
		83%	13%	4%	0%	4%
14	**Ventonteague Junction**	66%	26%	8%	0%	8%
		90%	10%	0%	0%	0%
		57%	36%	7%	0%	7%
15	**Carland Cross Roundabout**	74%	18%	5%	3%	8%
		74%	19%	6%	2%	7%
		80%	15%	3%	2%	6%

		70%	21%	5%	4%	9%
		0%	0%	0%	0%	0%
16	**Scotland Road/Henver Lane Junction**	86%	12%	2%	0%	2%
		77%	18%	4%	1%	4%
		85%	14%	1%	0%	1%
		80%	16%	3%	1%	4%
17	**Fiddlers Green Junction**	78%	18%	4%	1%	4%
		77%	19%	4%	1%	5%
		62%	15%	3%	20%	22%
		74%	17%	4%	5%	9%
18	**Chybucca East**	70%	21%	5%	4%	9%
		83%	14%	3%	0%	3%
		73%	20%	5%	3%	8%
19	**Chiverton Cross Roundabout**	78%	19%	3%	0%	3%
		70%	21%	5%	3%	8%
		83%	14%	2%	1%	3%
		77%	18%	4%	2%	6%
		79%	18%	3%	1%	3%
20	**A390 Threemilestone Bypass Roundabout**	94%	5%	0%	0%	0%
		87%	11%	2%	0%	2%
		86%	12%	2%	0%	2%
		84%	13%	2%	1%	3%
Note * Only one vehicle observed						

5.1.11 MCC vehicle proportions have been used for A30 ATC counts downloaded from Highways England's TRADS website. MCC counts on the A30 at Chiverton Cross Roundabout, Chybucca, Zelah and Carland Cross Roundabout were used. A 12hr average proportion has been applied to all TRADS outputs, an assumption was made that all sites either side of the scheme will use proportions generated from the Chiverton Cross and Carland Cross MCC sites.

5.1.12 Figure 5-5 shows the locations of the individual counts.

5.1.13 Table 5-4 shows the MCC vehicle proportions used at each TRADS ATC count site.

Table 5-4 MCC vehicle proportions applied to TRADS ATC sites (percentage)

Vehicle Type	TRADS_3703	TRADS_3704	TRADS_3707	TRADS_3708	TRADS_5242	TRADS_5243	TRADS_5266	TRADS_5267	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300125	TRADS_300153
Car	76	74	71	71	76	74	76	74	77	76	76	77	77	76	76	77	71	71	76	74	76	74	74	76	76	74	76
LGV	19	18	20	20	19	18	19	18	18	19	19	18	18	19	19	18	20	20	19	18	19	18	18	19	19	18	19
OGV1	3	5	5	6	3	5	3	5	4	3	3	4	4	3	3	4	5	6	3	5	3	5	5	3	3	5	3
OGV2	2	3	4	3	2	3	2	3	2	2	2	2	2	2	2	2	4	3	2	3	2	3	3	2	2	3	2

5.1.14 Local ATC sites provided by CC did not have vehicle breakdowns included in the data. Vehicle proportions from MCC sites have therefore been applied to these sites. Using the MCC site locations and junction type, each local ATC was assigned an MCC from which vehicle proportions were applied. Figure 5-6 shows the locations of the local ATC counts.

5.1.15 Table 5-5 details the local ATC vehicle proportions (N.B. Due to rounding when presenting the calculated proportions, some percentages may not sum to 100% in the table).

Table 5-5 MCC vehicle proportions applied to local ATC sites (percentages)

Vehicle Type	ATC_5_SB	ATC_35_NB	ATC_35_SB	ATC_41_EB	ATC_41_WB	ATC_76_EB	ATC_76_WB	ATC_77_NB	ATC_77_SB	ATC_137_EB	ATC_137_WB	ATC_218_NB	ATC_218_SB	ATC_973_EB	ATC_973_WB
Car (<5.2m)	83	83	80	80	87	87	80	80	83	83	83	83	80	80	86
LGV (5.2-6.6m)	14	14	15	15	11	11	15	15	15	15	14	14	15	15	12
OGV1 (6.6-11.6m)	3	3	3	3	2	2	3	3	2	2	2	2	3	3	2
OGV2 (>11.6m)	0	0	2	2	0	0	2	2	1	1	1	1	2	2	0
HGV (OGV1 + 2)	3	3	6	6	2	2	6	6	3	3	3	3	6	6	2

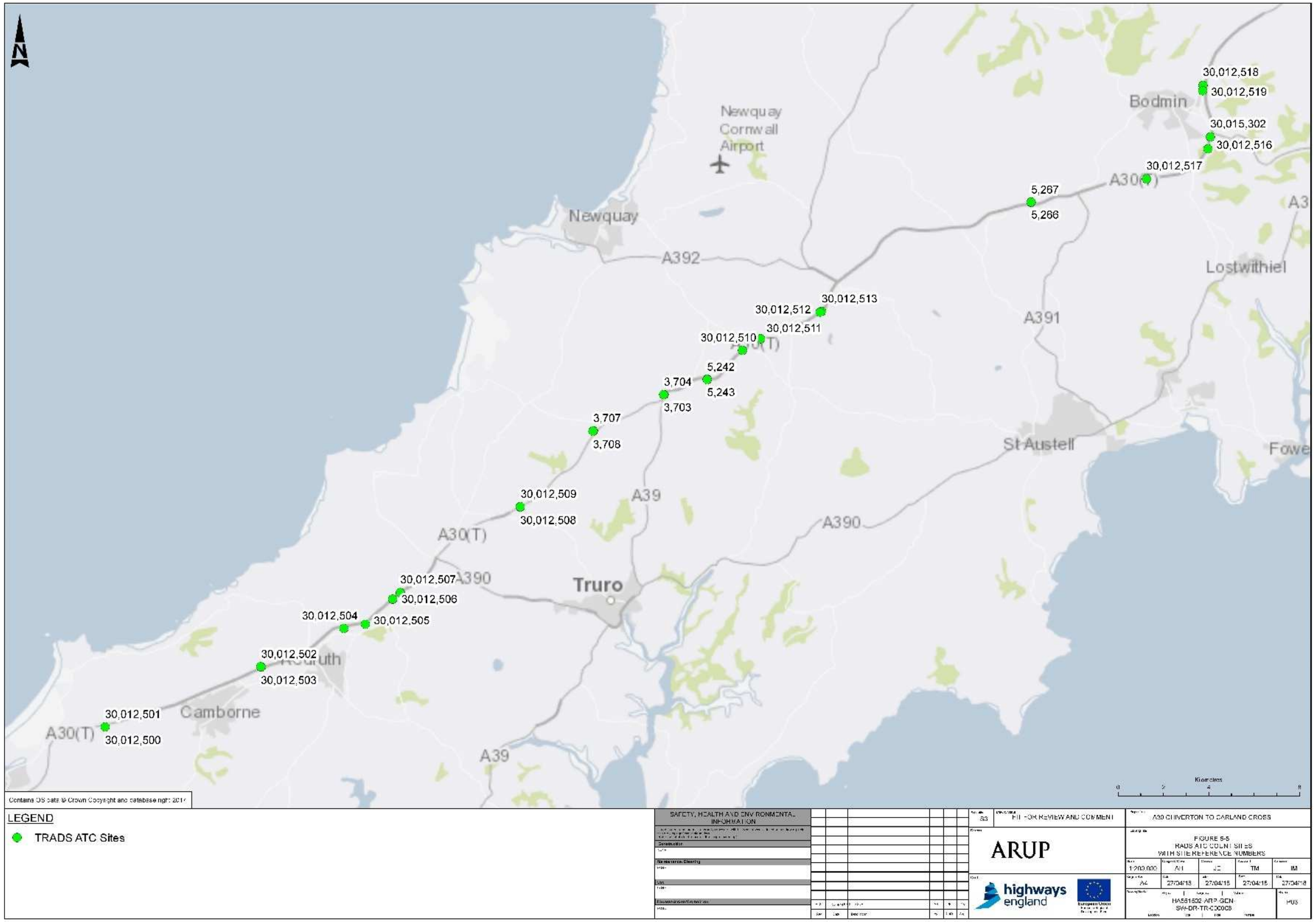

Figure 5-5 TRADS ATC locations with TRADS count references

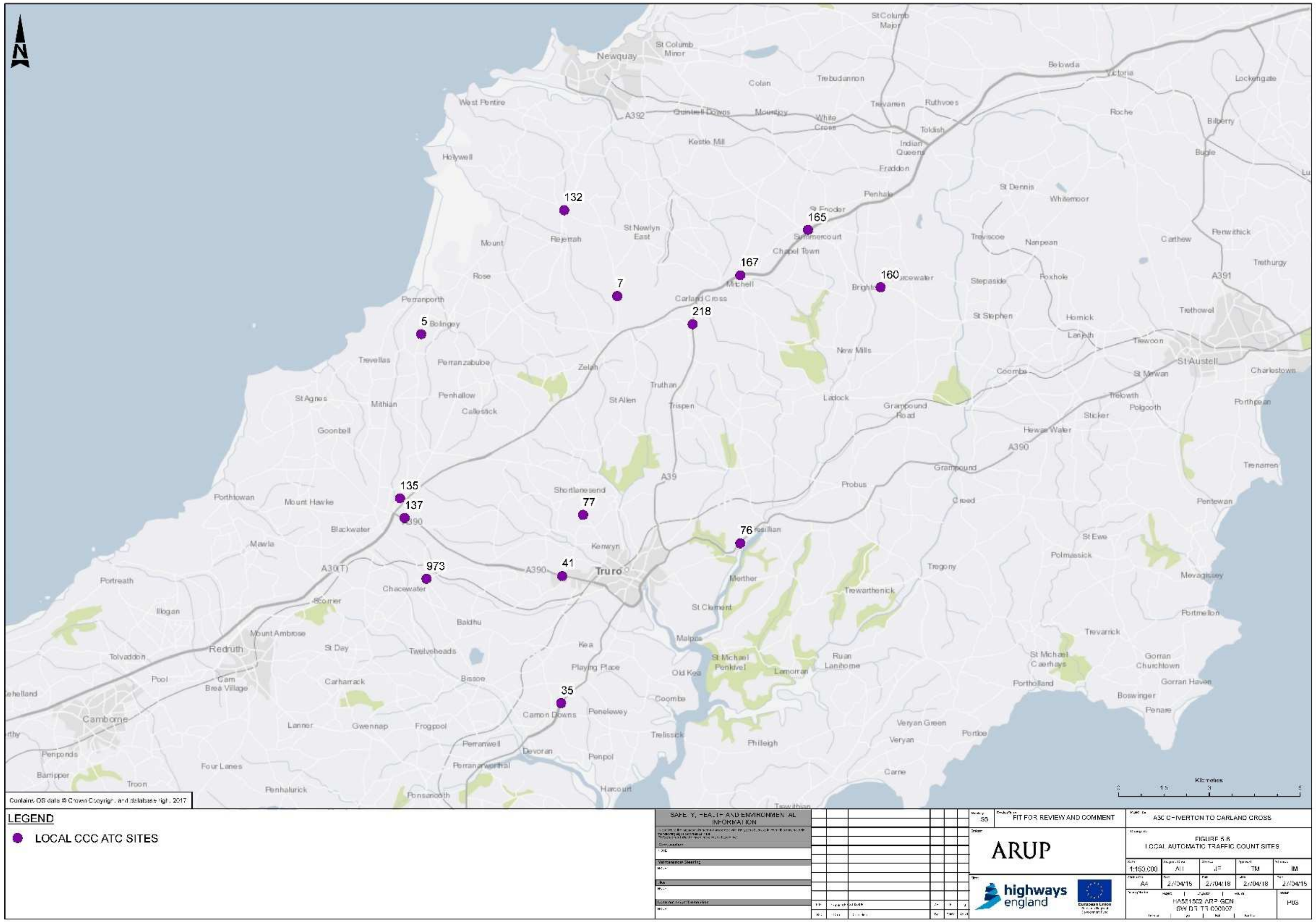

Figure 5-6 Local ATC locations

5.2 Adjustments for Expansion Purposes

5.2.1 The ATC data extracted from the TRADS and CC counts is presented hourly. For the purposes of the modelling it is necessary to be able to convert peak hour data into the average hour during a 3hr peak period. Table 5-6 shows the factors for converting the initial peak hour matrices into the average peak hour for that period. All other data is an average of the 3 hours.

Table 5-6 ATC peak hour to average hour factors

Peak Period	A30 between Chiverton and Carland Factor	Trunk Road Factor (Excluding Chiverton to Carland)	Average A30 Factor
AM	0.935	0.930	0.930
PM	0.879	0.896	0.893

5.2.2 The conversion to average peak hour will take place before any forecasting factors such as TEMPRO are applied to the matrices.

5.3 Interpretation of Results

5.3.1 Existing traffic conditions have been analysed on the A30 between Chiverton Cross and Carland Cross using the TRADS ATC counter between Zelah and Carland Cross roundabout, Figure 5-7 and Figure 5-8 show the existing daily traffic conditions on the A30.

5.3.2 Peaks in both graphs appear to occur during the AM and PM peak periods, from this it could be assumed that traffic is using the route in both directions as part of a commute.

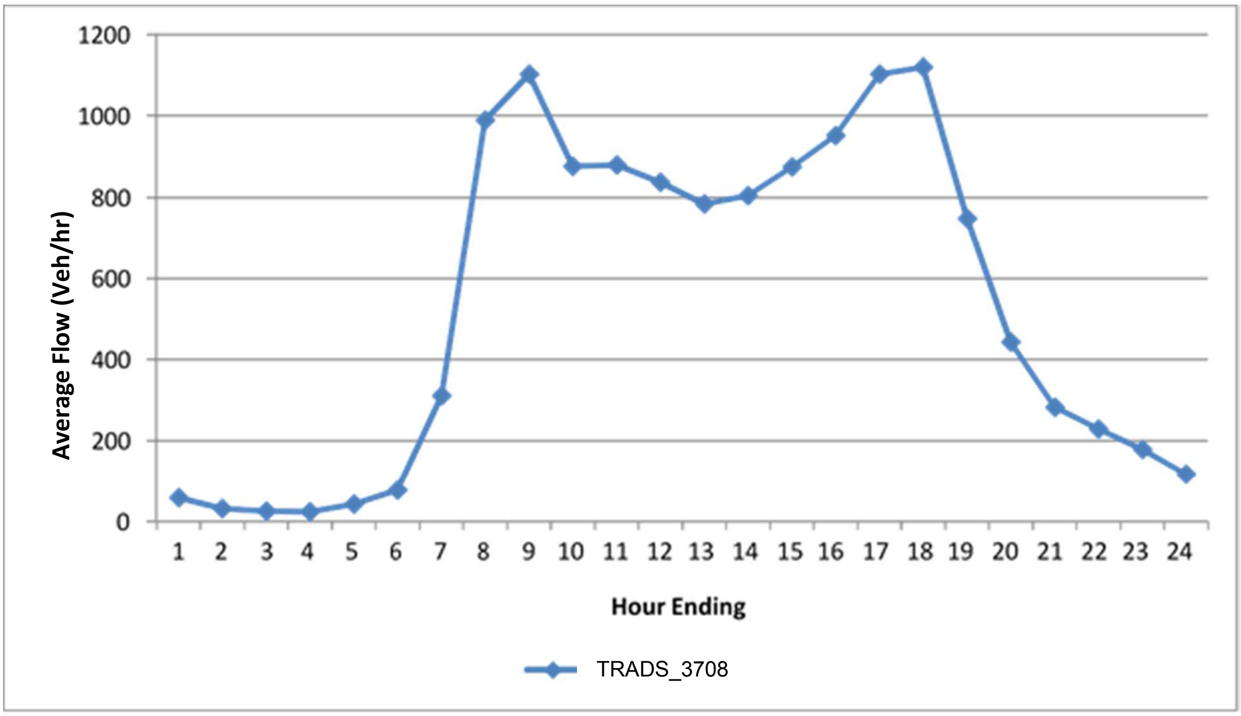

Figure 5-7 Average hourly 2015 westbound traffic flows between Zelah and Carland Cross

5.3.3 Figure 5-8 shows that the eastbound flow on the A30 experiences its largest level of traffic during the PM peak. This trend could suggest that in the AM peak, these vehicles could be using alternative routes such as the A3075 or A39.

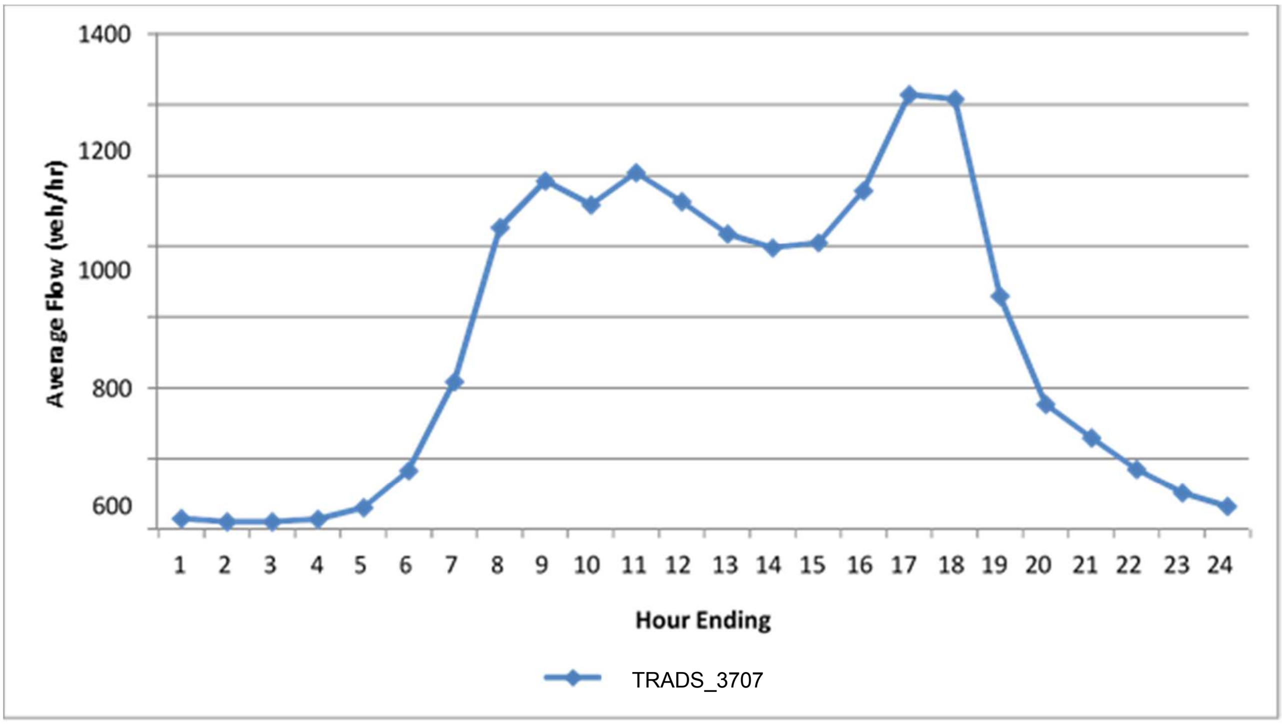

Figure 5-8 Average hourly 2015 eastbound traffic flows between Zelah and Carland Cross

5.3.4 Figure 5-9 and Figure 5-10 show the monthly traffic flows between Zelah and Carland Cross on the A30.

5.3.5 Figure 5-9 shows the westbound monthly traffic flows for the A30. The graph shows a peak in traffic levels during July and August with the trend indicating that the route experiences its highest levels of traffic during the summer. This trend can also be seen in Figure 5-10, where the traffic levels gradually increase throughout the year from January to the peak summer months of July and August. These two months are expected to be when traffic is busiest as Cornwall experiences a high volume of tourist traffic over the summer period, especially the school summer break.

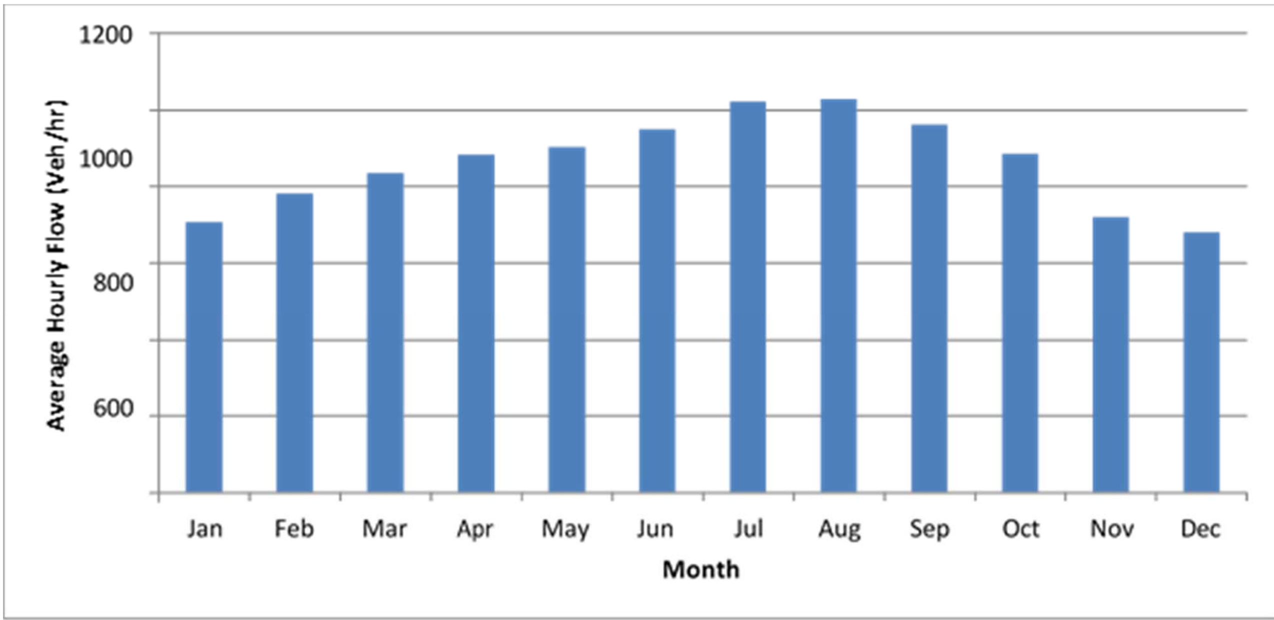

Figure 5-9 Monthly 2015 westbound traffic flows between Zelah and Carland Cross (TRADS 3708)

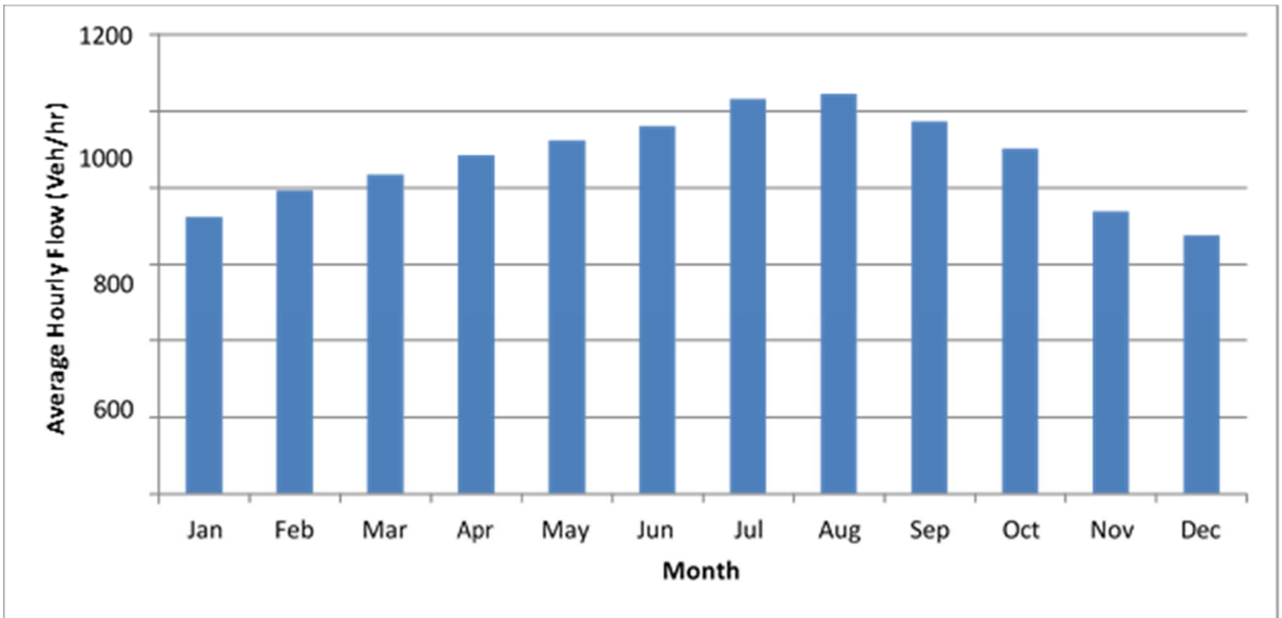

Figure 5-10 Monthly 2015 eastbound traffic flows between Zelah and Carland Cross (TRADS 3707)

5.3.6 Using the annual report for the 2014 flows for the sites in the figures above, the A30 in these locations is shown to be subject to the following seasonality indexes.

Table 5-7 Seasonality indices for the A30 between Zelah and Carland Cross

Site	Seasonality Index
TRADS_3707	1.1841
TRADS_3708	1.1691
Non Built-up Trunk Road Typical Value (COBA Manual)	***1.1000***

5.3.7 The A30 between Zelah and Carland Cross is within the range of seasonality index encountered (1.0 - 1.5) for a non-built-up trunk road as stated in the COBA manual. It is above the typical value of the seasonality index for a non-built-up trunk road.

6 Final Trip Dataset

6.1 Roadside Interview Data

6.1.1 For the final trip dataset, the RSI and postcard surveys undertaken by Nationwide Data Collection Ltd will be used. As previously outlined these were conducted on the following routes:

- A30 – Westbound towards Chiverton Cross Roundabout – RSI;
- A3075 – Southbound towards Chiverton Cross Roundabout – Postcard;
- A390 – Northbound towards Chiverton Cross Roundabout – Postcard;
- B3298 – Eastbound towards Truro; and,
- B3285 – Southbound towards the A30.

6.1.2 The surveys undertaken as part of the 2009 A390 improvements have already been incorporated into the initial 2009 Truro model matrix. The November 2011 RSI undertaken for the A30 Temple to Higher Carblake modelling will be used in the matrix building process of the PCF Stage 3 modelling.

6.2 Additional Surveys

6.2.1 No other additional interview or stated preference surveys were undertaken as part of the PCF Stage 3 data collection. The RSI surveys, covering five locations, are deemed to provide sufficient coverage of the main study area for the purposes of the modelling at PCF Stage 3.

6.3 Data from Other Sources

6.3.1 No other data sources were used outside of those previously specified.

6.4 Data Processing

6.4.1 The following data was recorded in each interview and postcard:

- Time;
- Vehicle type;
- Number of occupants; adults and children;
- Trip origin;
- Trip origin purpose;
- Trip destination;
- Trip destination purpose;
- Was the trip one-way; and,
- Estimated return time if two-way.

Origin destination data cleaning

6.4.2 Before the received data from the surveys was included in the trip dataset, WSP undertook a series of checks to ensure the received data was suitable and that all illogical trips had been removed.

6.4.3 As they will not be modelled, entries for motorcycles were removed. Each origin and destination recorded in the survey has been converted into British OS Coordinate system.

6.4.4 To identify illogical records the origin and destination of each survey record was plotted in MapInfo GIS software. Screen lines were used to logic check the origins and destinations and suspect points were further interrogated to determine if a logical route exists for the O/D pairing. Survey records with ambiguous or illogical origins or destinations have been removed.

6.4.5 A total of 117 records were removed based on illogical origins or destinations. It was suspected that the origin and destinations were reversed in some records which had been highlighted by NDC. As no additional information was available on these records, they were removed.

6.4.6 Following this cleaning process, the data was further interrogated by peak period to assess the peak period sample rates. Table 6-1 shows these peak period sample rates at each site.

Table 6-1 Cleaned RSI data - Peak period sample rates

Site	Peak Period	ATC (Peak Period)	Number of Interviews (Peak Period)	Sample Rate (Peak Period)
C1	AM	2885	179	6.2%
	IP	4796	505	10.5%
	PM	2934	246	8.4%
C2	AM	1267	38	3.0%
	IP	2216	85	3.8%
	PM	1175	73	6.2%
C3	AM	1919	231	12.0%
	IP	5100	413	8.1%
	PM	3302	164	5.0%
C4	AM	1046	268	25.6%
	IP	1275	348	27.3%
	PM	541	155	28.7%
C5	AM	378	120	31.7%
	IP	609	229	37.6%
	PM	373	100	26.8%

6.4.7 Site C2 was undertaken as a postcard survey. The sample rates of usable data from this type of survey are often lower as it relies of the surveys being returned and the fact that the interviewer cannot guide the respondent ensuring that questions are answered correctly and minimising illogical journey types such as permanent home to permanent home. At site C2 the sample rates in two of the peaks, AM and IP, are below 5% in both directions while the PM is below 5% in the non-interview direction. As such it has been decided that data from this site is to be excluded from the final trip dataset as it cannot be considered representative.

6.4.8 A full breakdown of the sample rates for each site by vehicle type can be found in the PCF Stage 3 Traffic Data Collection Report (HA551502-WSP-GEN-0000-RE-TR-00012-P02).

6.4.9 ATC data was provided at each count site for a two-week period leading up to, and including, the day of the survey. This data was used to calculate an expansion factor to growth the RSI sample to the average peak period traffic volume for the respective peak. ATC data for the day of the survey was excluded as NDC stated the slow moving traffic caused by the RSI/postcard surveys caused discrepancies with the count on those days. Therefore, seven neutral weekdays before the commencement of the surveys were instead used for expansion purposes.

6.5 Interpretation of Data

6.5.1 The trip purposes from each site of the survey are presented in Table 6-2 below. This data is further broken down by peak period to allow a comparison across the day. Car has been broken down into three purposes:

- Employers Business
- Commute
- Other

Table 6-2 Trip purpose proportions of survey data by site and time period (interview direction only)

Site	Time Period	User Class Proportion				
		Car – Employers Business	Car – Commute	Car – Other	LGV	HGV
C1	AM	2%	70%	28%	100%	100%
	IP	11%	23%	66%	100%	100%
	PM	7%	47%	45%	100%	100%
C2	AM	15%	44%	41%	100%	100%
	IP	8%	18%	75%	100%	100%
	PM	7%	26%	67%	100%	100%
C3	AM	9%	56%	36%	100%	100%
	IP	10%	14%	76%	100%	100%
	PM	1%	66%	34%	100%	100%
C4	AM	3%	65%	32%	100%	100%
	IP	6%	16%	77%	100%	100%
	PM	4%	35%	61%	100%	100%
C5	AM	5%	57%	39%	100%	100%
	IP	4%	15%	81%	100%	100%
	PM	2%	44%	54%	100%	100%

6.5.2 The trip purposes from each survey record was recorded and compared against the proportions quoted in TAG Data Book March 2017.

6.5.3 All sites are shown to have a lower than national average trip proportion for employers business. The sites located on more strategic corridors (C1 on the A30 and C3 on the A390) show a higher than average proportion of commuting trips across all peaks (70% at C1 and 56% at C3 compared to 46% nationally in the AM peak). The other sites also show this trend in the AM but are more consistent with or lower than the national average in the PM.

Table 6-3 Daily vehicle proportions

Site	Car Proportions		
	Employers Business	Commute	Other
C1	8%	39%	53%
C2	9%	26%	66%
C3	7%	37%	56%
C4	5%	37%	59%
C5	4%	32%	64%
TAG Data Book Weekday Average (March 2017)	15%	31%	54%

6.5.4 Table 6-3 above shows the daily proportions of car journey purposes over the course of the 12-hour survey period compared to the TAG Unit average. It shows that, as with the individual peak period data, there is a higher incidence of commuting trips in the survey sample, with the exception of site C2. The volume of trips with an 'other' purpose is also the same or higher than the national average. Employer's business trips form less than 10% of the sample of car trips recorded in the cleaned interview data at all site. This is below the national average of 15%.

6.5.5 Truro is likely to be the largest attraction for employers business trips. Route choice exists when access Truro, especially from the east and north. Trips to and from Truro from these directions would not necessarily use the Chiverton to Carland Cross section of the A30, instead using the A39 or routing via Shortlanesend.

6.5.6 Given that Sites C1 to C4 are all on roads that can reasonably be used as routes to Truro from various population centres, the high volume of commuter traffic recorded appears reasonable. Employers business is consistently lower than average at all sites in all peaks. For the purposes of the PCF Stage 3 modelling, and in the absence of up-to-date data from other sources, the sample is suitable for inclusion in the final trip dataset.

6.5.7 Table 6-4 shows the statistically representative sample rates need at each RSI site for each vehicle type. These have been calculated as per the calculations outlined in Appendix D13 of the Traffic Appraisal Manual (August 1991)[3].

[3] DMRB Volume 12 Section 1 (November 1997) *The Application of Traffic Appraisal to Trunk Road Schemes*. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol12/section1/12s1p1.pdf

Table 6-4 Comparison of statistically representative sample rates to actual sample rates

Direction	Vehicle Type	Peak Period	Statistically Representative Sample Rate (SRSR) vs. Actual Sample Rate (ASR)							
			Site C1		Site C3		Site C4		Site C5	
			SRSR	ASR	SRSR	ASR	SRSR	ASR	SRSR	ASR
Interview Direction	Car	AM	8%	5%	9%	5%	14%	5%	34%	32%
		IP	5%	9%	3%	8%	14%	27%	30%	39%
		PM	5%	8%	3%	5%	22%	29%	26%	24%
	LGV	AM	83%	13%	88%	14%	93%	30%	98%	40%
		IP	74%	15%	78%	11%	91%	23%	95%	37%
		PM	89%	13%	91%	1%	97%	36%	98%	75%
	HGV	AM	94%	20%	98%	18%	100%	100%	100%	0%
		IP	89%	28%	95%	9%	99%	138%	99%	20%
		PM	95%	4%	97%	0%	100%	41%	100%	0%

6.5.8 Table 6-4 shows that the sample rate for cars is approximately that needed to be statistically reliable. To achieve statistically reliability, the LGV and HGV sample rates are much higher. However, the HGV data was not used so the low actual sample does not affect the model. The LGV sample rate may affect the reliability of the model for this vehicle type but in the absence of alternative data, the RSI data has been used in the A30 Chiverton to Carland Cross model.

6.6 Regional Model Mobile Phone Matrices

6.6.1 For the final trip dataset, the SWRTM compressed matrices will be used to compare the outputs from the Regional Model with the A30 Chiverton to Carland Cross PCF Stage 3 base year model.

6.6.2 The trip purpose proportions for the Car vehicle type from the full Regional Model matrices are presented by time period and user class in Table 6-5.

Table 6-5 Trip purpose proportions of regional model matrices by time period

Site	Time Period	User Class Proportion		
		Car - Employers Business	Car - Commute	Car - Other
South West Regional Model	AM	8%	44%	47%
	IP	9%	22%	69%
	PM	6%	36%	58%
TAG Data Book Weekday Average (March 2017)		15%	31%	54%

6.6.3 Table 6-5 suggests that the Regional Model matrices have a lower proportion of Employers Business trips that the Weekday Average outlined in TAG Databook March 2017. Commuting trips make up a higher proportion of car trips in the AM and PM Regional Model matrices, with a similar trend in the Interpeak and PM Regional Model matrices for ‘other’ type trips.

7 Final Journey Time Dataset

7.1 Journey Time Routes

7.1.1 Journey time data is required to provide an understanding of traffic conditions experienced by road users on an average neutral day. The journey time data will also be used in validating the transport models.

7.1.2 Journey Time data was collected from the HATRIS JTDB on the A30 trunk road. The list below details the location of the routes on the A30 corridor in the vicinity of the study area:

- A3074 Hayle and Penzance (Westbound only);
- A3074 Nut Lane, Lelant and Tolvaddon Interchange;
- Tolvaddon Interchange and Scorrier Interchange;
- Scorrier Interchange and Chiverton Cross roundabout;
- Chiverton Cross roundabout and Carland Cross roundabout;
- Carland Cross roundabout and Mitchell Interchange;
- Mitchell Interchange and Chapel Town;
- Chapel Town and St Enoder;
- St Enoder and Indian Queens;
- Indian Queens and junction with A389/A391;
- Junction with A389/ A391 and Carminnow Cross;
- Carminnow Cross and Launceston Rd, Bodmin; and,
- A30 Entry Slip and A395, Tregadillett (Eastbound only).

7.1.3 These routes cover the A30 in detail between Lelant, near Hayle and Bodmin. The A30 journey time routes are shown in red in Figure 7-1.

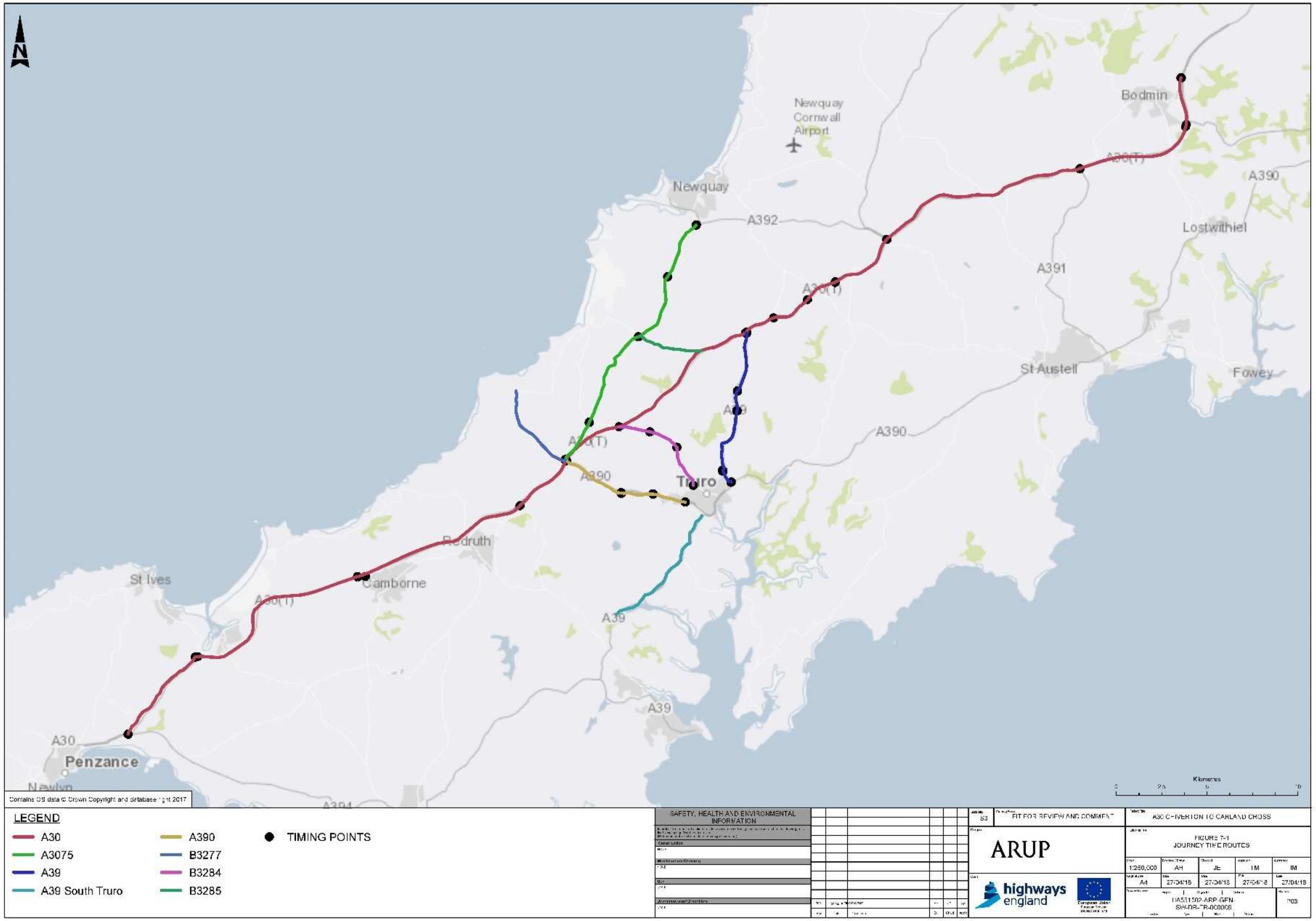

Figure 7-1 Journey time routes

7.2 Data Cleaning

7.2.1 The data used has come from the TRADS HATRIS database and is therefore considered to be viable and accurate. As such no data cleaning was undertaken on this data.

7.3 Data from other Sources

7.3.1 Cornwall Council has provided Traffic Master journey time data for a cordon encompassing the study area. Figure 7-1 shows these routes.

7.3.2 This data provides journey times between the 01/09/2013 and 31/10/2013 for the AM (07:00-10:00), Interpeak (10:00-16:00) and PM (16:00-19:00) peak periods. This represented the most up-to-date data available for the months required. The journey times have been extracted for the following routes:

- A390 between Chiverton Cross and County Hall, Truro;
- A39 between Carland Cross and Union Hill junction, Truro;
- A3075 between Chiverton Cross and Newquay;
- B3284 between Chybucca and Truro via Shortlanesend;
- A39 between Arch Hill, Truro and Carnon Gate, Devoran;
- B3285 between the A30 and the A3075;
- B3277 between Chiverton Cross and St. Agnes; and
- A30 between Chiverton Cross and Carland Cross.

7.4 Interpretation of Data

7.4.1 Each hour of journey time data is classified as high, medium or low quality. Table 7-1 shows the average quality of the data for each modelled period. The table shows that the majority of the data is of ‘low’ quality. This means that there is a high proportion of synthesised data per kilometre with fewer journey time loops per route to collect the data. This data is created by in-filling where data is lacking using data from either similar days or from before or after the missing time period. High and medium quality data would be preferable but the journey time data is limited to what is available from the HATRIS database and in this case low quality data has therefore had to be used.

Table 7-1 Journey time dataset quality

Site	Location	Neutral Weekday AM Peak			Neutral Weekday Interpeak			Neutral Weekday PM Peak		
		High	Medium	Low	High	Medium	Low	High	Medium	Low
AL784	*A30 Westbound (Between Camborne and Hayle)*	0%	1%	99%	0%	1%	99%	0%	0%	100%
AL801	*A30 Eastbound (Between Chiverton Cross Rbt and Carland Cross Rbt)*	0%	6%	94%	0%	12%	87%	0%	15%	84%
AL802	*A30 Westbound (Between A3076 Newquay Junction and Carland Cross Rbt)*	1%	18%	81%	0%	8%	92%	0%	6%	94%
AL1907	*A30 Eastbound (Between Mitchell and Summercourt)*	0%	4%	96%	0%	10%	90%	0%	15%	85%
AL1908	*A30 Westbound (Between Summercourt and Chapel Town)*	1%	18%	81%	0%	6%	94%	0%	5%	95%
AL1909	*A30 Eastbound (Between Carland Cross Rbt and A3076 Newquay Junction)*	0%	5%	95%	0%	11%	88%	0%	15%	85%
AL1910	*A30 Westbound (Between Mitchell and Summercourt)*	1%	19%	80%	0%	6%	94%	0%	7%	93%
AL1911	*A30 Westbound (Between Chiverton Cross Rbt and Scorrier)*	1%	17%	82%	0%	9%	91%	0%	14%	85%
AL1912	*A30 Eastbound (Between Camborne and Scorrier)*	0%	10%	90%	0%	10%	90%	0%	15%	85%
AL1913	*A30 Eastbound (Between Hayle and Camborne)*	0%	1%	99%	0%	1%	99%	0%	0%	100%
AL1914	*A30 Westbound (Between Scorrier and Camborne)*	0%	1%	99%	0%	0%	100%	0%	1%	99%
AL1918	*A30 Eastbound (A389 Lanivet Junction and A38 Bodmin)*	0%	1%	99%	0%	2%	98%	0%	1%	99%
AL1919	*A30 Westbound (Between A30 Entry Slip Bodmin and A38 Bodmin Junction)*	0%	2%	98%	0%	1%	99%	0%	1%	99%
AL2195A	*A30 Eastbound (Between Indian Queens and A389 Lanivet Junction)*	0%	11%	89%	1%	14%	86%	2%	13%	85%
AL2196A	*A30 Westbound (Between A38 Bodmin Junction and A389 Lanivet Junction)*	1%	20%	78%	0%	9%	91%	0%	10%	89%
AL3077	*A30 Eastbound (A38 Bodmin and A30 Entry Slip Bodmin)*	0%	2%	98%	0%	4%	96%	0%	2%	98%
AL3081	*A30 Westbound (Between Hayle and Penzance)*	0%	2%	98%	0%	1%	99%	0%	1%	99%
AL3083	*A30 Eastbound (Between Penzance and Hayle)*	0%	0%	100%	0%	1%	99%	0%	1%	99%
AL3084	*A30 Westbound (Between Carland Cross Rbt and Chiverton Cross Rbt)*	0%	4%	96%	0%	1%	99%	0%	1%	99%

Site	Location	Neutral Weekday AM Peak			Neutral Weekday Interpeak			Neutral Weekday PM Peak		
		High	Medium	Low	High	Medium	Low	High	Medium	Low
AL3085	*A30 Eastbound (Between Scorrier and Chiverton Cross Rbt)*	0%	1%	99%	0%	3%	97%	0%	3%	97%
AL3086A	*A30 Eastbound (Between Chapel Town and Indian Queens)*	0%	4%	96%	0%	8%	92%	0%	10%	89%
AL3087A	*A30 Westbound (Between A389 Lanivet Junction and Indian Queens)*	0%	12%	88%	0%	4%	96%	0%	6%	94%
AL3088	*A30 Westbound (Between Indian Queens and Summercourt)*	0%	15%	84%	0%	5%	95%	0%	4%	96%
AL3089	*A30 Eastbound (Between Summercourt and Chapel Town)*	0%	3%	97%	0%	8%	92%	0%	11%	89%
AL2196A	*A30 Westbound (Between A38 Bodmin Junction and A389 Lanivet Junction)*	1%	20%	78%	0%	9%	91%	0%	10%	89%

7.4.2 Both data sources included the A30 Chiverton Cross to Carland Cross and presented some differences between them. They are summarised in Table 7-2.

Table 7-2 Journey time differences (seconds) between HATRIS and Cornwall Council between Chiverton and Carland Cross

Direction	Data Source	AM	IP	PM
Eastbound	Cornwall Council	684	642	702
	HATRIS	656	652	697
	Relative Difference	4.09%	-1.56%	0.71%
Westbound	Cornwall Council	804	673	748
	HATRIS	734	657	690
	Relative Difference	8.71%	2.38%	7.75%

7.4.3 As shown above, there are only two significant differences. These are in the westbound direction during the AM and PM peaks. These differences are 70 and 58 seconds, which represent, approximately, 8- 9% of the journey time. Given that the HATRIS data was described as low quality, it was agreed with Highways England's Transport Planning Group (TPG)[4] to use the Cornwall Council data that was collected during two neutral months (September and October).

7.4.4 2014 journey time data will be used for the purpose of calibrating the A30 to the east and west of the scheme and the data provided by Cornwall Council will be used to calibrate the A30 between Chiverton and Carland and the surrounding routes. While some 2015 data is available, a whole year of data will not be available in time for inclusion within the PCF Stage 3 model. There are also differences in the site locations and lengths between the 2014 and 2015 datasets.

[4] Agreed with Highways England's TPG via email on 22/02/17

7.4.5 Sites were chosen to ensure full coverage of the A30 corridor through the study area, whilst ensuring the data collected was suitable for input to developing and validating the transport models.

7.4.6 Figure 7-2, Figure 7-3 and Figure 7-4 below show that on the Chiverton to Carland Cross section of the A30 there are high levels of congestion in the AM and PM peaks with the journey times higher than 150% of the free flow journey times. These free flow times represent the 99th percentile of the observed journey times on each route. In the interpeak period journey times are still above 125% of the free flow journey time. The figures also show that there are delays on the A30 on both of the approaches to this section.

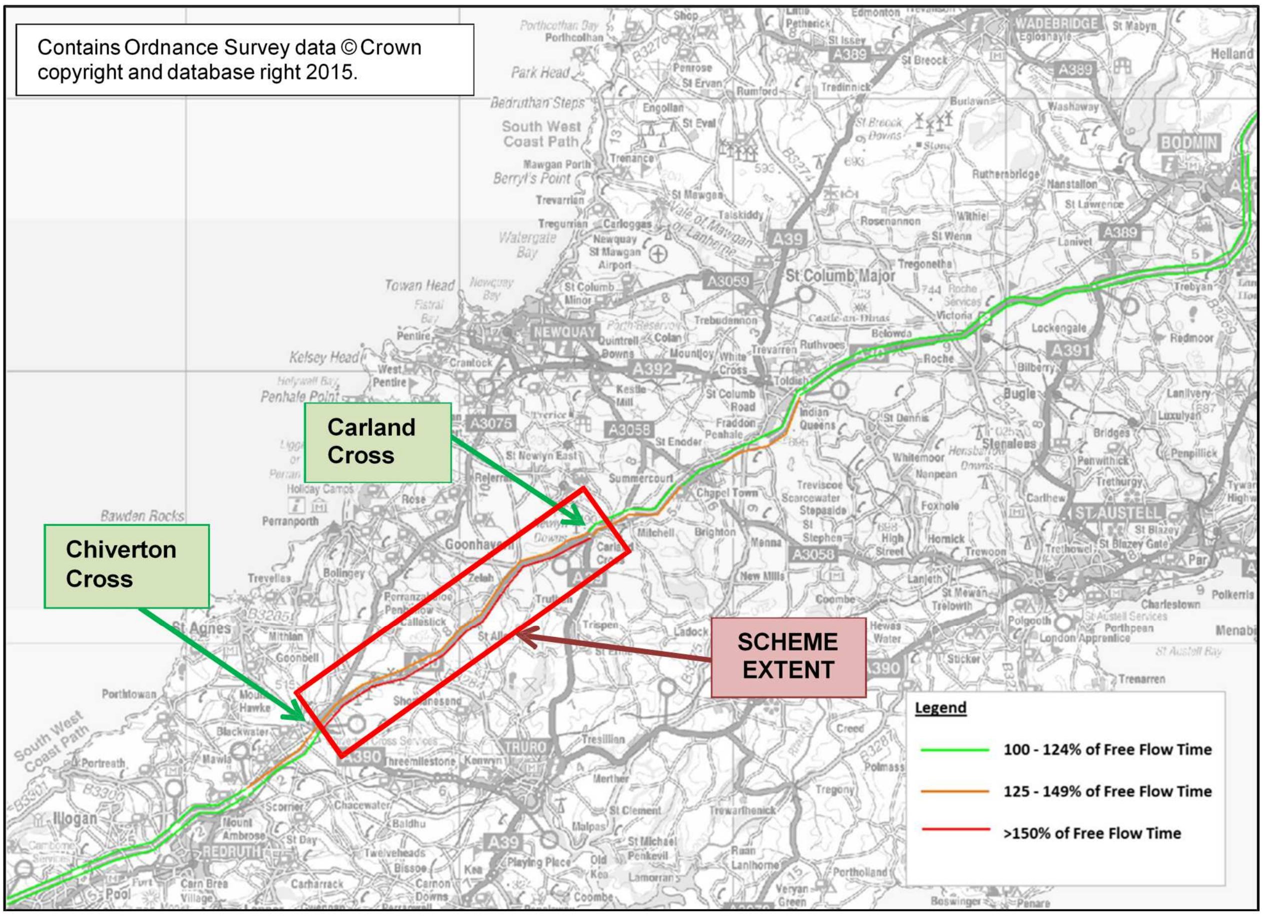

Figure 7-2 AM average peak hour journey times in relation to link free flow time

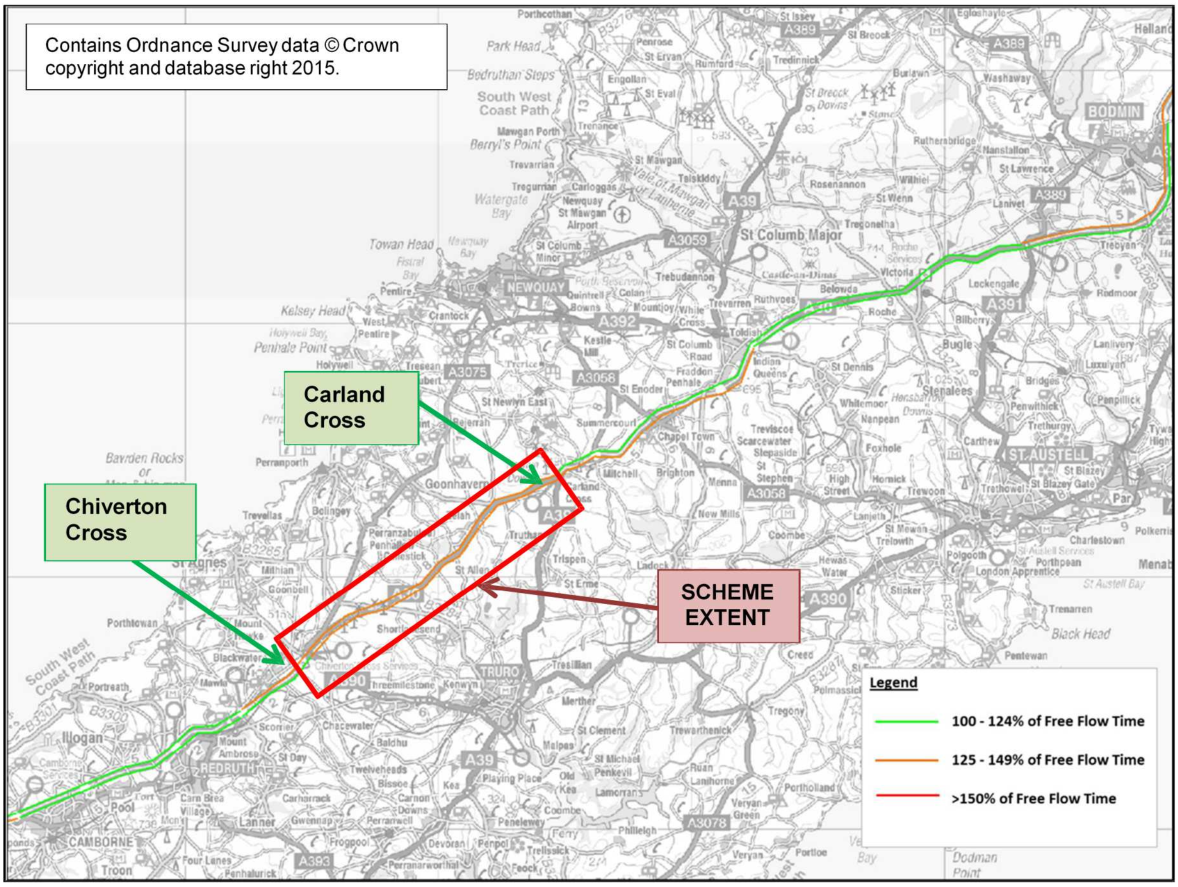

Figure 7-3 IP average peak hour journey times in relation to link free flow time

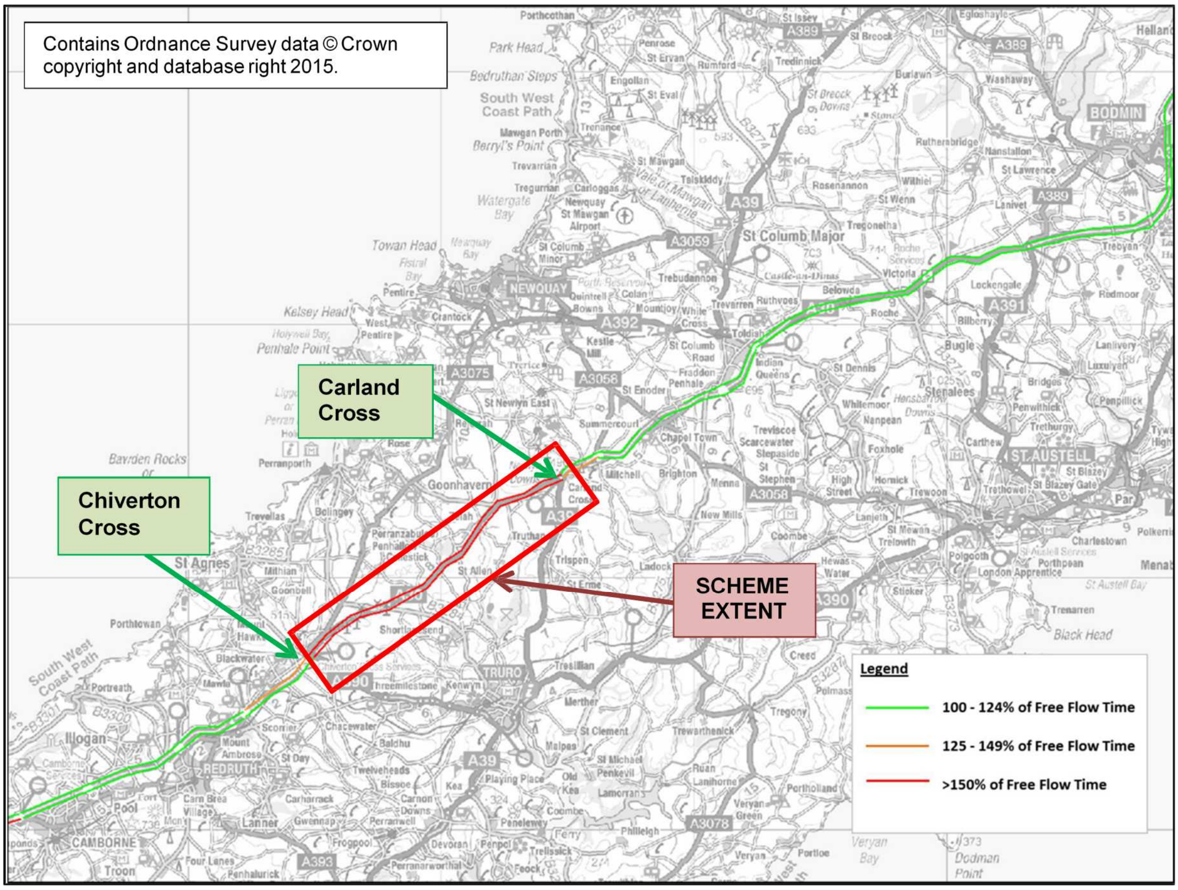

Figure 7-4 PM average peak hour journey times in relation to link free flow time

7.4.7 A full breakdown of the journey times for each link are found in the PCF Stage 3 Traffic Data Collection Report (HA5510502-WSP-GEN-0000-RE-TR-00012-P02).

7.4.8 Table 7-3 below shows the average speeds along the corridor between Hayle and Bodmin. The analysis shows the corridor exhibits an average speed of approximately 101kph (or 63mph) which is below the 70mph speed limit in operation for the majority of the route. This suggests that the single carriageway sections of the A30 between Carland Cross and Chiverton Cross and between Camborne and Hayle are suppressing the average speed. There is a lower speed limit for the single carriageway section (60mph or 96kph). Table 7-3 shows that average speeds on the A30 between Chiverton Cross roundabout and Carland Cross Roundabout are significantly below this.

Table 7-3 Average journey time speeds

Site	Location	Link Length (km)	Avg. Speeds (kph)		
			Neutral Weekday AM Peak	Neutral Weekday Interpeak	Neutral Weekday PM Peak
AL784	A30 Westbound (A3047 Camborne to A3074 Hayle)	10.88	83	77	73
AL801	A30 Eastbound (A39 Carland Cross Rbt to A3076 Newquay Junction)	1.78	93	93	95
AL802	A30 Westbound (A3076 Mitchell to A39 Carland Cross Rbt)	1.72	91	96	95
AL1907	A30 Eastbound (A3058 Chapel Town to A3058 Summercourt)	1.9	108	107	111
AL1908	A30 Westbound (A3058 Summercourt to A3058 Chapel Town)	1.86	110	107	114
AL1909	A30 Eastbound (A3076 Mitchell to A3058 Chapel Town)	2.24	107	108	111
AL1910	A30 Westbound (A3058 Chapel Town to A3076 Mitchell)	2.26	109	108	112
AL1911	A30 Westbound (A390 Chiverton Cross Rbt to A3047 Scorrier)	3.68	99	97	100
AL1912	A30 Eastbound (A3047 Scorrier to A390 Chiverton Cross Rbt)	3.6	93	94	91
AL1913	A30 Eastbound (A3047 Camborne to A3047 Scorrier)	9.9	108	108	113
AL1914	A30 Westbound (A3047 Scorrier to A3047 Camborne)	9.9	112	109	110
AL1918	A30 Eastbound (A38 Bodmin to A30 Entry Slip Bodmin)	2.76	110	99	113
AL1919	A30 Westbound (A30 Exit Slip Bodmin to A38 Bodmin Junction)	2.66	115	114	118
AL2195A	A30 Eastbound (A391 Lanivet Junction to A38 Bodmin)	6.74	108	106	112
AL2196A	A30 Westbound (A38 Bodmin Junction to A391 Lanivet Junction)	6.86	109	108	111
AL3077	A30 Eastbound (A30 Entry Slip Bodmin to A395 Tregadillett)	27.46	107	96	108
AL3083	A30 Eastbound (A3074 Hayle to A3047 Camborne)	11.08	90	87	90
AL3084	A30 Westbound (A39 Carland Cross Rbt to A3075 Chiverton Cross Rbt)	12.64	62	69	66
AL3085	A30 Eastbound (A3075 Chiverton Cross Rbt to A39 Carland Cross Rbt)	12.66	69	70	65
AL3086A	A30 Eastbound (A39 Indian Queens to A391 Lanivet Junction)	11.92	110	110	114
AL3087A	A30 Westbound (A391 Lanivet Junction to A39 Indian Queens)	11.92	110	110	112
AL3088	A30 Westbound (A39 Indian Queens to A3058 Summercourt)	4	108	105	109
AL3089	A30 Eastbound (A3058 Summercourt to A39 Indian Queens)	3.96	101	102	106
		Average	101	99	102

7.4.9 The following surveys are within the single carriageway section between Carland Cross and Chiverton Cross:

- AL3084
- AL3085

7.4.10 Table 7-4 below shows the journey time on these routes compared to the free flow journey time.

Table 7-4 Single carriageway journey time comparison to free flow time

Site	Location	Free Flow Time (s)	Journey Times (s)			Difference from Free Flow Time		
			Neutral Weekday AM Peak	Neutral Weekday Interpeak	Neutral Weekday PM Peak	Neutral Weekday AM Peak	Neutral Weekday Interpeak	Neutral Weekday PM Peak
AL3084	A30 Westbound (Between A39 Carland Cross Rbt and A3075 Chiverton Cross Rbt)	451	739	657	690	64%	46%	53%
AL3085	A30 Eastbound (Between A3075 Chiverton Cross Rbt and A39 Carland Cross Rbt)	454	656	652	697	44%	44%	53%

7.4.11 These sites show high levels of deviation from the free flow time suggesting that these links experience a high level of congestion. Table 7-4 shows these links are as much as 64% (AL3084) and 53% (AL3084 and AL3085) higher than the free flow time in the AM and PM peaks respectively.

8 Operational Data

8.1 Network Mapping

8.1.1 The original 2009 Truro model simulation and buffer networks will both be expanded for the 2015 base year. The simulation network will be expanded to include more detail on and to the north of the A30. This will encourage accurate route choice for trips accessing the A30 from towns to the north. The simulation network will be formed of the following sections:

- A30 between Indian Queens and Redruth;
- A3075 between Chiverton Cross Roundabout and Newquay;
- The city of Truro;
- The key routes around the western side of Redruth; and,
- Minor routes to smaller population centres have been added, including routes to Perranporth and St Agnes located north of the A30.

8.2 Geometric and Operation Data

Accident data

8.2.1 A summary of traffic Personal Injury Accidents (PIA) was provided by Cornwall Council for the A30 between Chiverton Cross and Carland Cross between 01/01/2012 and 31/12/2016. During this time there was a total of 1 Fatal, 17 Serious and 93 Slight accidents.

8.2.2 Figure 8-1 shows the location of the accidents within the study area. Accidents were more frequent in the vicinity of Chiverton Cross, Carland Cross, Zelah Hill, Chybucca and Callestick/Allet Cross Junction.

8.2.3 Regarding severity, the map does not show a clear distributional pattern of the killed or seriously injured (KSI) collisions. Out of 17 serious collisions, four occurred at Chiverton Cross, two at Carland Cross with the remaining four spread along the route. The only registered fatal collision occurred near Chybucca junction.

8.2.4 Table 8-1 shows the breakdown of the accidents by year and severity.

Table 8-1 Breakdown of accidents by severity and year

Year	Fatal	Serious	Slight	Total
2012	0	2	17	19
2013	1	2	13	16
2014	0	4	25	29
2015	0	3	20	23
2016	0	6	18	24
Total	1	17	93	111

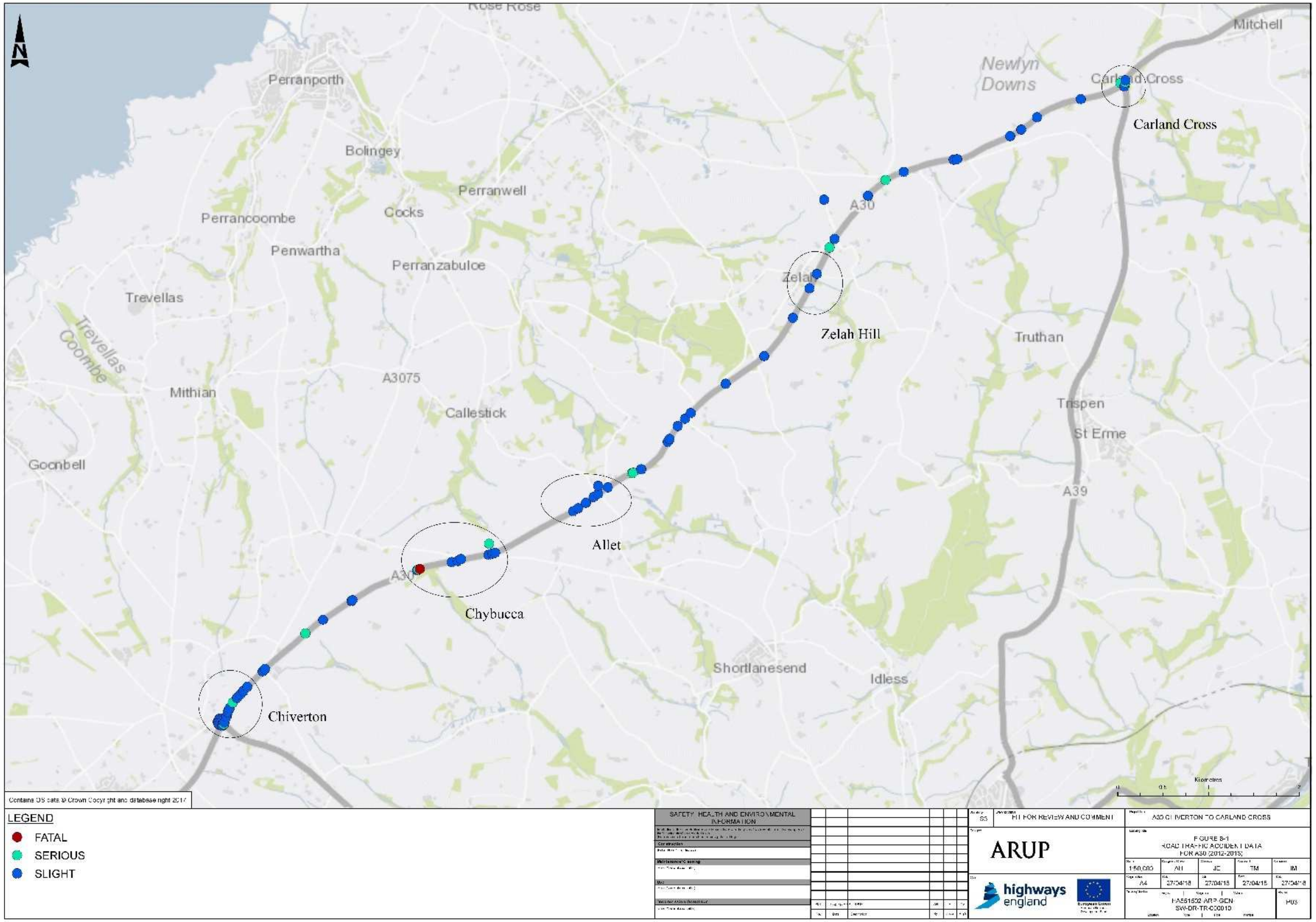

Figure 8-1 Accident map (January 2012 to December 2016)

8.2.5 Accident clusters are shown at Chiverton Cross, Chybucca, Allet Cross, Zelah Hill and Carland Cross.

Combined link and junction accident rate

8.2.6 Based on this accident data, combined link and junction accident rates were calculated for each year, with the study area on the A30 split into three sections:

- Chiverton Cross to B3284 Chybucca;
- B3284 Bybucca to B3285 Boxheater; and
- B3285 Boxheater to Carland Cross.

8.2.7 The annual accident rate was calculated using the formula below.

$$A = \frac{P}{(365 \times R \times N \times T \times 10^{-6})}$$

Where: *A* = Accident rate (PIAs per million vehicle kilometers);

P = Number of PIAs recorded between Y1 and Y1+N;

R = Link length (km);

N = Number of consecutive years accident data has been collected for;

T = Mean annual average daily traffic figure from the first year for which accidents were collected to the final year of accident data (veh/day);

8.2.8 Table 8-2 presents the annual two-way accident rates for each of the three sections of the A30 under consideration, followed by the average accident rate across the six years of accident data. AADT data was sourced from DfT traffic counts to complete the calculation.

Table 8-2 Annual accident rates per million vehicle kilometres

Year	Chiverton Cross to Chybucca	Chybucca to Boxheater	Boxheater to Carland Cross	National Average
2012	0.361	0.160	0.047	-
2013	0.497	0.040	0.046	-
2014	0.684	0.158	0.138	-
2015	0.486	0.156	0.076	-
2016	0.402	0.164	0.149	-
Average	0.486	0.136	0.091	0.244

8.2.9 Table 8-2 shows that the accident rates from Chybucca to Carland Cross are lower than the national average for an S2 A road type using combined link/junction analysis, which according to the TAG data book December 2017 v1.9.1 is 0.244 PIAs/mvkm. However, for the section of the A30 between Chiverton Cross and Chybucca, the accident rates are considerably higher than the national average.

8.2.10 The COBA-LT assessment utilised the accident rates for the average number of accidents per year over the five-year period to remove any bias that could be present from single years with large numbers of collisions. The accident rates were applied to the specific links of the COBA-LT network that make up the section of the A30 from Chiverton Cross to Carland Cross in place of the default values.

8.3 Data Quality and Risk Mitigation

8.3.1 The data is considered of adequate quality for the PCF Stage 3 modelling. Checks have been conducted to ensure the mapping used is up to date.

9 Model Description/Specification

9.1 Description of the Demand Modelling System

9.1.1 The PCF Stage 3 A30 Chiverton to Carland Cross SATURN model is a variable demand highway model. The future year demand forecasting is based on the PCF Stage 3 base year model, which in turn is based on the 2009 Truro SATURN model matrices. These matrices were updated to a base year of 2015 in PCF Stage 1 using roadside interview data collected for this study, which includes a site located on the A30.

9.1.2 The 2009 Truro SATURN model was designed to assess the impact of developments and highway improvement schemes in the vicinity of the city of Truro, Cornwall. The Truro 2009 demand matrices were built using RSI data from six sites on the key routes into Truro. Two of the sites, on the A390 near Highertown and the B3284 near Shortlanesend were surveyed in 2009; the other sites were surveyed in 2003. A gravity model was then used to estimate unobserved trips. A30 through trips were added from an older model matrix, and updated to 2009 volumes.

9.1.3 The 2009 Truro model covered the time periods listed below and carried forward to this study:

- AM Peak Hour – 08:00 to 09:00
- PM Peak Hour – 17:00 to 18:00

9.1.4 An additional interpeak hour model (average interpeak hour from 10:00 to 16:00) was constructed during the development of the PCF Stage 1 model, which has also been updated for PCF Stages 2 and 3.

9.1.5 Following on from PCF Stage 1, the model was converted into an average peak period model to fit with the Regional Traffic Models being developed at the time.

9.2 Explanation of how the Model Relates to other Components of the Demand Model

9.2.1 Variable demand modelling was carried out at PCF Stage 2 and will also be carried out at PCF Stage 3. The variable demand model will be an incremental type of model (also known as a “pivot-point” model) as recommended in WebTAG. The demand response in the model will therefore be a function of relative changes in cost between a forecast and comparator scenario.

9.2.2 Two separate stages will be required to produce the Do Minimum and Do Something forecasts.

- Do Minimum – pivot off base model (i.e. demand model will use base year costs as a comparator); and,
- Do Something – pivot off Do Minimum (i.e. demand model will use future year Do Minimum costs as a comparator).

9.2.3 The Department for Transport’s DIADEM software programme (Version 5) will be used to specify and operate the demand model processes.

9.2.4 The PCF Stage 3 model will include the key roads across Great Britain in order to model full trip lengths as required for variable demand modelling.

9.3 Description of Land Use Interaction Models Used

9.3.1 There is no interaction with land use transport interaction models; however, planned development is included within the forecast models in line with WebTAG and constrained to TEMPRO.

9.4 Description and Justification of Type of Highway Model Used

9.4.1 The 2009 Truro SATURN model was used as the basis for the PCF Stage 2 appraisal work. This model is considered to be the most suitable and appropriate model for the PCF Stage 3 appraisal work; the model has good network coverage in the area of interest and was developed in compliance with WebTAG guidance at the time.

9.4.2 In PCF Stage 3, this model is still considered to be the most suitable basis for the development of the PCF Stage 3 base model, as stated in the PCF Stage 3 Appraisal Specification Report (HA551502-WSP-GEN-0000-RE-TR-00009) which was agreed with Highways England's TPG on 03/02/17. In order to achieve the calibration and validation requirements set out in WebTAG, several modifications have been carried out. These modifications include definition of new roads, new zones, changes in the geometrical characteristics of the roads and capacity of junctions. With these changes the model has moved from a robust and efficient model of the region to a model precisely tailored for this scheme.

9.4.3 For PCF Stage 2, the level of detail within the model around the A30 was refined and the model updated to a base year of 2015. As part of PCF Stage 3, the level of detail within the model around the A30 has been further refined to ensure that the model is capable of analysing changes to flows on key links around the A30, including routes to Truro and Newquay, as a result of the scheme. The network to be used in the PCF Stage 3 model has been developed in consultation with Cornwall Council, as the local highway authority.

9.5 Description and Justification of Type of Public Transport Model Used

9.5.1 A public transport model has not been developed for PCF Stage 3 as the impact of the scheme on public transport routes and usage is not considered to be significant. This was agreed in the PCF Stage 3 Appraisal Specification Report (HA551502-WSP-GEN-0000-RE-TR-0009-P03).

9.6 Description of how Parking, Park-and-Ride and Slow Modes are Modelled

9.6.1 The base year model includes zones for major car parks within Truro, and also a zone for the western Park and Ride site, located on the A390 to the west of Truro city centre. Trips to and from these zones have therefore been included in the model, with demand determined through the roadside interview surveys and origin/destination surveys at the Park and Ride site.

9.7 Description, Plan and Justification of Geographical Model Coverage

9.7.1 The detailed modelled area includes the A30 between Redruth and Indian Queens. Further routes in the detailed network include the A3075 to Newquay, B3284 from Truro to St Agnes, and the A390 and A39 to Truro, along with several other important minor routes providing access to towns and villages in the vicinity of the A30 Chiverton to Carland Cross scheme area.

9.7.2 The wider study area includes the major routes to the west of Redruth, the A390 to the south of Truro towards Falmouth and the major strategic routes within Cornwall and Devon such as the A39, A38 and A30. The rest of the UK is modelled using the key Strategic Road Network (SRN) routes to link the various regions. Figure 4-1 in Section 4.1.1 of this report shows the extents of the network in the vicinity of Cornwall.

9.8 Software Package and Version Used

9.8.1 The model has been developed using version 11.3.12U of the software package SATURN. Diadem Version 5 for the VDM component of the modelling.

10 Model Development

10.1 Network

Description of network structure

10.1.1 From PCF Stage 1 onwards, the model for this scheme was based on the original 2009 base SATURN network, which was developed to assess the traffic impact of strategic developments around Truro. For the purposes of the subsequent modelling stages, further development of this network was undertaken to provide more detail to the simulation network along the A30 between Redruth and Indian Queens. The level of detail in the network to the north and south of the A30 has also been increased to represent the key routes to population centres in the north Cornwall such as Newquay, St Agnes and Perranporth.

10.1.2 During the PCF Stage 3 model development, the network has been further enhanced along the A30 corridor by the inclusion of all junctions with smaller unclassified roads between the Chiverton Cross and Carland Cross roundabouts. Where necessary, new zones have been created for these accesses to reflect the localised demand generated by adjacent farms and hamlets. Cornwall Council has been consulted to assist in the identification of the additional network links and nodes required.

10.1.3 The existing network provided detail of the major routes to and from Truro with the following sections coded in simulation part of the network; the A390 between the A30 Chiverton Cross Roundabout and Truro, the city of Truro, the A3075, the A30 between Scorrier and Mitchell, and the A39 between the A30 Carland Cross Roundabout and Truro.

10.1.4 The buffer network has also been extended to include the key roads in Great Britain to enable the modelling of long distance trips. Fixed speeds were coded on these links because there is only partial trip representation in this area.

10.1.5 The extent of the detailed and wider study area is illustrated in Figure 10-1. The simulation network is now formed of the following sections:

- A30 between Indian Queens and Redruth;
- A3075 between Chiverton Cross Roundabout and Newquay;
- The city of Truro;
- The key routes around the western side of Redruth;
- Minor routes to smaller population centres have been added including routes to Perranporth and St Agnes located north of the A30.

10.1.6 The buffer network was expanded to include the rest of the UK. This allows realistic modelling of long range trips. The additional UK network consists of the major strategic routes used to access major population centres such as the M4, M6 and M25.

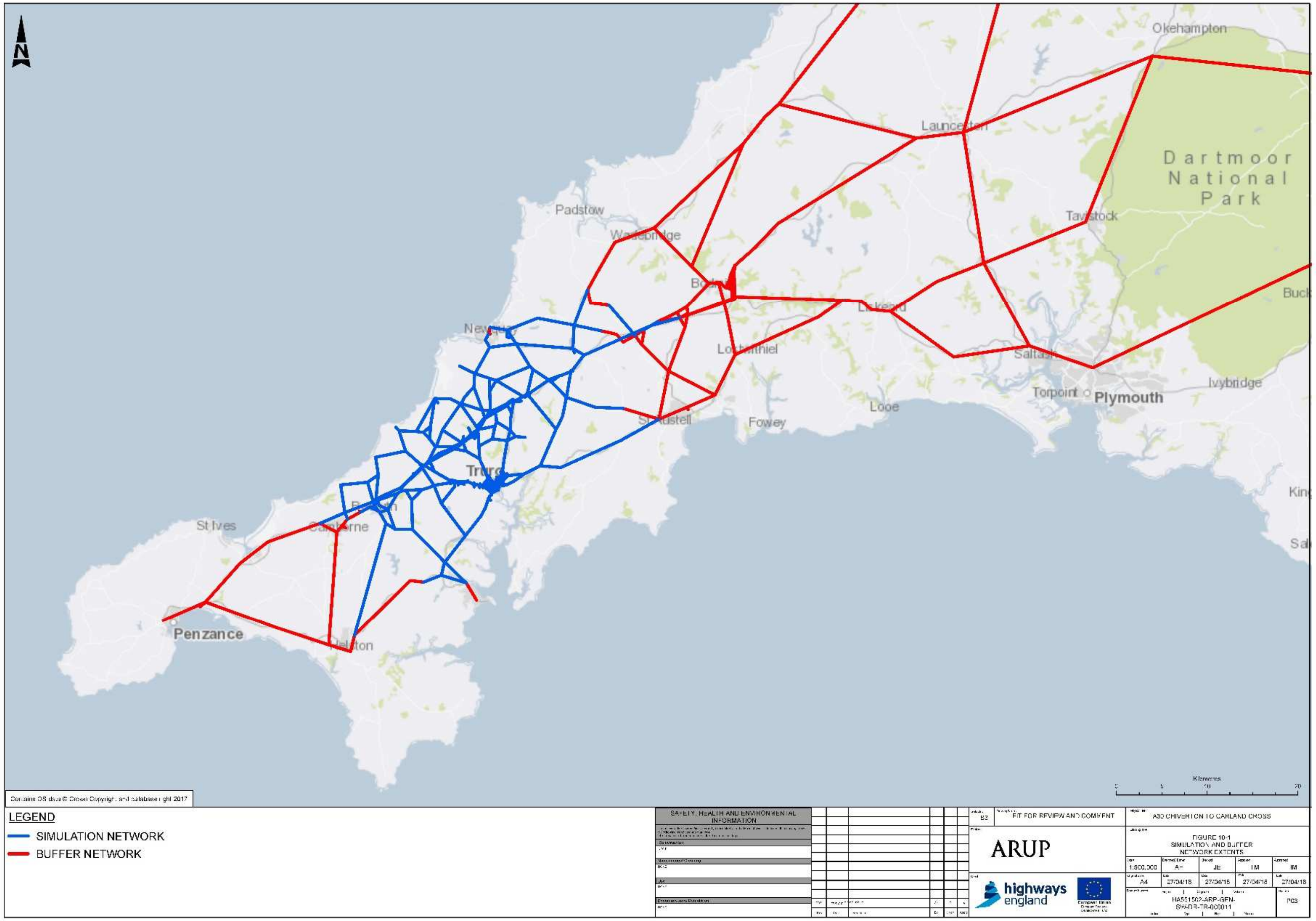

Figure 10-1 Simulation and buffer network extents

10.1.7 A number of schemes have been identified as being introduced before the new base year of 2015. The following schemes have been added into the network coding:

- **Trafalgar Roundabout (Truro):** Increased the number of approach lanes on the A390 Tregolls Road and the B3284 St Austell Street. The improvements also saw an increase in the number of circulatory lanes.
- **Union Hill junction (Truro):** These improvements were introduced as part of the Tregurra Park P&R site; the improvements saw the number of lanes increase to two on the A39 Newquay Road towards Truro. The improvements also introduced a new arm to north providing access to the P&R site for buses.
- **Chiverton Cross Roundabout widening:** This scheme introduced additional lanes on the entry arms of the roundabout along with an additional circulatory lane to increase the roundabout capacity.

10.1.8 Figure 10-2 shows the location of the three improvement schemes:

10.1.9 For the Chiverton to Carland Cross PCF Stage 3 model a number of additional local roads to the south and north of the A30 and in Redruth were added to the simulation network following consultation with Cornwall CC.

10.1.10 Figure 10-3 shows the additional network added to the model.

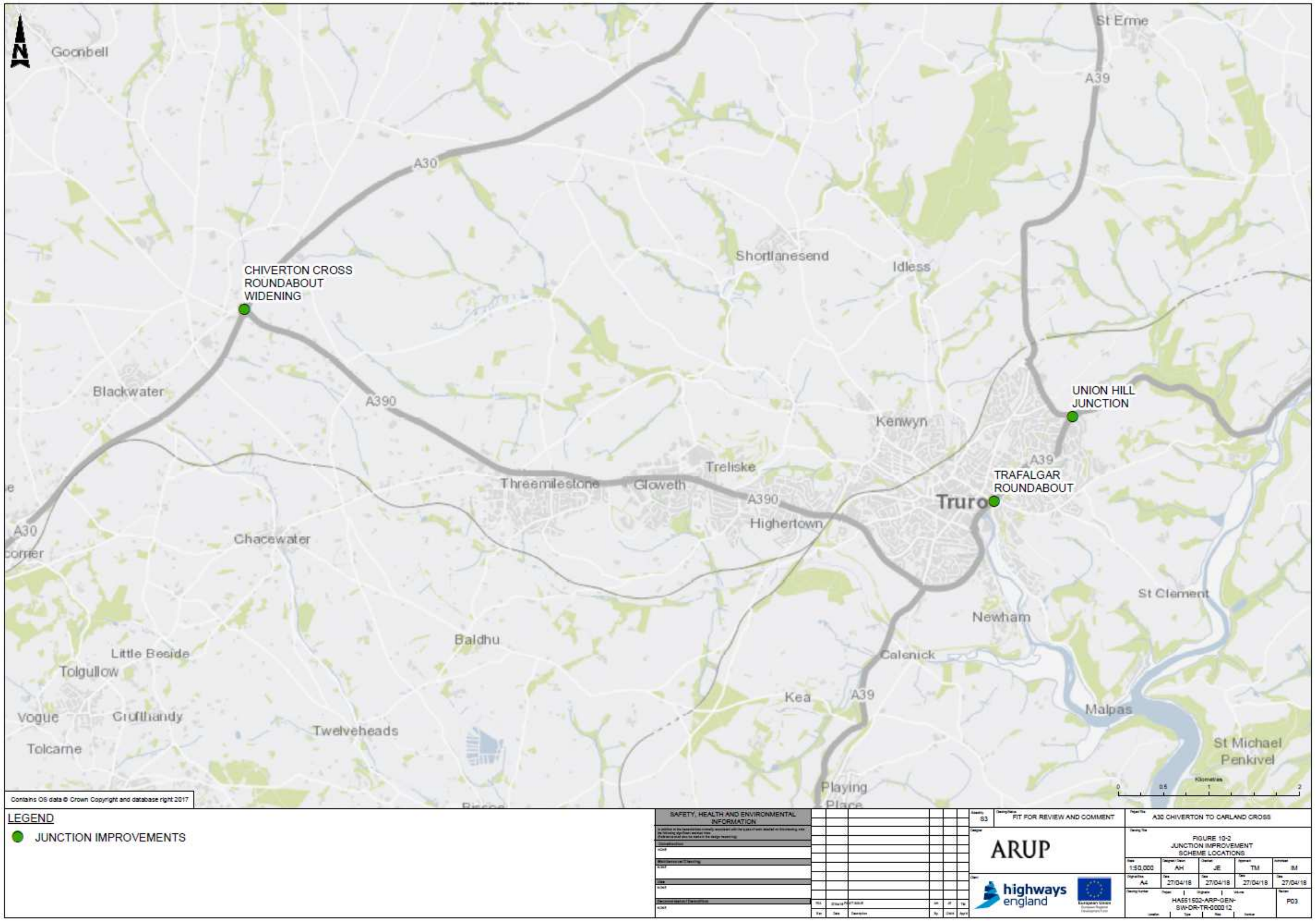

Figure 10-2 Junction improvement scheme locations

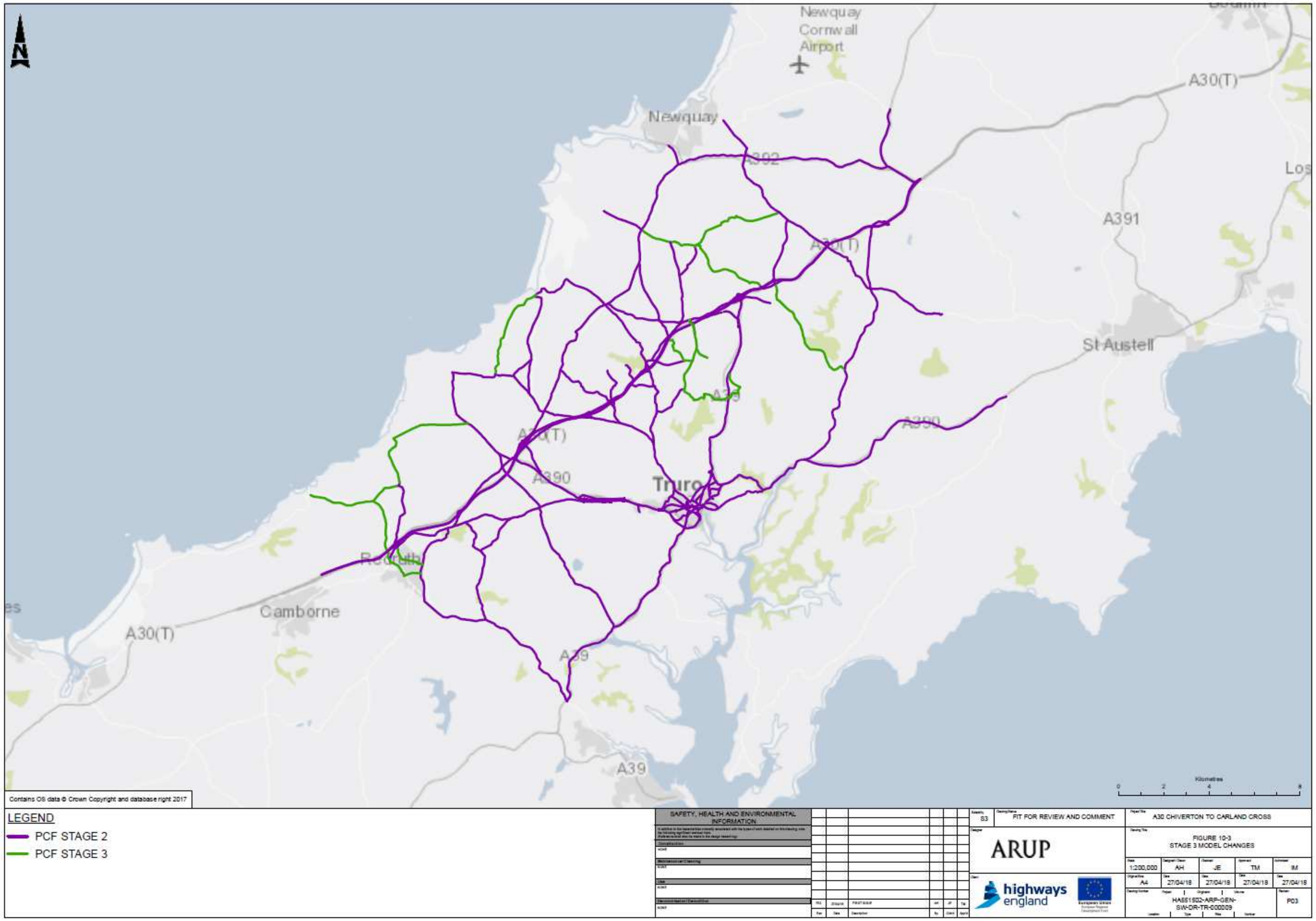

Figure 10-3 PCF Stage 3 Model changes

Description of coding process

10.1.11 All node locations have been validated using MapInfo GIS software. Link lengths have been determined through the use of satellite imagery on Google Earth Pro. The calculation of saturation flows and speed limits are covered in Sections 10.1.12 to 10.1.16. Information on how signal timings were calculated is outlined in Sections 10.1.18 to 10.1.19.

Evidence for assessment of speed limits/road types

10.1.12 Speed-flow curves were added to a number of routes through the network in order to limit link capacity and provide a better representation of traffic speed at times of high traffic flow. This was particularly important to accurately model the difference in capacities between dual and single carriageway sections of the A30. Speed-flow curves have been added to routes in rural areas. In these areas link capacity, rather than junction capacity, is the key constraint on flow.

10.1.13 The speed-flow curves have been obtained from the Regional Traffic Models Network Coding Manual (Version 08). The exception to this is the speed-flow curve 39 – Rural Lane two directions with difficulty passing. Some of the routes in the modelled network are very narrow, but still represent important local roads that have needed to be modelled. On these roads, two cars travelling in opposite directions can only pass with difficulty, usually one of them having to stop or pull in to let the other vehicles pass. It is considered reasonable to describe a new Speed Flow Curve that would have a limited speed and half the capacity of a regular road to accurately model the characteristics of these routes.

10.1.14 Table 10-1 below shows the Speed Flow Curves which have been used in the simulated network for this purpose.

Table 10-1 List of speed-flow curves used in model

Index	Description	Free Flow Speed (kph)	Speed at Capacity (kph)	One-Way Link Capacity (pcu/hr)	No. Lanes	Power
20	Rural – Dual Carriageway (2 Lane, All Purpose)	112	73	4,199	2	2.7
21	Rural WS2 10.0m A Road	93	55	1,686	1	2.15
22	Rural – Single Carriageway (10m width, Typical)	87	58	1,328	1	2.0
23	Rural – Single Carriageway (7.3m width, Good)	82	53	1,328	1	2.0
24	Rural – Single Carriageway (7m width, Typical)	64	34	1,328	1	2.4
25	Rural – Single Carriageway (6.5m width, Bad)	67	45	1,010	1	1.8
26	Suburban D2 (Slight Development)	75	35	3,540	2	2.56
27	Suburban – Dual Carriageway (Typical Development)	71	35	3,540	2	2.0
29	Suburban – Single Carriageway (Slight Development)	65	25	1,680	1	2.6
30	Suburban – Single Carriageway (Typical Development)	61	25	1,680	1	1.6
31	Suburban – Single Carriageway (Heavy Development)	58	25	1,680	1	1.0
32	Small Town (35% Development)	63	32	1,344	1	2.9
33	Small Town (60% Development)	56	30	1,344	1	2.4
34	Small Town (90% Development)	46	30	1,344	1	1.3
35	Rural Village	47	30	1,100	1	2.5
36	Rural Village – Traffic Calmed	30	20	1,100	1	2.5
37	Rural S2 narrow carriageway	82	53	950	1	2.1
38	Rural S2 Other Road (slow, narrow carriageway)	54	35	950	1	1.5
39	Rural Lane two directions with difficulty passing	45	35	475	1	1.5

10.1.15 Table 10-2 below details the Speed Flow Curves applied to the key routes within the model.

Table 10-2 Speed Flow Curves applied to key routes

Route	Curve Index
A30 from Hayle to Bodmin	20, 21, 23
A39 from Carland Cross to Bodmin Road	21, 23, 25, 30
A39 from Falmouth to Calenick/Arch Hill	23, 24
A39 Morlaix Avenue	20
A390 between Treliske Roundabout and Dalvenie Roundabout	33
A390 from Chiverton Cross to Threemilestone Roundabout	23
A390 from Tresillian to Union Hill	23
A3047 through Redruth and Camborne	26, 34
A3058 from St Austell to A30	24, 25, 30
A3075 from Chiverton Cross Roundabout to Newquay	24, 25
A391 from St Austell to A30	23
A393 from Redruth to Four Cross	24, 30, 34, 35
B3274 from St Austell to A30	25
B3284 between Chybucca Crossroads and Pydar Street	24, 25, 36, 38
B3284 at Shortlanesend	33, 35
B3303 and B3297 from Helston to Camborne/Redruth	25
Station Road between Blackwater and Chasewater	39

Description of calculation and assumptions

10.1.16 Saturation flows, based on the characteristics of the individual junctions, have been used for junctions in the simulation network. Table 10-3, Table 10-4 and Table 10-5 show the typical saturation flows for different junction types coded within the A30 Chiverton to Carland Cross model. These saturation flows are based upon Highways England’s RTM Network Coding V08 guidance.

Table 10-3 Priority junction saturation flows (PCU/hr)

Movement	Saturation Flow (PCU/hr)
Major Straight Ahead	1,980
Major Left Turn	1,530
Major Right Turn[5]	830
Minor Left Turn[6]	770
Minor Right Turn[7]	640

[5] Standard Major Lane to Minor Lane right turn, crossing traffic with good visibility (RTM Network Coding V 08)
[6] Standard Minor Lane to Major Lane left turn, with average visibility and without central reserve (RTM Network Coding V 08)
[7] Standard Minor Lane to Major Lane right turn, with average visibility and without central reserve (RTM Network Coding V 08)

Table 10-4 Signalised junction saturation flows (PCU/hr)

Movement	Saturation Flow (PCU/hr)
Straight Ahead	1,980
Turn	1,740

Table 10-5 Roundabout saturation flows (PCU/hr)

Approach Lanes	Number of Entry Lanes		
	1	2	3
Single (3.5m)[8]	1,100	1,620	1,800
Single (5.0m)[9]	1,380	1,920	2,100
Dual 2 Lane[10]	-	2,200	2,760
Dual 3 Lane[11]	-	-	3,320

Description of any network inventory undertaken

10.1.17 No additional network inventory has been undertaken at this stage of the modelling process.

Description of any junction operation data

10.1.18 Where new signalised schemes have been added to the network, such as Union Hill signalised junction, fixed signal times obtained from Cornwall Council have been coded into the network. Where schemes operate via vehicle actuation, fixed signal timings have also been used due to the limitation that SATURN cannot model vehicle actuation at discrete junctions. The existing signalised junctions in the base model have not been updated as part of the A30 Chiverton to Carland Cross appraisal work.

10.1.19 Merges were introduced to the network on the A30 entry links at Scorrier and Avers Roundabout where detail has been coded into the model. Merges have been used at these points in the network to ensure that all traffic entering the mainline of the A30 do so in the correct manner and are not modelled to stop at the entrance to the junction. All merges in the SATURN model have been coded using the ‘M’ marker, which indicates a turn merging with another turning movement at a priority junction.

Description of any modelling assumptions

10.1.20 The model has three vehicle classifications: Cars, Light Goods Vehicles (LGV) and Heavy Goods Vehicles (HGV). The car vehicle class has been further split into the following purposes, resulting in a total of five user classes:

- Employers business;
- Commute; and
- Other.

[8] Standard Width Entry Capacity (RTM Network Coding V 08)
[9] Wide Width Entry Capacity (RTM Network Coding V 08)
[10] Standard Width Entry Capacity for 2 Lanes (RTM Network Coding V 08)
[11] Standard Width Entry Capacity for 3 Lanes (RTM Network Coding V 08)

10.1.21 The trip matrices are specified in Passenger Car Units (PCUs). The PCU factors used are shown in Table 10-6.

Table 10-6 PCU factors

Vehicle Class	PCU Factor
Car	1
LGV	1
HGV	2

10.1.22 The PCU factor of 2 for HGVs has come from the 2009 Truro model. TAG Unit M3.1 states that the PCU equivalent for HGVs on motorways and all-purpose dual carriageways should be 2.5 and the PCU equivalent for HGVs on other road types should be 2.0. This model study area includes dual carriageway on the A30 to the east of Carland Cross and the west of Chiverton Cross but focuses on the single carriageway section of the A30 between Chiverton Cross and Carland Cross, and other road types around Truro and the routes. The PCU factor is therefore thought to be reasonable.

10.1.23 A queue length of 5.75m per PCU has been assumed in the model. This is the default PCU length value within SATURN.

Description of any public transport modelling

10.1.24 The bus routes present in the 2009 Truro model have been preserved in the A30 Chiverton to Carland Cross modelling. Updates to these have been made where necessary due to the use of version 11.3.12U of SATURN in the development of the 2009 Truro model.

Description of treatment of freight transport

10.1.25 HGVs have been included as User Class 5 of the model. No further disaggregation for long haul freight has been undertaken.

Description of network assumptions relating to representation of tolls, High Occupancy Vehicles lanes, Active Traffic Management and Variable Speed Limits

10.1.26 There are no toll routes within Cornwall. The Tamar Bridge between Plymouth and Saltash is the nearest toll route. This is located within the buffer network and is deemed unlikely to affect routing via the scheme location as the A38 joins the A30 before this location so does not provide an alternative route. The toll has not been included in A38 coding for the A30 Chiverton to Carland Cross model.

10.2 Matrices

Description of zone structure

10.2.1 The original zone system was plotted in GIS software to understand the zone coverage of the original model. To accurately model the traffic, further detail was required for the zoning system in the vicinity of the study area. To do this, several larger zones containing multiple larger population centres were disaggregated into smaller zones as detailed later in this section.

10.2.2 Figure 10-4 shows that the zone structure is very detailed within Truro itself but the surrounding areas have been grouped into larger zones, with the exception of Camborne, Redruth, Penryn and Falmouth which are large population centres near to Truro. The other zones contained several settlements of varying sizes. The following stages were undertaken to form the zone system used during the PCF Stage 3 modelling:

10.2.3 Zones 79, 73 and 64 were identified as requiring further separation due to additional simulation network being added to the SATURN model. Zone 62 was also identified as requiring further disaggregation due to it including St Austell, which is a large population centre, alongside other towns and settlements that would likely have varied route choices. The new zones are centred around population centres which are likely to use similar loading points on the network. The boundaries of these new zones are based upon combined boundaries of the 2011 Census Output Areas that form them. The updated Cornwall zone structure can be seen in Figure 10-5.

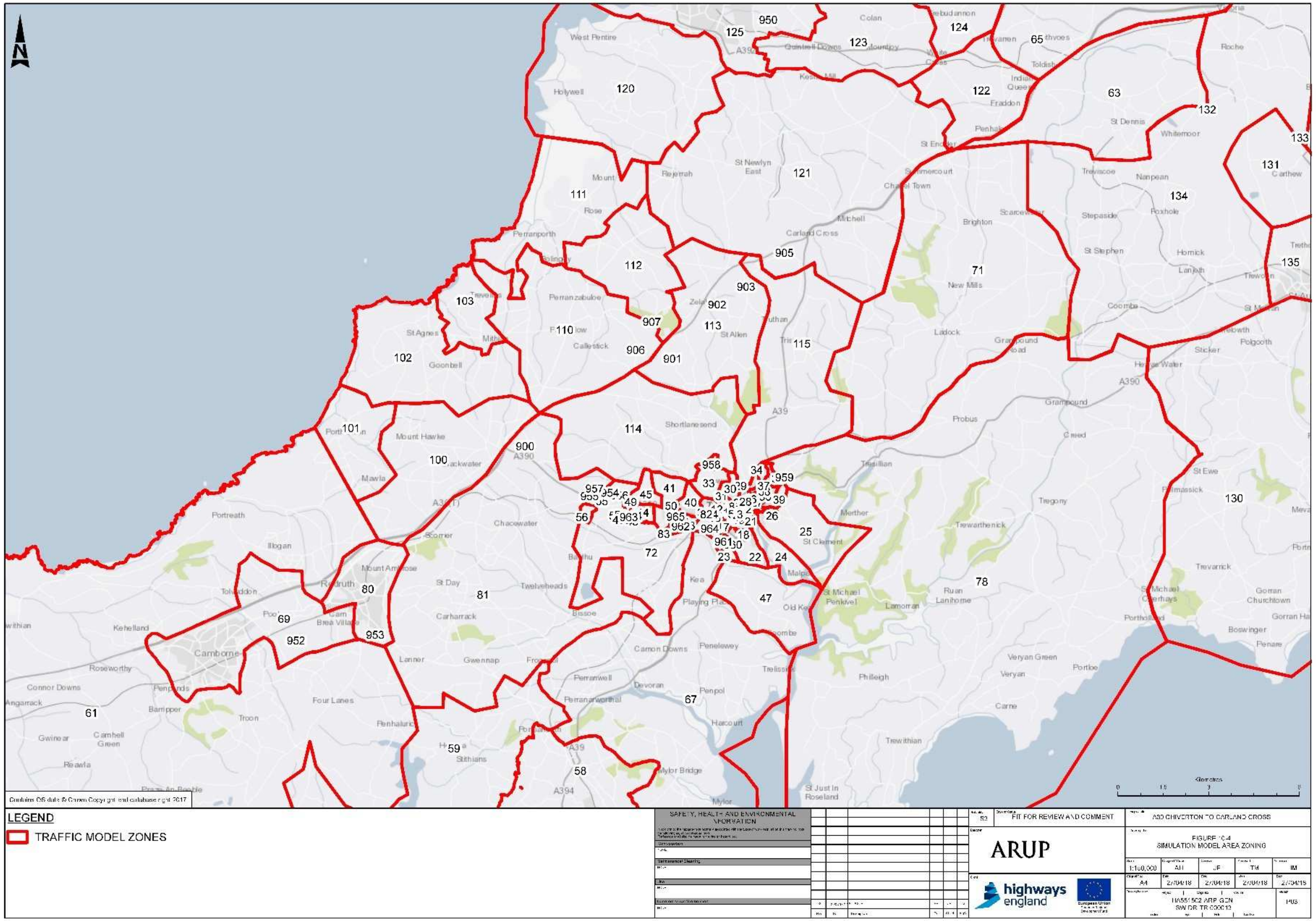

Figure 10-4 Model simulation area zone structure

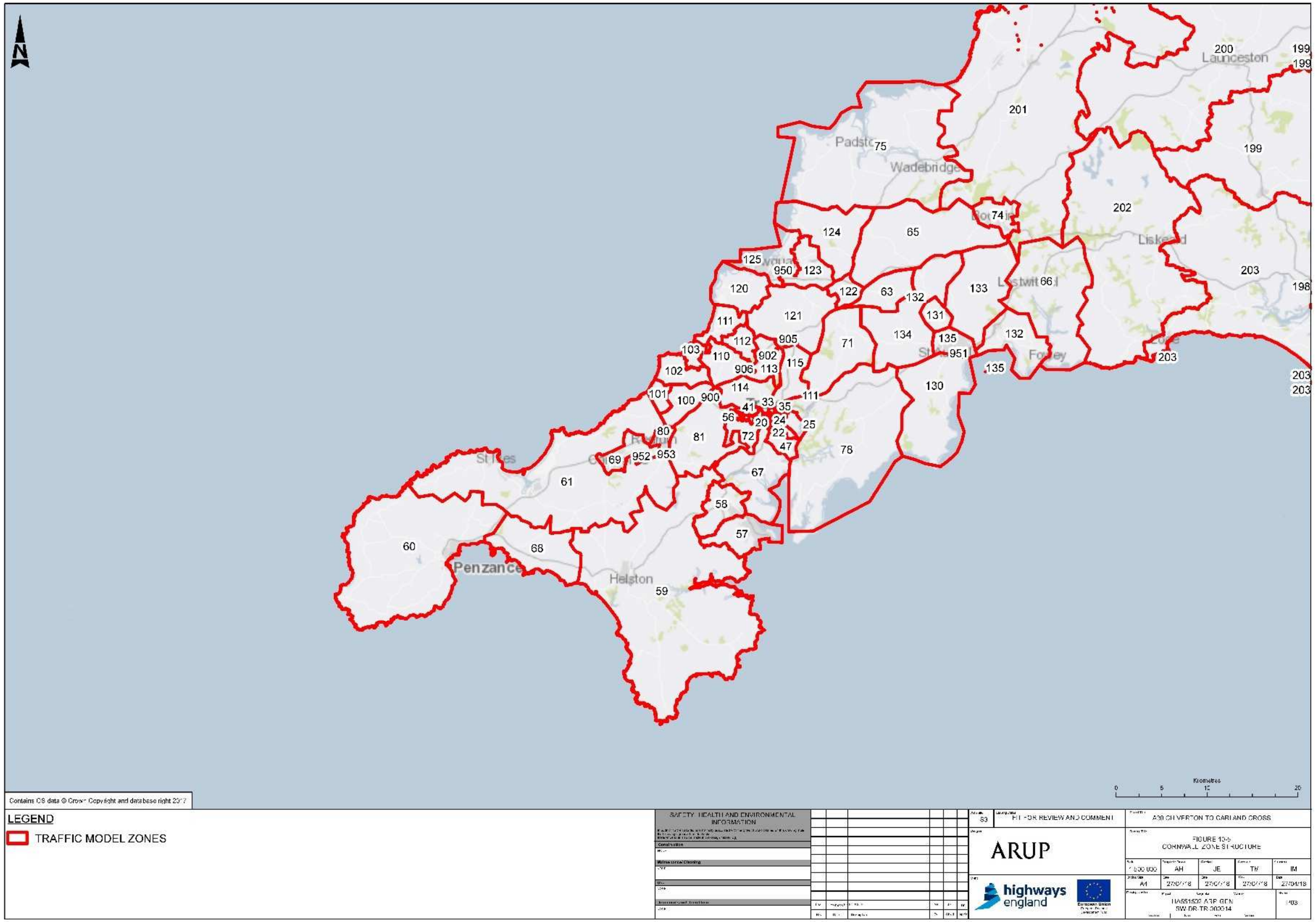

Figure 10-5 Updated Cornwall zone structure

10.2.4 To disaggregate the trips from the larger original zones, the original trip volumes were assigned in proportion to the population of the new smaller zones. A table showing the populations can be found in the PCF Stage 3 Local Model Validation Report (HA11505-WSP-GEN-0000-RE-TR-0013-P04).

10.2.5 The original coverage of the 2009 Truro model included a single zone, Zone 76, which encompassed most of Devon, Exeter and the rest of the UK.

10.2.6 The Devon zone has been disaggregated around larger settlements and their surrounding hinterland. These zones will load onto the network at the location of the main population centre they contain e.g. Tavistock, Plymouth or Exeter. The updated Devon zone structure can be seen in Figure 10-6.

10.2.7 The rest of the UK zones have been assigned based upon a regional structure with the South West showing a further disaggregation given its proximity to the study area (relative to the remainder of the UK). The zone structure for the remainder of the UK can be seen in Figure 10-7.

10.2.8 For the purposes of assigning trips to these zones, trips to and from Zone 76 in the original matrices have been assigned to these zones based upon proportions of trips originating or finishing within the new zones according to proportions taken from the RSIs undertaken by NDC in support of the PCF Stage 1 and Stage 2 modelling.

10.2.9 During PCF Stage 3, new zones have been defined in order to increase the level of detail in key areas of the network. Zones 900-907 represent different small accesses, farms and hamlets that interact with the A30 through the whole length of the scheme. Zone 121 (St. Newlyn East) has been split in two zones, 121 and 899, to represent Mitchell as a different demographic unit that accesses the A30 by different roads to St. Newlyn's East.

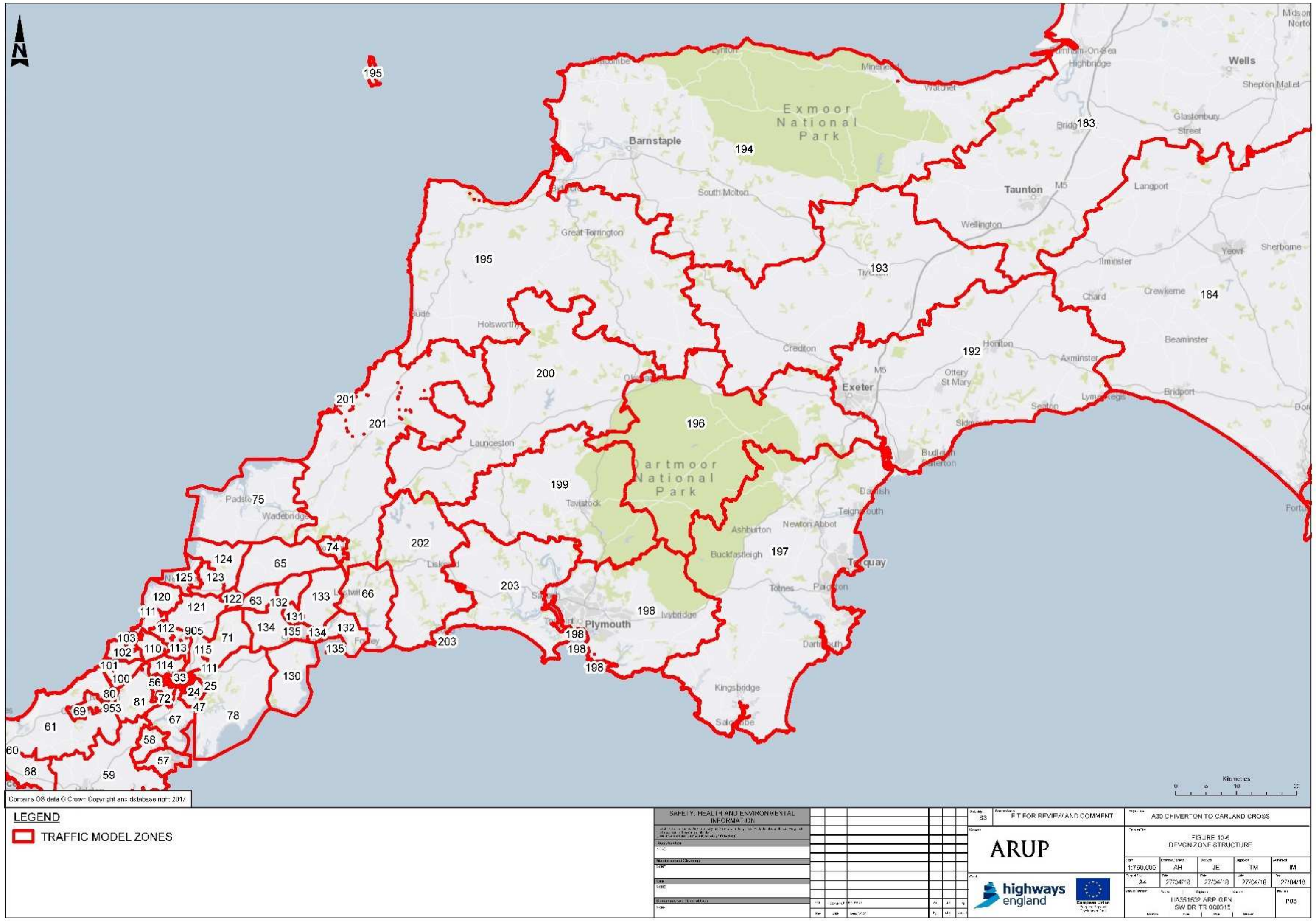

Figure 10-6 Devon zone structure

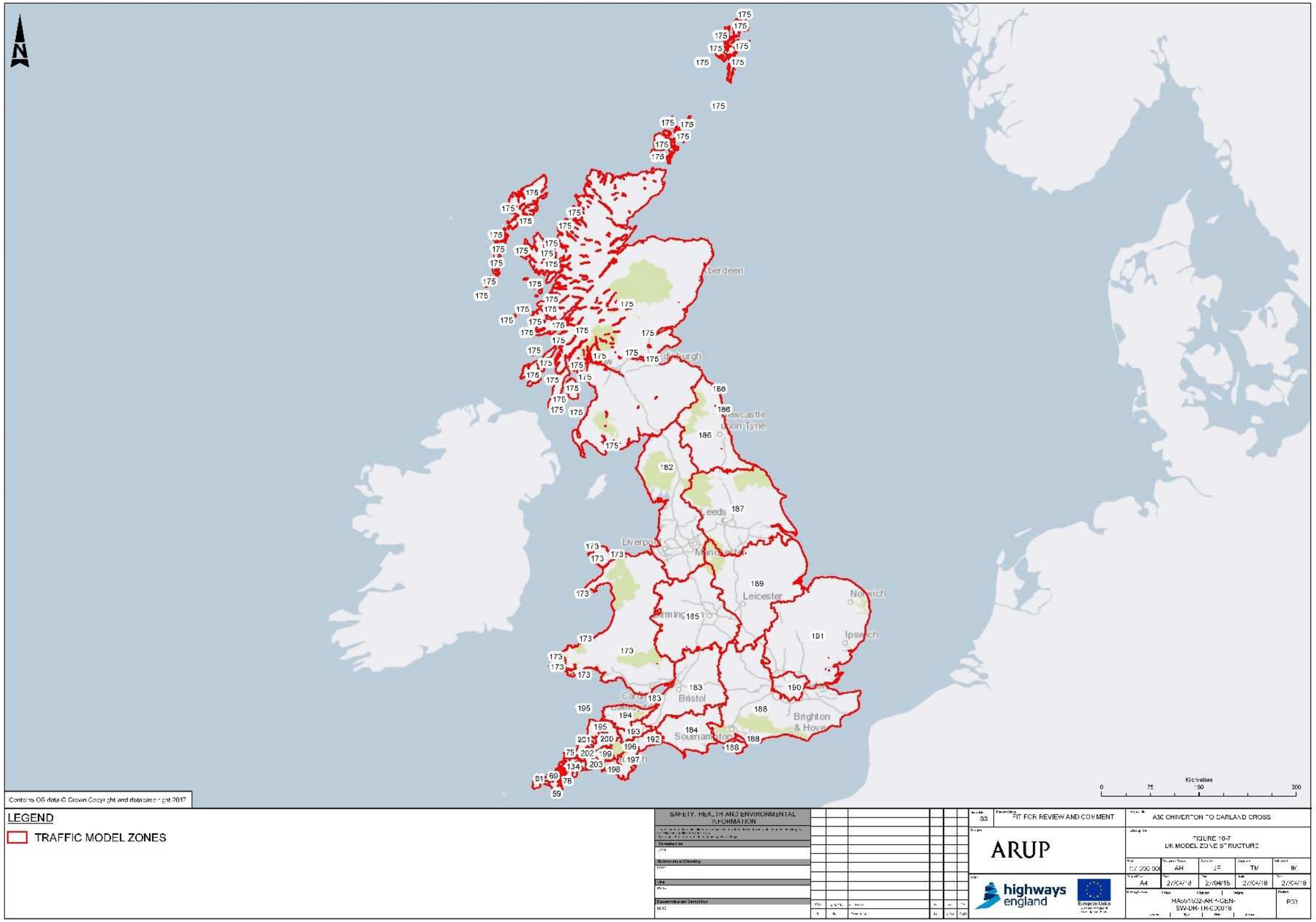

Figure 10-7 Zone structure of the remainder of the UK

Specification and justification of any demand segmentation within the traffic model

10.2.10 The model has five user classes. There are three car classes and one for LGV. OGV 1 and OGV 2 class vehicles have been grouped to form a single HGV user class. This is deemed a suitable disaggregation for the economic assessment for PCF Stage 3. Table 10-7 outlines the user classes in the model.

Table 10-7 Modelled user classes

User Class	Trip Purpose	Vehicle Type
1	Employers Business	Car
2	Commute	
3	Other	
4	All	LGV
5	All	HGV

10.2.11 The totals and respective proportions of each user class in each post ME2 average peak hour matrix are shown in Table 10-8. These have been compared to the proportions quoted in TAG Data Book March 2017.

Table 10-8 Post ME2 average peak hour matrix user class totals

UC	Vehicle Type	AM			Interpeak			PM		
		Total Trips	Proportion	TAG Proportion	Total Trips	Proportion	TAG Proportion	Total Trips	Proportion	TAG Proportion
1	Car	4,688	25%	16.5%	3,906	22%	16.5%	3,661	18%	11.8%
2		5,990	32%	44.1%	4,273	24%	11.8%	5,908	29%	41.3%
3		8,022	43%	39.5%	9,406	53%	71.7%	10,491	52%	46.9%
4	LGV	2,524	100%	100%	2,390	100%	100%	2,694	100%	100%
5	HGV	1,474	100%	100%	1,272	100%	100%	1,226	100%	100%

10.2.12 Table 10-8 shows that User Class 3 (UC3), Car – Other, forms the largest part of the matrix in all peak periods. Commute trips are shown to form a lower proportion of the AM and PM matrices when compared to the TAG average proportions.

10.2.13 Truro is expected to be the largest attraction for Employers Business trips. Route choice exists when accessing the city, especially from the west and north, although the alternatives from the north are often more minor routes. Trips to and from Truro from these directions would not necessarily use the Chiverton Cross to Carland Cross section of the A30, instead routing via the A39 or Shortlanesend.

Description of data sources including previous study matrices, new RSI data, synthetic matrices

10.2.14 The Truro 2009 demand matrices were built using RSI data from six sites on the key routes into Truro. Two of the sites, on the A390 near Highertown and the B3284 near Shortlanesend, were surveyed in 2009. The other sites were surveyed in 2003. A gravity model was then used to estimate unobserved trips. A30 through trips were added from an older model matrix, and updated to 2009 volumes.

10.2.15 The surveys undertaken by NDC on behalf of Mott MacDonald Sweco, as detailed in Section 4, were used to aid the development of the 2015 Chiverton to Carland Cross base year model. ATC and MCC counts undertaken at these locations were also used to expand the RSI data to average peak hour volumes.

10.2.16 The use of an RSI from November 2011 undertaken on the A30 to the east of Bodmin in support of the A30 Temple to Higher Carblake improvements provided additional data for the A30 and was included in the base model matrix building process along with the 2015 surveys.

Description of matrix building process including process of adjusting for unobserved directions and unobserved periods, reference to dealing with double counting and substitution of old data with new/more reliable data

10.2.17 The following steps have been carried out to convert the existing 2009 AM and PM peak hour matrices to 2015 peak period matrices.

- TEMPRO factors have been applied to the 2009 matrices to growth them to 2015. The factors used are:

Table 10-9 TEMPRO factors to growth 2009 traffic flows to 2015 volumes

TEMPRO Factor 2009 – 2015	AM	PM
Cornwall- Average Origin-Destination	1.06	1.07

- A factor derived from TRADS data from sites on the A30 between Chiverton Cross and Carland Cross has been applied to the AM and PM peak hour matrices to convert to average AM and PM peak period matrices. The factors used are:

Table 10-10 Factors to convert peak hour to average peak period

Peak Hour to Peak Period Factor	AM	PM
TRADS data on A30	0.93	0.89

- Some of the zones in the vicinity of the scheme have been split into smaller, more detailed zones using census population data. The zone which covered the rest of the country was split into regions in order to model full trip lengths.
-
- An interpeak average hour matrix was created by adding the AM and PM peak period matrices and multiplying by a factor of 44.3%, derived from TRADS data on the A30.

10.2.18 Roadside interview data collected at five locations in October 2015 was incorporated into the existing 2015 peak period matrices. Further information about the roadside interview surveys can be found in Section 4 The locations of the roadside interview surveys are shown in Figure 4-1.

10.2.19 The following steps describe the process undertaken to incorporate the roadside interview data into the 2015 peak period prior matrices.

10.2.20 Each site was assessed by user class to examine the sample rates based on the direction of the traffic. A minimum sample threshold of 5% of the average neutral weekday ATC traffic for the period was set, under which the data was deemed to be unrepresentative of the site traffic. Such data would not be incorporated into the matrix update.

10.2.21 To create the matrix for the non-interview direction in the interpeak and PM peaks, the time period was assigned based on the estimated return time, if they answered that the journey was a two-way trip. The question asked '*If this journey is part of a 2-way return trip, please give the start time of your trip in the other direction?*' To create the non-interview direction matrices for the AM peak, the PM interview direction sample was transposed and then expanded using factors calculated using the total transposed sample. The AM non-interview direction matrix was created this way due to the low AM sample in this direction from the RSI as illustrated in Table 10-11 below.

10.2.22 Table 10-11 shows the sample rates at each survey site by modelled vehicle type for both the interview and non-interview directions.

Table 10-11 Sample rate by vehicle type

Direction	Vehicle Type	Period	C1	C2	C3	C4	C5
Interview Direction	Car	AM	5%	4%	12%	25%	32%
		IP	9%	4%	8%	27%	39%
		PM	8%	4%	5%	29%	24%
	LGV	AM	13%	4%	14%	30%	40%
		IP	15%	2%	11%	23%	37%
		PM	13%	14%	1%	36%	75%
	HGV	AM	20%	0%	18%	100%	0%
		IP	28%	4%	9%	138%[12]	20%
		PM	4%	0%	0%	41%	0%
Non-Interview Direction	Car	AM	0%	2%	6%	4%	1%
		IP	3%	3%	5%	11%	10%
		PM	5%	5%	8%	14%	19%
	LGV	AM	1%	3%	3%	2%	0%
		IP	6%	3%	6%	10%	8%
		PM	13%	6%	15%	23%	44%
	HGV	AM	0%	0%	2%	54%	0%
		IP	13%	4%	7%	62%	7%
		PM	20%	12%	10%	29%	0%

10.2.23 Table 10-11 shows that the sample rates at Site C2 are below the 5% threshold in all but four instances. For this reason, data from site C2 was excluded from the final matrix as it is not considered to be a representative sample of demand on the route.

[12] Number of interviews higher than average ATC count for the interpeak period

10.2.24 The majority of the low sample rates occur in the non-interview direction, particularly in the AM. This is thought to be because of the wording of the question regarding ‘return’ trips. While the survey asks if the trip is two-way, this question asks what time the person will make the ‘return’ journey. In the PM peak, it is thought that interviewees may be unlikely to answer that they have made the reverse trip in the morning of the survey leading to a small AM sample in the non-interview direction.

10.2.25 The sample rate for HGV vehicles was low at several sites so HGV’s were excluded from both the Select Link and RSI matrices for the purposes of matrix building. The LGV sample rate for Site C3 was low in the PM peak in the interview direction and AM peak in the non-interview direction. This meant that no data was available to be transposed to create these peaks. LGVs were therefore excluded from the Site C3. Enough data was present at the other sites to allow LGV’s to be included for the other sites.

10.2.26 Due to the low sample rates in the AM non-interview direction, the non-interview direction matrix for the AM peak was created by transposing the PM interview direction matrix before the application of any expansion factors.

10.2.27 Expansion factors to grow the RSI data to the average peak period traffic volume were created using ATC data collected in the two-week period before the roadside interview. Data from the day of the survey was not included as the road was not under normal traffic conditions and Nationwide Data Collection, the survey provider, noted that the ATC for these days exhibited errors due to the slow moving traffic caused by the survey traffic management.

10.2.28 The expansion factors were created directionally by vehicle type with the car expansion factor applied to User Classes 1, 2 and 3 and the LGV factor applied to User Class 4. This is in line with the types of vehicle represented by each user class. These factors growth the RSI interviews from each peak period up to the average trips within the period. The expanded number of trips is then divided by the number of hours in the relevant peak period (3 hours in the AM and PM and 6 hours in the interpeak period).

10.2.29 Table 10-12, Table 10-13, Table 10-14 and Table 10-15 show the peak period expansion factors used for each site.

Table 10-12 Expansion factor by vehicle type – Site C1

Direction	Vehicle Type	Peak Period	Total RSI Trips	Ave Period ATC Trips	Expansion Factor to Average Peak Hour
Interview Direction	Car	AM	122	2,491	20.42
		IP	366	4,098	11.20
		PM	219	2,660	12.15
	LGV	AM	37	289	7.80
		IP	73	489	6.70
		PM	23	184	8.00
Non-Interview Direction	Car	AM	*219*[13]	2,682	12.25
		IP	120	4,361	36.34
		PM	130	2,511	19.32
	LGV	AM	232	268	11.64
		IP	34	524	15.41
		PM	27	210	7.78

Table 10-13 Expansion factor by vehicle type – Site C3

Direction	Vehicle Type	Peak Period	Total RSI Trips	Ave Period ATC Trips	Expansion Factor to Average Peak Hour
Interview Direction	Car	AM	200	1,698	8.49
		IP	363	4,591	12.65
		PM	163	3,085	18.92
Non-Interview Direction	Car	AM	*163*[14]	2,647	16.24
		IP	231	4,372	18.92
		PM	144	1,874	13.01

Table 10-14 Expansion factor by vehicle type – Site C4

Direction	Vehicle Type	Peak Period	Total RSI Trips	Ave Period ATC Trips	Expansion Factor to Average Peak Hour
Interview Direction	Car	AM	228	916	4.02
		IP	302	1,105	3.66
		PM	137	479	3.50
	LGV	AM	30	99	3.30
		IP	33	142	4.30
		PM	16	45	2.79
Non-Interview Direction	Car	AM	*137*[15]	374	2.73
		IP	134	1,212	9.05
		PM	137	988	7.21
	LGV	AM	*16*[16]	47	2.92
		IP	13	124	9.54
		PM	15	67	4.44

[13] Based on total of the transpose of the PM Interview Direction Matrix

Table 10-15 Expansion factor by vehicle type – Site C5

Direction	Vehicle Type	Peak Period	Total RSI Trips	Ave Period ATC Trips	Expansion Factor to Average Peak Hour
Interview Direction	Car	AM	106	334	3.15
		IP	199	516	2.59
		PM	82	339	4.14
	LGV	AM	14	35	2.47
		IP	26	71	2.74
		PM	18	24	1.33
Non-Interview Direction	Car	AM	*82*[17]	329	4.01
		IP	52	546	10.49
		PM	73	388	5.31
	LGV	AM	18	41	2.29
		IP	6	75	12.52
		PM	14	32	2.27

10.2.30 For each site, a roadside interview matrix for each time period and user class was created for each direction. Each interview record has been assigned a model user class as per those previously specified in Table 10-7, based on origin and destination purpose, and the time period in which the interview was conducted. Table 10-16 shows how the origin and destination trip purposes were combined into model user classes for the car vehicle type. LGV and HGV trips were grouped by vehicle type and trip purpose was not used for assigning these vehicle classifications a User Class.

[14] Based on total of the transpose of the PM Interview Direction Matrix
[15] Based on total of the transpose of the PM Interview Direction Matrix
[16] Based on total of the transpose of the PM Interview Direction Matrix
[17] Based on total of the transpose of the PM Interview Direction Matrix

Table 10-16 Car trip purpose to user class matrix

		Destination Purpose									
		Permanent Home	Holiday Home	Place of Work	Employers Business	Education	Shopping	Personal Business	Visit Friends	Recreation/ Leisure	Other
Origin Purpose	Permanent Home	-	3	2	1	3	3	3	3	3	3
	Holiday Home	3	-	3	1	3	3	3	3	3	3
	Place of Work	2	3	1	1	3	3	3	3	3	3
	Employers Business	1	3	3	1	3	3	3	3	3	3
	Education	3	3	3	1	3	3	3	3	3	3
	Shopping	3	3	3	1	3	3	3	3	3	3
	Personal Business	3	3	3	1	3	3	3	3	3	3
	Visit Friends	3	3	3	1	3	3	3	3	3	3
	Recreation/leisure	3	3	3	1	3	3	3	3	3	3
	Other	3	3	3	1	3	3	3	3	3	3

10.2.31 To ensure the model accurately modelled the level of traffic along the A30, the RSI data from November 2011 collected as part of the A30 Temple to Higher Carblake project has also been incorporated into the model using the same data processing methodology as Sites C1 to C5.

10.2.32 It was identified that there was the possibility of trips being double counted at the roadside interview locations. The survey data was therefore incorporated into the existing matrix in a number of stages, with priority given to the data on the A30 (Site C1) as this location is the key focus of the scheme assessment, then the A30 Temple RSI added only in the stage before C1 and C4 were added. To incorporate the RSI data, two-way select link matrices were extracted from the existing model at the locations of the RSI sites. These were then subtracted in order of importance. At each subtraction phase, the relevant RSI matrices were added to the matrix, effectively replacing the Select Link trips. This approach eliminates any double counting.

Description of any matrix infilling process including the use of synthetic trip matrices/gravity models

10.2.33 The 2009 Truro matrices were updated with 2011 and 2015 RSI data. No matrix infilling processes were carried out as part of this update.

Description of the matrix estimation process

10.2.34 Matrix estimation was used to calibrate the matrices, using guidance set out in WebTAG.

10.2.35 In the PM peak some zones were frozen as part of the calibration process. This included the local accesses along the A30, the services at Carland and the

Threemilestone Park and Ride (zones 899, 900, 901, 902, 903, 904, 905, 906, 907, 111, 114, 120).

Discussion of where the model is less robust with statement on how this impacts on the model's performance

10.2.36 Table 10-17 shows the statistically representative sample rates needed at each RSI site for each vehicle type. These have been calculated as per the calculations outlined in Appendix D13 of the Traffic Appraisal Manual (August 1991)[18].

Table 10-17 Comparison of statistically representative sample rates to actual sample rates

Direction	Vehicle Type	Peak Period	Statistically Representative Sample Rate (SRSR) vs. Actual Sample Rate (ASR)							
			Site C1		Site C3		Site C4		Site C5	
			SRSR	ASR	SRSR	ASR	SRSR	ASR	SRSR	ASR
Interview Direction	Car	AM	8%	5%	9%	5%	14%	5%	34%	32%
		IP	5%	9%	3%	8%	14%	27%	30%	39%
		PM	5%	8%	3%	5%	22%	29%	26%	24%
	LGV	AM	83%	13%	88%	14%	93%	30%	98%	40%
		IP	74%	15%	78%	11%	91%	23%	95%	37%
		PM	89%	13%	91%	1%	97%	36%	98%	75%
	HGV	AM	94%	20%	98%	18%	100%	100%	100%	0%
		IP	89%	28%	95%	9%	99%	138%	99%	20%
		PM	95%	4%	97%	0%	100%	41%	100%	0%

10.2.37 Table 10-17 shows that the sample rate for cars is approximately as required to be statistically reliable. To achieve statistical reliability, the LGV and HGV sample rates are much higher. However, the HGV data was not used so the low actual sample does not affect the model. The LGV sample rate may affect the reliability of the model for this vehicle type but in the absence of alternative data, the RSI data has been used in the A30 Chiverton to Carland Cross model.

10.3 Assignment Process

Description of approach used

10.3.1 The assignment methodology used within SATURN in this assessment is based on Wardrop's Principle of Traffic Equilibrium. This method of assignment has been chosen because there is congestion evident on the network and it is therefore essential to account for the effects of capacity restraint on route choice. Wardrop's Principle states that 'traffic arranges itself on congested networks such that the cost of travel on all routes used between each O-D pair is equal to the minimum cost of travel and all unused routes have equal or greater cost'.

[18] DMRB Volume 12 Section 1 (November 1997) The Application of Traffic Appraisal to Trunk Road Schemes. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol12/section1/12s1p1.pdf

Model time slices

10.3.2 The following time periods have been modelled:

- 07:00 – 10:00 Average hour – AM peak period;
- 10:00 – 16:00 Average hour – Interpeak period;
- 16:00 – 19:00 Average hour – PM peak period.

10.3.3 The average hour peak period matrices are consistent with those being developed for Highways England's Regional Model (average peak period rather than peak hour) and will thus minimize the difference between the emerging models.

10.3.4 There is no interaction between the three time periods.

Generalised cost calculation

10.3.5 All assignment techniques within SATURN assume that individual drivers seek to minimise their travel cost. The travel cost has been defined as a generalised cost, which is a linear combination of time and distance defined by:

$$c = at + bd$$

where c = cost (pence), t = time (minutes), d = distance (km), a = pence per minute (PPM), b = pence per kilometre (PPK).

10.3.6 The generalised cost parameters a and b used in the 2015 base year model are shown in Table 10-18. The values have been calculated using the DfT values of time from the March 2017 WebTAG Databook as are the GDP growth rates, purpose splits, and vehicle operating cost. An average network speed of 54 kph has been assumed in the calculation of the PPK parameters.

Table 10-18 Generalised cost equation parameters

Time Period	Parameter	Car Employers Business	Car Commute	Car Other	LGV	HGV
AM	PPM	29.82	20.00	13.80	21.08	21.40
	PPK	12.19	5.66	5.66	12.67	43.88
Interpeak	PPM	30.56	20.32	14.70	21.08	21.40
	PPK	12.19	5.66	5.66	12.67	43.88
PM	PPM	30.25	20.07	14.45	21.08	21.40
	PPK	12.19	5.66	5.66	12.67	43.88

Assignment convergence criteria

10.3.7 Convergence is required in order to provide stable, consistent and robust model results and to differentiate between real changes and those associated with differing degrees of convergence. The convergence criteria guidance from TAG has been used and is shown in Table 10-19.

Table 10-19 Convergence criteria

Measure of Convergence	Base Model Acceptable Values
Delta and %GAP	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P) < 1%	Four consecutive iterations greater than 98%
Percentage of links with cost change (P2) < 1%	Four consecutive iterations greater than 98%
Source: TAG Unit M3.1 Highway Assignment Modelling | Table 4	

Assignment parameters used by software

10.3.8 The assignment parameters used in SATURN and the values used in the model are described in Table 10-20.

Table 10-20 SATURN assignment parameters

Parameter	Definition	Value
PCNEAR	Percentage change in flows judged to be “near” in successive assignments.	1
RSTOP	Used in the test for convergence of the assignment/simulation loops. The loops stop automatically if STOP % of the link flows change by less than “PCNEAR” percent (default 5%) from one assignment to the next.	98
STPGAP	Critical gap value (IN %) used to terminate assignment-simulation loops when KONSTP = 1.	0.1
NISTOP	The number of successive loops which must satisfy the “ISTOP” criteria in the test for convergence of the assignment/simulation loops.	4
KONSTP	“KONtrol of Stopping Criteria”. The stopping criteria for assignment – simulation loops are based on either: ISTOP (KONSTP = 0); %GAP value (1); CPU time (2); ISTOP and/or CPU (3); %GAP and/or CPU (4); %GAP and ISTOP (5); %GAP or %ISTOP (6).	5
MASL	Maximum number of assignment/simulation loops.	150
NITA	Maximum number of assignment iterations.	10
NITS	Maximum number of simulation iterations.	150

11 Model Calibration

11.1 Network

Network structure

11.1.1 Checks were undertaken to ensure that the network provided good coverage and realistic route choice. To understand the detailed part of the network, an assessment was undertaken of the network in GIS.

11.1.2 Figure 11-1 shows the existing PCF Stage 1 and 2 network in purple. The green links represent routes that were added in Stage 3 to more fully represent alternative options in the area immediately surrounding the scheme. The additional network also allowed the disaggregation of the zone structure to the north of the A30 detailed in Section 10.2 of this report. Some zone connectors have also been modified and now join to the new network, including at Trispen and St Allen, where it was deemed likely that this would represent the more suitable loading point for these trips.

Link length checks

11.1.3 To check for potential errors within the modelled link distances, the coded distances were compared to the crow-fly distances between the two nodes at either end of the link. This allowed the identification of suspect link distances which could then be checked with Google Earth Pro. Discrepancies can arise due to multiple bends in the route. A table showing the results of the original check can be found in the PCF Stage 3 Local Model Validation Report (HA551502-WSP-GEN-0000-RE-TR-0013-P04).

One-way links

11.1.4 The coding of one-way links has been reviewed across the network, particularly on the slip roads of the A30, due to the strategic focus of the model. All one-way links have been correctly coded within the model.

HGV restrictions

11.1.5 There is one HGV restriction in the network. It is located on the unnamed road that joins the old A30, east of Blackwater, to Chacewater Hill, east of Chacewater. The restriction of HGV is due to a small bridge over the railway. The location of this structure can be found in Figure 11-2.

11.1.6 There is an 18 tonne weight restriction in place on the bridge but given the narrowness of the structure it does not seem realistic that any HGV would attempt to use the bridge. This HGV restriction was included in the network coding.

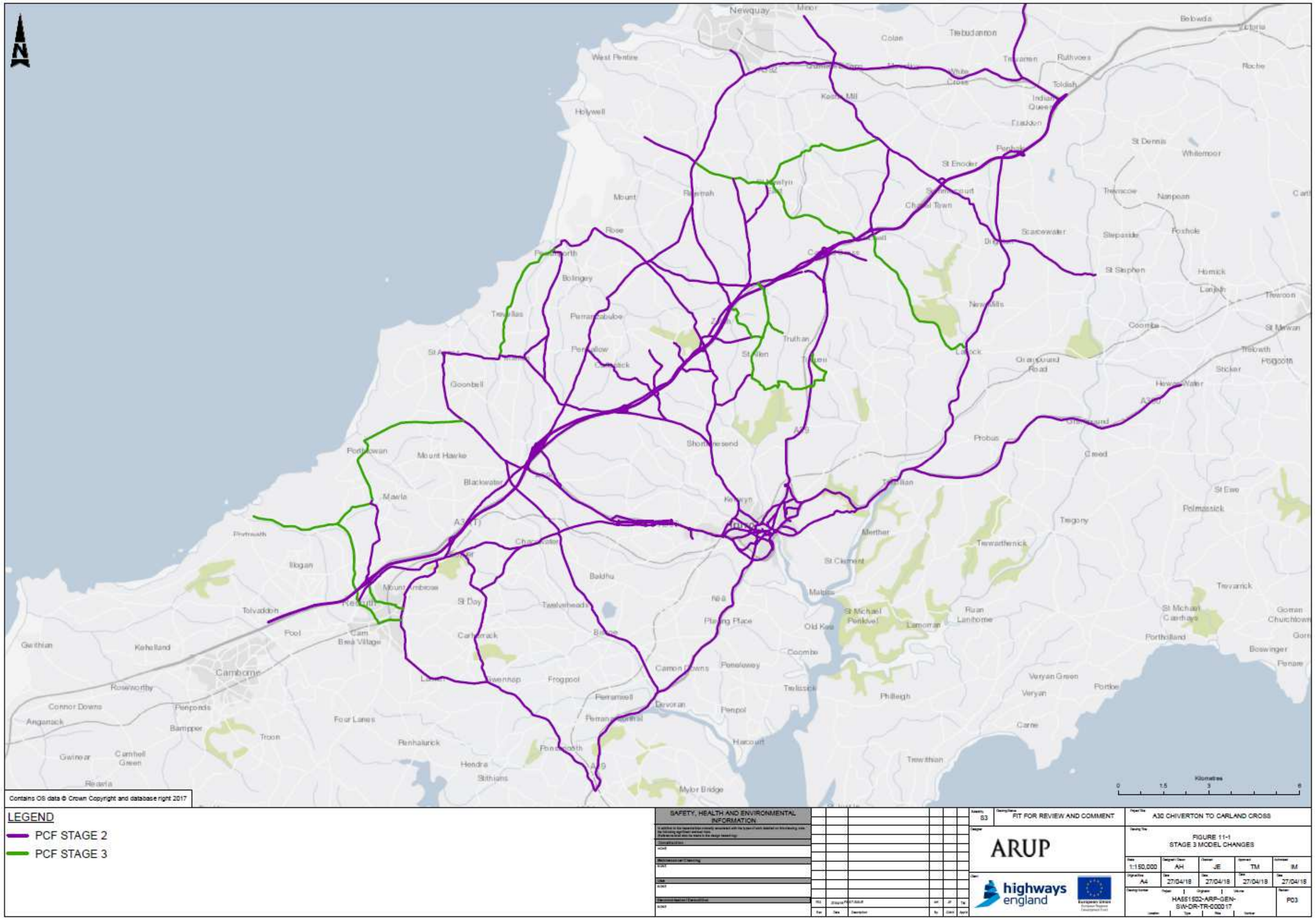

Figure 11-1 Network coverage in the vicinity of the scheme area

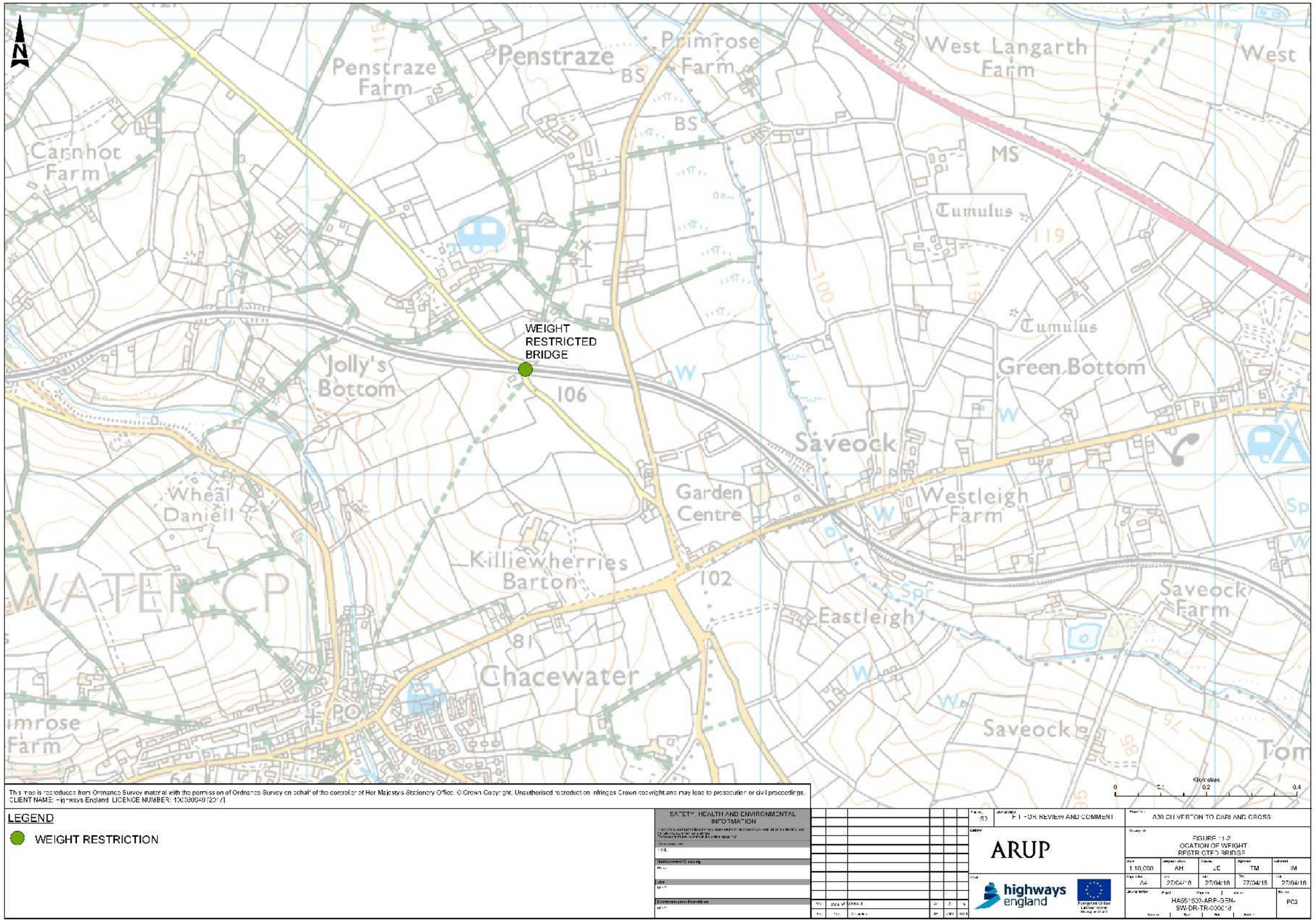

Figure 11-2 Location of weight restricted bridge

Speed Flow Curves check

11.1.7 To validate the capacity of the modelled link, checks were undertaken using Google Earth Pro to ensure that the Speed Flow Curves (SFC) were representative of the actual conditions of the infrastructure.

11.1.8 Speeds and flows were checked for the three modelled time periods to ensure that the model links were responding to different levels of traffic in a similar way to the actual roads.

Junction saturation flows

11.1.9 Values in Table 10-3, Table 10-4 and Table 10-5 offer the general values of the saturation flows in the junctions based upon Highways England's RTM Network Coding V08 guidance. Checks were carried out using Google Earth Pro to assess the width, visibility and turn radius in the junctions within the key study area to model turning saturation flows as realistically as possible.

11.2 Assignment Process

11.2.1 Link speeds and junction delays have been checked and amendments made as part of the initial network development phase where suspect routing was identified.

Matrices

11.2.2 The WebTAG criteria apply for the matrix estimation carried out at this stage. The criteria are included with the results in Table 11-1.

Matrix zonal demand changes

11.2.3 WebTAG requires monitoring of the changes made by the Matrix estimation; the zonal movement statistics are reported in Table 11-1.

Table 11-1 Matrix zonal statistics

Measurement		Requirement	AM	Interpeak	PM
Cells	Slope	Within 0.98 and 1.02	0.97	0.993	0.995
	Intercept	Near 0	-0.034	-0.024	0.008
	R-Sq	> 0.95	0.9774	0.9917	0.9901
Rows	Slope	Within 0.99 and 1.01	0.952	0.989	0.991
	Intercept	Near 0	-1.297	-2.263	1.788
	R-Sq	> 0.98	0.9882	0.996	0.9932
Columns	Slope	Within 0.99 and 1.01	0.952	1.002	1.007
	Intercept	Near 0	-1.364	-4.62	-1.095
	R-Sq	> 0.98	0.9835	0.9928	0.993
Trip Length Distributions	Mean	Within 5%	0.8%	1.2%	7.3%
	Standard Dev.	Within 5%	3.1%	1.2%	1.5%

11.2.4 The table shows that the overall matrix estimation statistics are generally good and generally comply with WebTAG. Where the statistics do not fully meet WebTAG criteria, the differences are minimal. Routing choices have been sense checked using tree plots and journey time paths and these are considered acceptable for the purposes of the PCF Stage 3 modelling.

11.2.5 The total number of trips by user class before and after the matrix estimation are shown in Table 11-2.

Table 11-2 Matrix total per user class, before and after matrix estimation

Matrix	UC1	UC2	UC3	UC4	UC5	Totals
AM Prior	4,976	7,058	8,782	1,739	1,474	24,029
AM Post	4,689	5,991	8,022	2,524	1,474	22,700
IP Prior	4,156	4,705	10,121	1,684	1,151	21,816
IP Post	3,906	4,274	9,407	2,390	1,272	21,249
PM Prior	3,888	6,336	11,272	1,663	795	23,953
PM Post	3,662	5,909	10,491	2,695	1,226	23,982

11.2.6 Any changes between the prior and post matrices have been checked and assessed; there are no significant changes in the matrices as a result of the matrix estimation process. This is reported further in Sections 11.2.11 to 11.2.15.

11.2.7 The matrix estimation process has made some changes to the UC4 and UC5 totals. This is due to an historic issue with Truro model under-representing these trips, which the matrix estimation process has corrected to enhance calibration and validation. The UC4 and UC5 trips using the A30 and parallel routes were observed through the road side interviews and were accurately represented in the prior matrices.

11.2.8 The results from the matrix estimation process are therefore considered to be acceptable.

Trip length distribution

11.2.9 Figure 11-3, Figure 11-4 and Figure 11-5 show the changes in trip length distribution between the prior and post matrix estimation models.

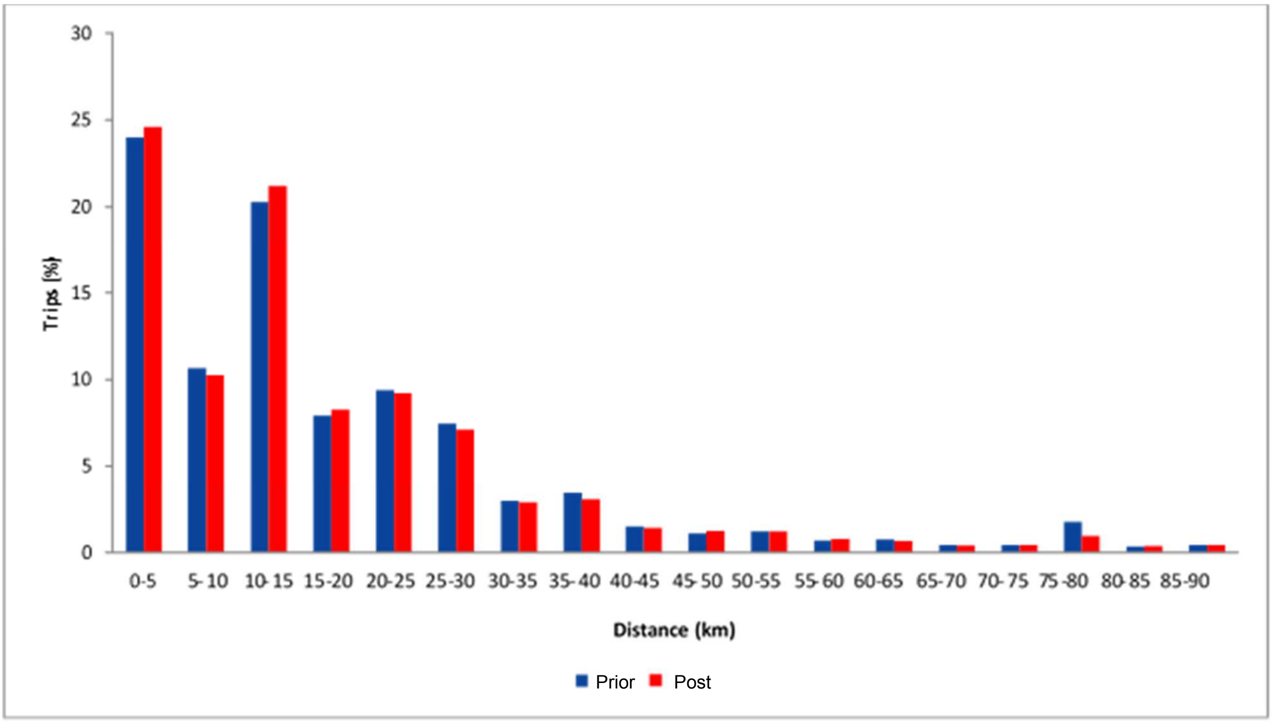

Figure 11-3 AM peak trip length distribution

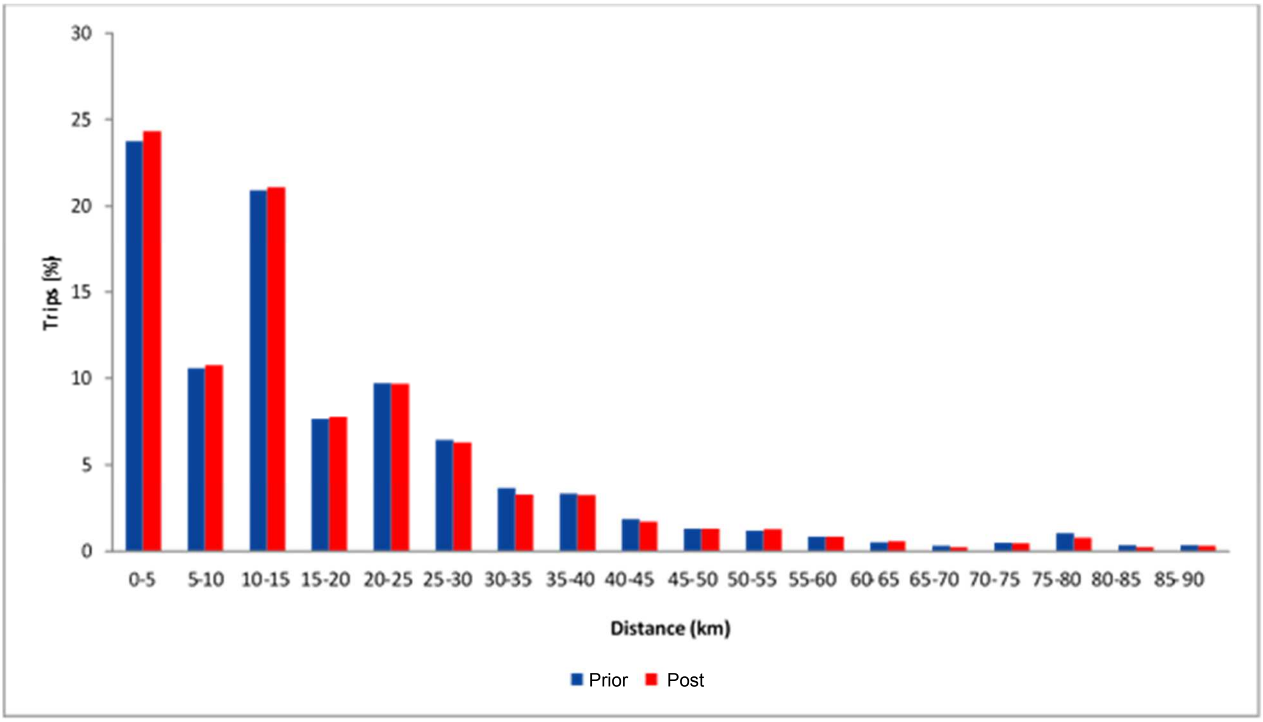

Figure 11-4 Interpeak trip length distribution

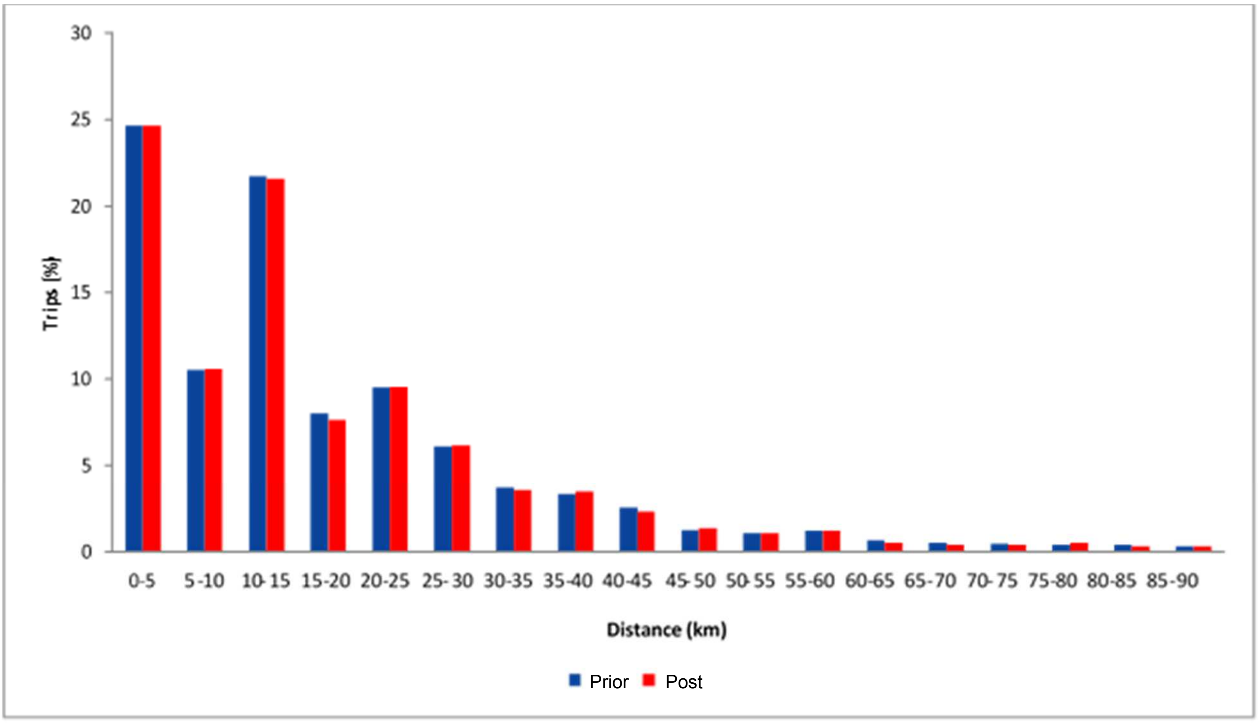

Figure 11-5 PM peak trip length distribution

11.2.10 The figures show that there are no significant changes in trip length distribution in any of the peaks as a result of the matrix estimation process.

Sector matrices

11.2.11 A sector system was created to analyse the movements between the sectors within the model and assess whether these matched previous and observed proportions. Figure 11-6 below shows the sector system used in this analysis.

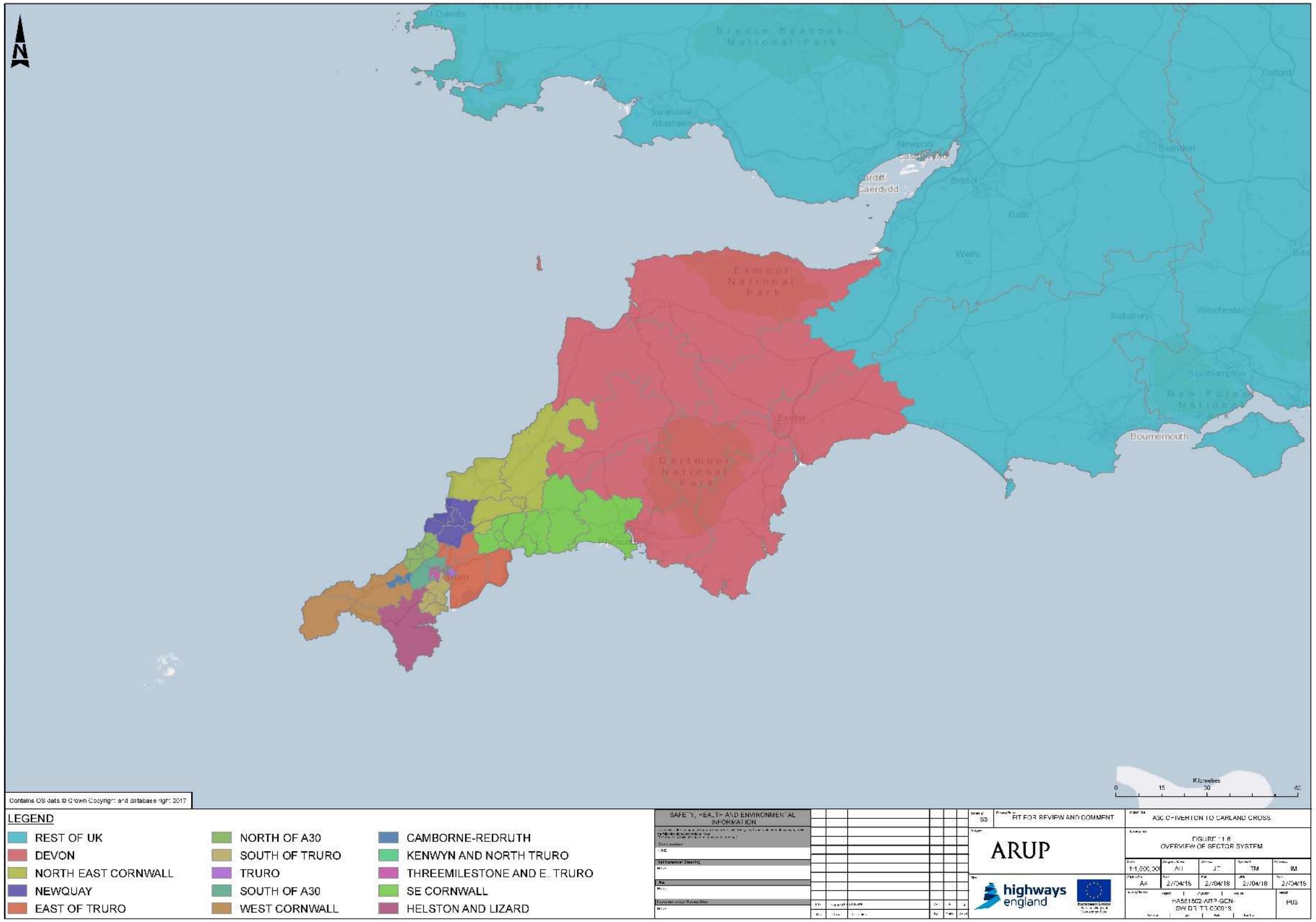

Figure 11-6 Overview of sector system

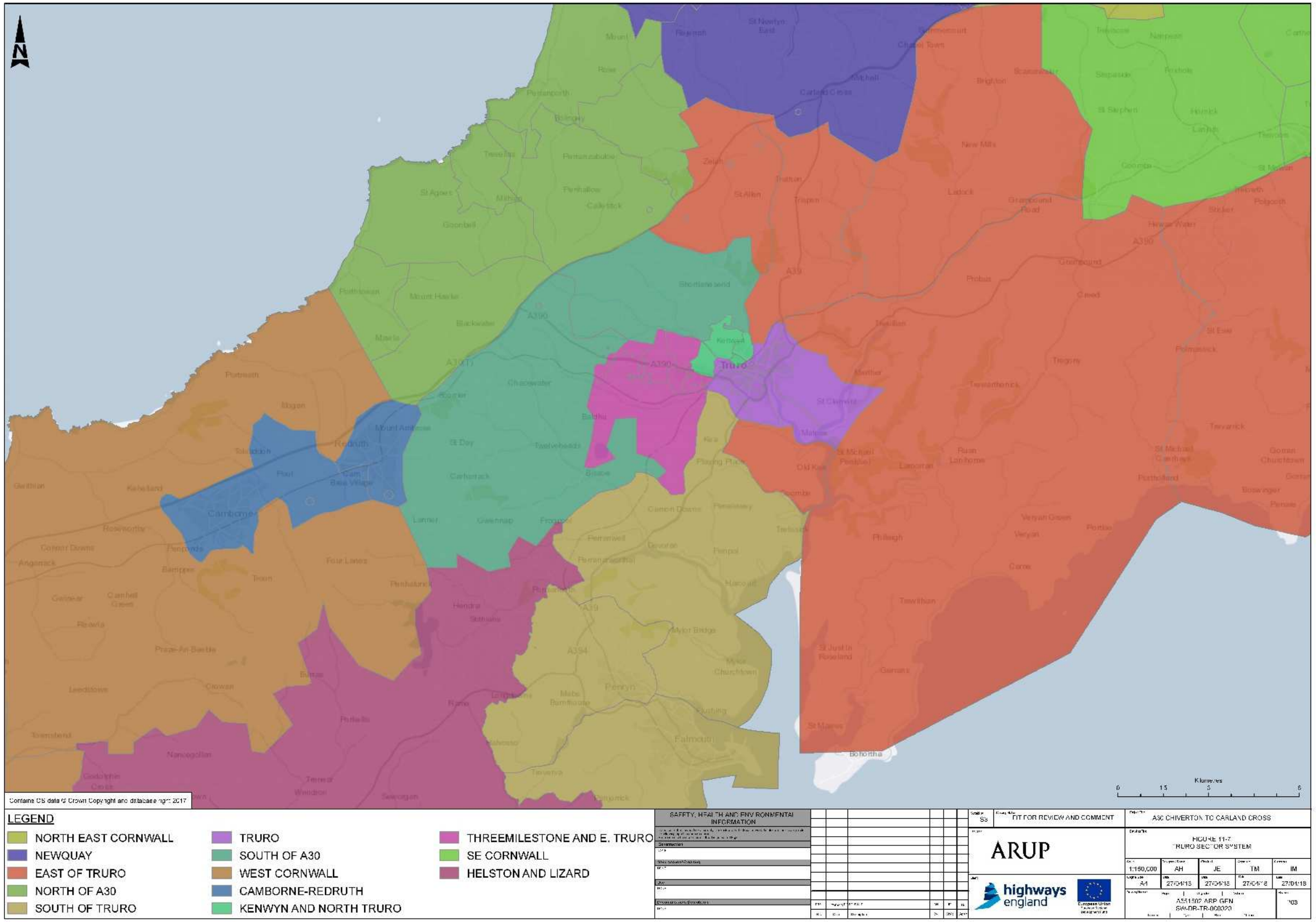

Figure 11-7 Scheme area sector system

11.2.12 The full post ME2 matrix was compared to the prior ME2 matrix to understand if there had been any significant changes in the distribution of the trips due to the matrix estimation process. Table 11-3,

11.2.13 Table 11-4 and Table 11-5 show the changes in the proportion of movements between sectors when the two matrices are compared against each other in each of the peak periods.

Table 11-3 AM peak period proportional changes in sector movements in the post ME2 matrix compared to the prior ME2 matrix

Sector		Origin	Destination
Rest UK	1	-7%	1%
Devon	2	-1%	7%
NE Cornwall	3	-6%	-1%
Newquay	4	-14%	12%
East of Truro	5	-9%	-13%
North of A30	6	11%	1%
South of Truro	7	-1%	0%
Truro	8	-5%	-13%
South of A30	9	-4%	2%
West Cornwall	10	-4%	-18%
Camborne-Redruth	11	7%	-3%
Kenwyn and North Truro	12	-8%	-5%
Threemilestone and E Truro	13	-11%	-8%
SE Cornwall	14	-7%	-11%
Helston and Lizard	15	-12%	1%

Table 11-4 Interpeak period proportional changes in sector movements in the post ME2 matrix compared to the prior ME2 matrix

Sector		Origin	Destination
Rest UK	1	0%	-5%
Devon	2	1%	-5%
NE Cornwall	3	-2%	-6%
Newquay	4	0%	4%
East of Truro	5	-15%	-14%
North of A30	6	-5%	-15%
South of Truro	7	0%	2%
Truro	8	-7%	-6%
South of A30	9	15%	15%
West Cornwall	10	2%	2%
Camborne-Redruth	11	2%	12%
Kenwyn and North Truro	12	-1%	-3%
Threemilestone and E Truro	13	-1%	0%
SE Cornwall	14	-8%	-12%
Helston and Lizard	15	1%	5%

Table 11-5 PM peak period proportional changes in sector movements in the post ME2 matrix compared to the prior ME2 matrix

Sector		Origin	Destination
Rest UK	1	7%	18%
Devon	2	19%	2%
NE Cornwall	3	3%	-5%
Newquay	4	11%	4%
East of Truro	5	-14%	-7%
North of A30	6	16%	-1%
South of Truro	7	0%	4%
Truro	8	-7%	0%
South of A30	9	32%	12%
West Cornwall	10	9%	4%
Camborne-Redruth	11	3%	18%
Kenwyn and North Truro	12	-2%	8%
Threemilestone and E Tpruro	13	10%	6%
SE Cornwall	14	-8%	-9%
Helston and Lizard	15	0%	-2%

11.2.14 Table 11-3, Table 11-4 and Table 11-5 show that the matrix estimation processes have produced some changes in all of the peak periods with regards to the proportion of trips originating or travelling to the sectors. The largest changes shown in any of the peaks are up to 32% which is shown in the Sector 9 origin trips. Despite this, the majority of changes sector do not exceed ±15% which is considered within acceptable thresholds for the PCF Stage 3 modelling.

11.2.15 Based on this analysis presented above, the limited changes to trip length distributions and the general compliance of the matrix estimation statistics with WebTAG, the changes made to the matrices during the ME process are not considered to be significant and are within acceptable thresholds.

11.3 Overall Model Calibration

Calibration criteria

11.3.1 The link and turning flows of the key junctions in the model included in the calibration must pass parameters set in in Table 2 of TAG unit M3.1[19]. These are detailed in Table 11-6.

Table 11-6 TAG Unit M3.1 Table 2: Link and turning flow criteria and acceptability guidelines

Criteria	Level of flow	Description of criteria	Acceptability guidelines
1	<700 veh/hr	Individual flows within 100 veh/hr of observed	**>85% of cases**
	700< x <2,700 veh/hr	Individual flows within 15% of observed	**>85% of cases**
	>2,700 veh/hr	Individual flows within 400 veh/hr of observed	**>85% of cases**
2	Any	GEH <5%	**>85% of cases**

11.3.2 The screenlines included in the calibration must pass the criteria in Table 11-6, a parameter set in in Table 1 of TAG unit M3.1.

Table 11-7 TAG Unit M3.1 Table 1: Screenline criteria and acceptability guidelines

Level of flow	Description of criteria	Acceptability guidelines
Any	Modelled flow within 5% of observed	All or nearly all screenlines

Link flows and screenlines

11.3.3 The model has been calibrated to a number of counts and screenlines. The post ME2 modelled flows were compared to the observed flows at the calibration link and screenline locations. The table below provides an overview of the number of links and screenlines that pass criteria as defined in Table 11-6.

[19] Department for Transport (2014) TAG Unit M3.1 – Highway Assignment Modelling [Online]. Available at: (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427124/webtag-tag-unit-m3-1-highway-assignment-modelling.pdf)

Table 11-8 Number of calibration links and screenlines that pass TAG criteria

Count	AM		IP		PM	
	GEH Pass	Flow Pass	GEH Pass	Flow Pass	GEH Pass	Flow Pass
Link Flows	87%	95%	87%	94%	75%	94%
Screenlines		3 of 4		3 of 4		3 of 4

11.3.4 The results above show that the AM and Interpeak models calibrate well against the observed data with over 90% of the links passing both GEH and Flow criteria. The PM model shows 75% of links passing the GEH criteria with 94% passing the Flow criteria.

11.3.5 Screenlines are only assessed regarding flow levels, which must be within 5% of observed flows. In each of the three modelled periods, 3 out of 4 pass the criteria. In the AM peak, the North of Truro (northbound) screenline fails, with a flow difference of -10% compared to observed counts. In the interpeak and PM peak periods, the North of Truro (southbound) screenline fails, with flow differences of -6% and -9% respectively compared to observed counts. In each of the three modelled periods, the failure of the screenlines is due to the cumulative flow differences from all of the count locations, rather than an obvious failure at one specific count location.

11.3.6 A full breakdown of the results of the link flow and screenline analyses can be found in Appendix A.

Junction turning flows

11.3.7 It is important that the model accurately replicates the turning movements at the key junctions within the study area. The following seven junctions were included in the calibration process:

- Chybucca (undertaken as two three arm T-junction counts);
- Henver Ln/B3285 Junction;
- Fiddler's Green Junction;
- Boxheater;
- Chiverton Cross Roundabout;
- Threemilestone Roundabout; and,
- Carland Cross Roundabout.s

11.3.8 Table 11-9 shows the proportion of turns that pass the TAG flow criteria based on the flow criteria set out in Table 11.6.

Table 11-9 Proportion of turns at key junctions that pass TAG criteria

Junctions	AM PASS	IP PASS	PM PASS
Chybucca (East)	89%	100%	100%
Chybucca (West)	100%	100%	100%
Henver Ln/B3285 Junction	100%	100%	100%
Fiddlers Green Junction	100%	100%	100%
Boxheater	100%	89%	89%
Chiverton Cross Roundabout	96%	88%	84%
Threemilestone Roundabout	94%	88%	88%
Carland Cross Roundabout	100%	94%	88%

11.3.9 Based on the data shown in Table 11-9 the model is considered to provide a good representation of the key junctions within the study area.

11.3.10 A full breakdown of the results of the Junction Turning Flow analysis can be found in Appendix B.

11.3.11 The results presented above demonstrate the model calibrates in accordance with WebTAG and therefore that the model calibration is acceptable.

12 Model Validation

12.1 Network

Analysis of paths

12.1.1 Journey paths have been assessed to ensure that the model is providing sensible routing. The paths in the model appear to be realistic.

12.1.2 Origin/Destination (OD) Trees for the following paths have been provided in Appendix C:

- A30 East of Truro – to and from west Truro;
- A30 East of Truro – to and from north Truro;
- A30 West of Truro – to and from west Truro;
- A30 West of Truro – to and from north Truro; and,
- Through route on the A30.

12.1.3 Figure 12-1 shows the OD Tree for trips from Camborne to West Truro.

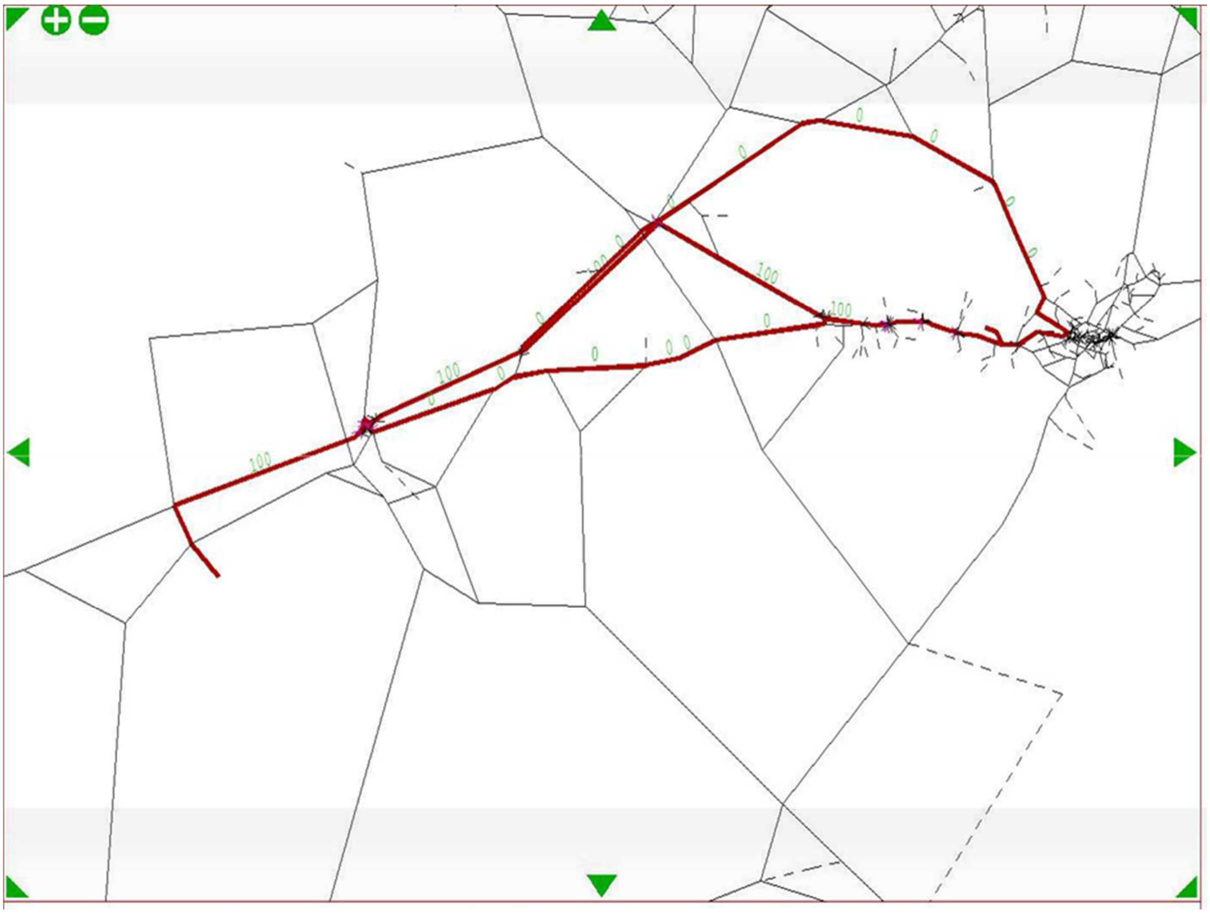

Figure 12-1 OD Tree for the west of Truro (AM peak period)

12.1.4 Three routes are identified in the figure, of which the A30 and A390 route shows nearly all the traffic flow. This is reasonable from Camborne especially given the destination location.

Application of Speed Flow Curves

12.1.5 To represent the reduction in network capacity related to increasing demand, Speed Flow Curves (SFCs) have been implemented within the model. The need for SFCs comes from the interaction between vehicles on the road. SFCs are of increased importance in rural roads with the national speed limit but that only offer a high speed to users when flows are low.

12.1.6 A description of the standard Speed Flow Curves has been previously outlined in Table 10-1. Within the detailed study area, these speed-flow curves have been applied following checks of the route in Google Earth Pro. To further assess their suitability, routing checks were undertaken after implementation.

12.1.7 The SFC types 20 to 25 represent various grades of rural road with few or no adjacent property frontages, the lack of which allows faster link speeds. The different types represent the different geometrical characteristics such as width and number of lanes.

12.1.8 The SFC types 27 to 31 represent suburban roads with some properties nearby which influence the speed and capacity. The different types represent the different geometrical characteristic and also the level of development along the link.

12.1.9 The SFC types 34 to 36 represent the small town roads or rural minor routes which are constrained by their geometrical features such as tight turns or poor visibility. Different SFCs have been produced to represent the levels of development.

12.1.10 Routing checks have been carried out to ensure that traffic remains sensible and that minor roads are not attracting an unrealistic level of traffic from the major routes. The types of SFC applied do not always perfectly match the links' location and a rural road may need a suburban road Speed Flow Curve due to the standard of carriageway or the level of development along its length.

12.1.11 In addition, the inclusion of some unclassified roads as alternative routes in the study area required the creation of new SFCs (37, 38 and 39) to reflect the limited speed and capacity of narrow country lanes where vehicles cannot pass comfortably on many stretches.

Junction coding

12.1.12 Junctions have been coded according to Highway England's RTM Network Coding V 08 guidance.

12.1.13 Junctions within the key study area have been updated to implement the latest values for the saturation turning flows. Checks have been carried out using Google Earth Pro to assess the visibility, turning radius, priority and number of lanes at intersections so that the correct saturation flow can be coded.

12.1.14 Where new network was added, routing checks were carried out to ensure that the distribution of users remained realistic. There are differences between some of the MCC and the ATC and TRADS in some of the key routes of the scheme. The ATC and TRADS have a more robust data because their collection covers a longer period of time, but they do not include the turns which do appear in the MCC. It has been assumed that the turning proportions are constant and accordingly decided to factor the turns in the MCC to match the ATC and TRADS. It is considered reasonable compared to surveys on either side of the scheme. As such this is considered a more robust representation of the flows on the A30.

Other network

12.1.15 The coded link distances have been compared against the crow-fly distances between the relevant nodes to ensure these have been coded accurately. Discrepancies may arise for reasons such as frequent turning or approximation of coordinates and these checks were designed to identify whether there is a mistake or a genuine reason for the difference.

12.1.16 Some small zones, representing traffic from the side roads on the A30, were moved to connect to nodes in the newly added rural network since it offered a more realistic location.

Network routing checks

12.1.17 Traffic matrices from the PCF Stage 1 base model were assigned to the updated PCF Stage 3 model network to assess whether the changes to the network resulted in significant changes in traffic behaviour.

12.1.18 The additional rural network was checked to ensure that it did not reroute an unrealistic volume of users from the main routes. The junctions between the additional rural network and the major routes were checked to ensure that they were sufficiently constraining the side roads. Checks were undertaken to ensure that the rural routes were not more attractive than the major network roads in instances when the distance was shorter on the rural option.

12.2 Assignment

Independence of validation data

12.2.1 The datasets used for validation purposes have been kept independent of the calibration data and were not included in the matrix estimation process. The locations of the counts used for validation can be found in Section 3.3 of the PCF Stage 3 Local Model Validation Report (HE551502-WSP-GEN-0000-RE-TR-0013-P04).

Validation Criteria

12.2.2 It is important that journey times are accurately modelled for the purposes of the economic analysis. These must meet criteria set in TAG unit M3.1.

Table 12-1 TAG Unit M3.1 Table 3: Journey time criteria and acceptability guidelines

Length of route	Description of criteria	Acceptability guidelines
Any	Modelled time within 15% of observed (or 1 minute is higher than 15%)	>85% of cases

12.2.3 The modelled flows at these locations must conform to the criteria previously outlined in Table 11-6 for calibration and validation counts.

Journey time validation

12.2.4 The model has been validated against a number journey time routes. The post ME2 modelled flows and times were compared to the observed data. Table 12-2 shows the proportion of routes that pass the WebTAG journey time criteria.

Table 12-2 Number of validation journey times that pass TAG criteria

Type	AM PASS	IP PASS	PM PASS
Journey Times	95% (19 out of 20)	95% (19 out of 20)	85% (17 out of 20)

12.2.5 The results show that over 85% of the journey time routes pass the validation criteria in all peaks. The model is deemed to therefore reasonably model journey times on key routes.

12.2.6 The individual results for each journey time route are found in Appendix D.

Link flow and screenline validation

12.2.7 A number of counts were retained to validate the model against along the key A30 corridor and to the north of the A30 where the majority of the zonal changes have occurred.

Table 12-3 Number of validation link flows that pass TAG criteria

Count	AM		IP		PM	
	GEH Pass	Flow Pass	GEH Pass	Flow Pass	GEH Pass	Flow Pass
Link Flows	90%	90%	90%	90%	70%	80%
Screenlines		2 of 2		2 of 2		2 of 2

12.2.8 The results show that at least 80% of the PM peak links meet the criteria. In the AM and Inter Peaks, 90% of the links pass the Flow and GEH criteria.

12.2.9 Further analysis shows that in the PM peak it is only two of the validation counts that do not meet the link flow criteria; between Zelah and Carland Cross (eastbound) and A390 between Chiverton Cross and Threemilestone.

12.2.10 The validation screenline is only assessed regarding flow levels and all the differences between modelled and observed values are below the 5% recommended by WebTAG.

12.2.11 Table 12-4, Table 12-5 and Table 12-6 show the validation results for all vehicles at the validation count sites.

Table 12-4 AM peak validation count results

ID	Site location	Data type	AM peak ALL VEHICLES Observed	Modelled	GEH	GEH Pass?	Flow Pass?
TRADS_3707	A30, between Zelah and Carland Cross Rbt.	TRADS ATC	914	792	4.167	Yes	Yes
TRADS_3708	A30, between Zelah and Carland Cross Rbt.	TRADS ATC	987	933	1.745	Yes	Yes
TRADS_30012504	A30, between Redruth and Scorrier	TRADS ATC	1611	1526	2.153	Yes	Yes
TRADS_30012505	A30, between Redruth and Scorrier	TRADS ATC	1125	1320	5.560	No	No
TRADS_30012512	A30, Between Summercourt and Indian Queens	TRADS ATC	1214	1336	3.417	Yes	Yes
TRADS_30012513	A30, Between Summercourt and Indian Queens	TRADS ATC	1325	1458	3.560	Yes	Yes
ATC_137_EB	A390, Between Chiverton Cross and Threemilestone	CC ATC	965	833	4.409	Yes	Yes
ATC_137_WB	A390, between Chiverton Cross and Threemilestone	CC ATC	705	630	2.935	Yes	Yes
MCC_17_SW	Road Between Boxheater West and Fiddler’s Green Junction	MCC	22	14	1.961	Yes	Yes
MCC_17_NE	Road Between Boxheater West and Fiddler’s Green Junction	MCC	14	10	1.136	Yes	Yes

Table 12-5 Interpeak validation count results

ID	Site location	Data type	Interpeak ALL VEHICLES Observed	Modelled	GEH	GEH Pass?	Flow Pass?
TRADS_3707	A30, between Zelah and Carland Cross Rbt.	TRADS ATC	885	752	4.629	Yes	Yes
TRADS_3708	A30, between Zelah and Carland Cross Rbt.	TRADS ATC	853	836	0.594	Yes	Yes
TRADS_30012504	A30, between Redruth and Scorrier	TRADS ATC	1291	1268	0.639	Yes	Yes
TRADS_30012505	A30, between Redruth and Scorrier	TRADS ATC	1149	1410	7.301	No	No
TRADS_30012512	A30, Between Summercourt and Indian Queens	TRADS ATC	1227	1299	2.028	Yes	Yes
TRADS_30012513	A30, Between Summercourt and Indian Queens	TRADS ATC	1160	1183	0.674	Yes	Yes
ATC_137_EB	A390, Between Chiverton Cross and Threemilestone	CC ATC	826	721	3.807	Yes	Yes
ATC_137_WB	A390, between Chiverton Cross and Threemilestone	CC ATC	935	867	2.293	Yes	Yes
MCC_17_SW	Road Between Boxheater West and Fiddler's Green Junction	MCC	16	30	2.843	Yes	Yes
MCC_17_NE	Road Between Boxheater West and Fiddler's Green Junction	MCC	18	45	4.778	Yes	Yes

Table 12-6 PM peak validation count results

ID	Site location	Data type	PM peak ALL VEHICLES Observed	Modelled	GEH	GEH Pass?	Flow Pass?
TRADS_3707	A30, between Zelah and Carland Cross Rbt.	TRADS ATC	1030	841	6.169	No	No
TRADS_3708	A30, between Zelah and Carland Cross Rbt.	TRADS ATC	988	874	3.726	Yes	Yes
TRADS_30012504	A30, between Redruth and Scorrier	TRADS ATC	1369	1236	3.705	Yes	Yes
TRADS_30012505	A30, between Redruth and Scorrier	TRADS ATC	1455	1670	5.454	No	Yes
TRADS_30012512	A30, Between Summercourt and Indian Queens	TRADS ATC	1363	1471	2.867	Yes	Yes
TRADS_30012513	A30, Between Summercourt and Indian Queens	TRADS ATC	1282	1281	0.022	Yes	Yes
ATC_137_EB	A390, Between Chiverton Cross and Threemilestone	CC ATC	699	432	6.734	No	No
ATC_137_WB	A390, between Chiverton Cross and Threemilestone	CC ATC	1152	1250	2.826	Yes	Yes
MCC_17_SW	Road Between Boxheater West and Fiddler's Green Junction	MCC	14	11	0.705	Yes	Yes
MCC_17_NE	Road Between Boxheater West and Fiddler's Green Junction	MCC	29	45	2.601	Yes	Yes

12.2.12 The full results for the validation link flow and screenline analysis by vehicle type are found in Appendix E.

12.2.13 The results demonstrate that the model validates in accordance with WebTAG criteria in all modelled time periods.

Convergence

12.2.14 The final four iterations of the SATURN assignments for each time period are presented in Table 12-7, Table 12-8 and Table 12-9.

Table 12-7 AM peak – Final four SATURN iterations

Iteration	Delta	%Flow	%Gap
23	0.0039	98.3	0.0051
24	0.0034	98.3	0.0054
25	0.0099	99.0	0.0032
26	0.0038	99.5	0.0031

Table 12-8 Interpeak – Final four SATURN iterations

Iteration	Delta	%Flow	%Gap
18	0.0011	98.8	0.00045
19	0.0006	99.2	0.00042
20	0.0004	98.2	0.00053
21	0.0005	99.6	0.00030

Table 12-9 PM peak – Final four SATURN iterations

Iteration	Delta	%Flow	%Gap
49	0.0127	98.1	0.017
50	0.0136	98.5	0.037
51	0.0267	98.3	0.029
52	0.0118	98.1	0.031

12.2.15 Table 12-10 provides a summary of the convergence parameters used in the SATURN model against WebTAG Unit M3.1 acceptability criteria.

Table 12-10 Summary of model convergence

Measure of convergence	Acceptability criteria	AM	Interpeak	PM
'Delta' and %GAP	Less than 0.1% or at least stable with convergence fully documented and all other criteria met.	Pass	Pass	Pass
Percentage of links with flow change < 1%	Four consecutive iterations greater than 98%.	Pass	Pass	Pass
Percentage change in total user costs	Four consecutive iterations less than 0.1%.	Pass	Pass	Pass

12.2.16 The convergence results show stability within the final iterations with a flow percentage greater than 98% in all peak periods. The Delta value is stable and less than 0.1 all peaks which is considered acceptable.

12.3 Matrices

Matrix zonal demand changes

12.3.1 A comparison of the matrix demand against the South West Regional Transport Model (SWRTM) data is provided in the PCF Stage 3 Local Model Validation Report (HE551502-WSP-GEN-0000-RE-TR-0013-P04).

13 Forecast Assumptions

13.1 Overview of Demand Forecasting Procedure

13.1.1 This section details the approach used to produce future year demand matrices to be used in the PCF Stage 3 modelling work.

13.1.2 The demand forecasting procedure involved the interrogation of local planning documents to identify developments to be point loaded to specific zones in the model. Large developments in the proximity to the scheme that were considered likely to have a direct impact on future demand on the A30 were explicitly modelled. These included developments in large settlements such as Newquay, Redruth and St Austell, trips from which were expected to use either the A30 between Chiverton Cross and Carland Cross or pass through one of the junctions in the scheme area. The developments are detailed in Section 13.3.

13.1.3 Once all developments were identified and point loaded, the forecast growth was compared to TEMPRO v7.2 projections at settlement level for these locations. Any shortfall or surplus in growth across the settlement and the wider county was corrected by application of a factor to adjust to overall county growth levels to ensure that forecast growth across the county is constrained to TEMPRO growth projections. This was only applied to new trip ends resulting from adjusted background growth and specific developments to ensure no zones exhibited negative growth.

13.1.4 The following steps were undertaken to produce the demand forecasts:

- Car trip development totals were calculated for each new zone by year, time period and user class. In the towns of Newquay, St Austell and CPIR (Camborne, Pool, Illogan and Redruth), correction factors derived from census journey to work data were applied to account for local trips, internal to the zone, which will not impinge on the modelled road network. Further details on the calculation of the development totals are in sections 13.3.1 to 13.3.2. To distribute the trips from the new developments, the average distributions from existing zones with similar characteristics were applied using the trip ends from these zones.
-
- Alternative planning assumptions factors from TEMPRO were applied to the trip ends. This was applied at settlement level four key towns with specifically modelled development with growth for zones outside of these applied at a Cornwall and GB level.
-
- These trip ends were then constrained to TEMPRO growth at county level.
-
- LGV and HGV growth forecasts have been calculated using National Transport Model (NTM) and the NRTF (National Road Traffic Forecasts).

13.2 The National Transport Model and NTEM

13.2.1 The NTM is a tool that compares the national consequences of alternative transport policies or widely applied transport policies. These policies are then compared against a range of background scenarios which account for major factors affecting future patterns of travel. Road Traffic Forecasts are produced every two years, with the most recent, from March 2015 being used for the A30 Chiverton to Carland Cross forecasting.

13.2.2 The National Trip End Model (NTEM) provides predictions for the growth of car ownership and traffic. This is influenced by planning data projections. The predictions are a forecast of vehicle movements not of personal travel. The most recent dataset released was in 2013 and this dataset was used in the A30 Chiverton to Carland Cross forecasting.

13.3 Demand Forecasting for Specific Developments

Developments

13.3.1 Local planning data was obtained for the key settlements in the vicinity of the scheme. These settlements are Truro, Newquay, St Austell and Camborne, Pool, Illogan and Redruth (CPIR).

13.3.2 Outside of these areas, local planning data is of less significance to the scheme as growth will be constrained to TEMPRO at County Level. Therefore the distribution of development is of limited significance to growth on the A30 between Chiverton Cross and Carland Cross, and hence modelling specific development locations was not considered to be necessary.

13.3.3 Developments were identified using planning data provided by Cornwall Council. This includes size of development, type of development and development phasing. In addition, the development certainty has been identified for each development, in consultation with Cornwall Council. The likelihood of each development coming forward has been considered and assigned a probability in line with Table 13-1.

Table 13-1 Classification of future developments

Probability of the input	Status
Near certain: The outcome will happen or there is a high probability that it will happen.	- Intent announced by proponent to regulatory agencies. - Approved development proposals. Projects under construction.
More than likely: The outcome is likely to happen but there is some uncertainty.	- Submission of planning or consent application imminent. Development application within the consent process.
Reasonably foreseeable: The outcome may happen, but there is significant uncertainty.	- Identified within a development plan. - Not directly associated with the transport strategy/ scheme, but may occur if the strategy/scheme is implemented. - Development conditional upon the transport strategy/scheme proceeding. Or, a committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty.
Hypothetical: There is considerable uncertainty whether the outcome will ever happen.	- Conjecture based upon currently available information. - Discussed on a conceptual basis. - One of a number of possible inputs in an initial consultation process. Or, a policy aspiration.

Source: TAG Unit M4 Table A2 Classification of Future Inputs

13.3.4 Table 13-2 shows the total developments by town or strategic development, which are considered to be 'Near Certain' or 'More than Likely'. Detailed locations of the developments can be found in the Traffic Forecasting Report (HA551502-WSP-GEN-0000-RE-TR-0018-P03).

Table 13-2 Total 'Near Certain' and 'More Than Likely' developments (2038 build out levels)

Name	Housing	Retail				Employment							Education	
		Local Shops	Food superstore	Retail Park no food	Retail park with food	B1(a)	B1(mixed)	B2	B8	A3	A3/A4	C2 Care Home	D1 Primary School	D1 Nursery
			m2	m2	m2	m2	m2	m2	m2	m2	m2	bed	pupil	pupil
Newquay	4936	0	0	0	23234	0	34037	0	0	0	0	0	0	0
St Austell	2422	0	0	0	5285	0	9600	0	0	0	0	0	0	0
Camborne	992	1359	0	0	0	0	5686	0	0	0	0	0	0	0
Redruth	1141	1804	0	0	0	11000	0	17000	0	0	0	0	0	0
Langarth	1500	0	1120	0	7339	4505	9010	0	0	929	929	60	360	500
Pollards Field	78	0	0	0	0	0	0	0	0	0	0		0	0
Willow Green	515	0	0	9643	0	3513	0	0	0	640	460	0	0	0
Maiden Green	435	0	0	8200	0	0	0	0	0	861	0	0	211	0
Hendra	0	0	6828	0	0	116	0	0	0	0	929	0	0	465
Pencoose	173	0	0	0	0	0	0	0	0	0	0	80	0	0
Union Corner	96	0	0	2000	0	0	0	0	0	70	0	0	0	0
Higher Newham	150	0	0	0	0	0	0		0	0	0	0	0	0
Tolgarrick	520	0	0	0	0	0	0	0	0	0	0	0	0	0
Dudman Farm	275	0	0	0	0	0	0	0	0	0	0	0	0	0
Higher Besore	175	0	0	0	0	0	0	0	0	0	0	0	0	0
Treyew Road Football Ground	0	0	0	0	12545	0	0	0	0	464	0	0	0	0
Penn an Dre	118	0	0	0	0	0	0	0	0	0	0	0	0	0

Trip generation

13.3.5 TRICS v7.2.4 has been used to extract trip rates for each of the development types identified for inclusion within the forecast models. These rates were based upon similar developments to ensure they are representative of the development to which they are being applied for the purposes of trip generation.

13.3.6 Table 13-3 shows the car only average trip rates that were used for each time period by development type.

Table 13-3 Trip rates

Development Type	Trip Rate Divisor	AM Peak		Interpeak		PM Peak	
		Origin	**Dest**	**Origin**	**Dest**	**Origin**	**Dest**
Housing	per	0.314	0.140	0.093	0.174	0.209	0.407
Local Shops	per 100	3.805	4.224	4.800	4.800	5.208	4.609
Food superstore	per 100	2.170	2.744	6.300	6.300	7.346	7.061
Retail Park no	per 100	0.262	0.480	1.500	1.500	1.177	1.090
Retail park with	per 100	2.599	1.968	4.500	4.500	4.150	4.433
B1(a)	per 100	0.246	1.796	0.450	0.450	1.265	0.206
B1(mixed)	per 100	0.127	1.529	0.400	0.400	1.338	0.510
B2	per 100	0.549	0.353	0.430	0.430	0.500	0.140
B8	per 100	0.330	0.200	0.140	0.150	0.040	0.252
C1	per 100	0.588	0.232	0.140	0.169	0.116	0.312
A3	per 100	0.000	0.000	0.000	0.000	2.247	2.809
A3/A4	per 100	0.000	0.000	1.061	1.515	2.424	3.182
C2 Care home	Per Room	0.089	0.089	0.101	0.098	0.013	0.070
D1 Primary	Per Pupil	0.107	0.133	0.015	0.021	0.027	0.012
D1 Nursery	per 100	3.509	4.575	0.533	0.577	4.375	3.575

13.3.7 The trip rates for the neutral month weekday periods were taken directly from TRICS for the modelled time periods. The trip generation process assumes the new developments would only generate trips in user classes 1 to 3, as LGV and HGV growth has been modelled using National Transport Model (NTM) and the NRTF (National Road Traffic Forecasts).

13.3.8 Table 13-4 shows the trip totals by town or strategic development for each modelled year and time period.

Table 13-4 Development trips

Name	2023						2038					
	AM		IP		PM		AM		IP		PM	
	Origin	Dest	Origin	Dest	Origin	Dest	Origin	Dest	Origin	Dest	Origin	Dest
Newquay	682	580	598	707	850	1030	2197	1669	1641	2041	2451	3213
St Austell	623	307	192	352	439	814	910	590	501	698	854	1269
Camborn	323	234	126	205	293	438	370	283	180	261	354	495
Redruth	280	170	149	204	234	357	547	494	315	408	557	594
Langarth	349	292	401	431	473	533	775	682	612	736	932	1126
Pollards Field	24	11	7	14	16	32	24	11	7	14	16	32
Willow Green	100	91	105	126	138	168	199	183	209	251	277	337
Maiden Green	56	39	50	61	58	81	186	130	168	205	194	272
Hendra	165	211	433	433	544	525	165	211	433	433	544	525
Pencoose	31	16	12	19	19	38	61	31	24	38	37	76
Union Corner	36	23	39	47	44	61	36	23	39	47	44	61
Higher Newham	47	21	14	26	31	61	47	21	14	26	31	61
Tolgarrick	70	31	21	39	47	91	163	73	48	90	109	212
Dudman Farm	43	19	13	24	29	56	86	39	26	48	57	112
Higher Besore	55	25	16	30	37	71	55	25	16	30	37	71
Treyew Road Football	329	248	565	565	521	558	329	248	565	565	521	558
Penn an Dre	37	16	11	20	25	48	37	16	11	20	25	48

Trip distribution

13.3.9 It was necessary to create a distribution for the trips generated by the new developments. In Truro, this was done by using an average distribution from similar existing zones and applying this distribution to the new development zones. In the remaining towns, which are generally modelled as a single zone, the trips created by specifically modelled developments were distributed based on the existing trip distribution in that zone. Checks were undertaken to ensure the development distributions appeared sensible.

13.3.10 2011 Census Journey to Work data was used to adjust the development trips to and from Newquay, St Austell and CPIR to account for the expected intrazonal movements within these zones. This represents movements where people live and work in a similar area (i.e. within the same zone in the model). Given strategic nature of the model, several zones do not model a full set of trips for the town. The

Redruth and Camborne zones for example, only model the trips through the A30 between Chiverton Cross and Carland Cross and to and from Truro.

13.3.11 A factor was applied to the total volume of trips to correct the overall volume to remove these intrazonal trips. Table 13-5 shows these factors.

Table 13-5 Intrazonal trip correlation factors

Town	Origin Factor	Destination Factor
Newquay	0.50	0.52
St Austell	0.50	0.66
Camborne, Pool & Illogan*	0.38	0.32
Redruth*	0.54	0.51
* Intrazonal factor also removes trips to and from western Cornwall		

13.4 Demand Forecasting and NTEM

13.4.1 Growth factors have been derived from TEMPRO v7.2 for Car user classes (Ucs). Table 13-6 shows the equivalence between the TEMPRO time periods and the model time periods.

Table 13-6 TEMPRO time period equivalence

Model Time Period	Model Time Period Name	TEMPRO Time Period
01	AM	Weekday AM peak period (0700-0959)
02	IP	Weekday Inter peak period (1000-1559)
03	PM	Weekday PM peak period (1600-1859)

13.4.2 To proportion the trips between the user classes, TEMPRO user classes have been used to calculate the purpose splits.

13.4.3 TEMPRO v7.2 has been used in modelling for PCF Stage 3. One of the key differences between the new NTEM dataset and that from version 6.2 is the change in the zone structure. The version 7 dataset uses a more granular system with more zones. A check was undertaken in MapInfo GIS software to ensure that the zone boundaries previously used align with the boundaries for the updated dataset. On a county and national level, these boundaries have not changed.

13.4.4 For the purposes of the PCF Stage 3 modelling a new regional grouping has been used reflects the areas where there are specifically modelled developments in the model. The following regions will be used for PCF Stage 2:

- GB (Whole Country)
- Cornwall (County)
- Truro
- Newquay
- St Austell
- Camborne, Pool and Redruth (CPIR)

13.4.5 Table 13-7 below shows the LSOA to geographical area equivalence used in PCF Stage 3.

Table 13-7 LSOA to geographical area equivalence

Geographic area	LSOA
GB	GB
Cornwall	Cornwall (County)
Truro	E02003908
	E02003909
	E02003910
Newquay	E02003954
	E02003955
St Austell	E02003961
	E02003963
CPIR	E02003919
	E02003920
	E02003922
	E02003923
	E02003925

13.4.6 An overview of the zone coverage is provided in Figure 10-4 to Figure 10-7 in Section 10.2 of this report. The zone to TEMPRO area equivalence can be found in Section 4.4 of the PCF Stage 3 Traffic Forecasting Report (HA551502-WSP-GEN-0000-RE-TR-0018-P03).

13.4.7 The alternative planning assumptions tool has been used in TEMPRO to remove the developments that have been explicitly modelled. Growth factors based on this amended forecast were extracted and used in the model growth. Table 13-8 shows the TEMPRO Factors extracted for the three user classes.

Table 13-8 District TEMPRO factors by user class

Peak	Year	District	UC1		UC2		UC3	
			Origin	Dest	Origin	Dest	Origin	Dest
AM	2015 - 2023	GB	1.03	1.03	1.05	1.05	1.06	1.06
		Cornwall	1.02	1.04	1.04	1.05	1.05	1.06
		Truro	0.99	1.01	1.01	1.02	1.02	1.03
		Newquay	1.00	1.00	1.01	1.02	1.02	1.03
		St Austell	1.00	1.04	1.03	1.06	1.04	1.07
		CPR	1.00	1.04	1.03	1.06	1.02	1.06
	2015 - 2038	GB	1.12	1.12	1.14	1.14	1.20	1.20
		Cornwall	1.09	1.10	1.12	1.12	1.15	1.16
		Truro	0.99	1.04	1.02	1.07	1.07	1.09
		Newquay	0.99	1.04	1.02	1.06	1.06	1.09
		St Austell	1.00	1.12	1.05	1.15	1.09	1.18
		CPR	1.07	1.12	1.10	1.14	1.12	1.17
IP	2015 - 2023	GB	1.03	1.03	1.04	1.04	1.06	1.06
		Cornwall	1.02	1.02	1.04	1.04	1.06	1.06
		Truro	0.99	0.99	1.01	1.01	1.02	1.02
		Newquay	0.99	0.99	1.01	1.01	1.03	1.02
		St Austell	1.02	1.01	1.05	1.04	1.05	1.05
		CPR	1.01	1.00	1.04	1.04	1.04	1.04
	2015 - 2038	GB	1.11	1.11	1.13	1.13	1.21	1.21
		Cornwall	1.08	1.08	1.11	1.11	1.15	1.15
		Truro	1.01	1.00	1.04	1.04	1.08	1.08
		Newquay	0.99	0.98	1.04	1.04	1.07	1.07
		St Austell	1.06	1.04	1.11	1.11	1.13	1.13
		CPR	1.07	1.07	1.12	1.12	1.14	1.14
PM	2015 - 2023	GB	1.03	1.03	1.05	1.05	1.05	1.05
		Cornwall	1.03	1.02	1.05	1.04	1.05	1.05
		Truro	1.00	0.98	1.02	1.01	1.02	1.02
		Newquay	0.99	0.99	1.02	1.01	1.02	1.02
		St Austell	1.03	0.99	1.05	1.03	1.04	1.03
		CPR	1.02	0.99	1.04	1.03	1.03	1.02
	2015 - 2038	GB	1.11	1.11	1.14	1.14	1.18	1.18
		Cornwall	1.08	1.08	1.12	1.11	1.14	1.14
		Truro	1.03	0.96	1.06	1.02	1.07	1.06
		Newquay	1.01	0.97	1.05	1.02	1.06	1.05
		St Austell	1.10	0.98	1.13	1.06	1.12	1.08
		CPR	1.10	1.05	1.13	1.10	1.13	1.12

13.4.8 Table 13-9 shows the equivalence between the TEMPRO user classes and the model user classes used for purpose splits.

Table 13-9 TEMPRO user class equivalence

Model User	Model User Class	TEMPRO UCs	OD or PA
1	Employers Business	HB Employers Business, NHB Employers	Average
2	Commute	HB Work, NHB Work	Average
3	Other	HB Education, HB Shopping, HB Personal Business, HB Recreation/Social, HB Visiting Friends & Relatives, HB Holiday/Day Trip, NHB Education, NHB Shopping, NHB Personal Business, NHB Recreation/Social, NHB Visiting Friends & Relatives, NHB Holiday/Day Trip	Average OD
4	LGV	- (NTM Growth)	-
5	HGV	- (NTM Growth)	-

13.4.9 The total trip generation and growth was constrained to the overall standard growth from TEMPRO for Cornwall as a county. Table 13-10 shows the TEMPRO factors used.

Table 13-10 TEMPRO factors used to constrain total growth

Peak	Year	District	UC1		UC2		UC3	
			Origin	**Dest**	**Origin**	**Dest**	**Origin**	**Dest**
AM	2015 - 2023	Cornwall	1.05	1.05	1.07	1.07	1.08	1.08
	2015 -2038	Cornwall	1.14	1.13	1.17	1.16	1.21	1.20
IP	2015 - 2023	Cornwall	1.04	1.04	1.06	1.06	1.08	1.08
	2015 -2038	Cornwall	1.12	1.12	1.15	1.15	1.20	1.20
PM	2015 - 2023	Cornwall	1.04	1.04	1.06	1.06	1.07	1.07
	2015 -2038	Cornwall	1.12	1.13	1.15	1.16	1.18	1.19

13.4.10 To constrain the growth to the levels shown in Table 13-10, the development trip ends and those resulting from background growth were reduced. This ensured that the trips from no zone reduced below the base year levels. Bespoke constraint factors were created for each zone to reduce their trip ends by the required levels. These trip ends were then furnessed for each used class and the matrix then restacked.

13.5 Demand Forecasting using the Road Transport Forecasts

13.5.1 LGV and HGV growth within the model were forecast using the 2015 National Road Traffic Forecast (NRTF) from NTM. The NRTF incorporate economic and demographic data and evidence on travel behaviour. Five scenarios are available to account for various levels of uncertainty and use difference income and fuel adjustments. Table 13-11outlines the factors applied to these user classes.

Table 13-11 NRTF growth factors used for LGV and HGV classes

Year	LGV	OGV
2023	1.21	1.05
2038	1.62	1.17

13.6 Supply Forecasting

Infrastructure

13.6.1 Table 13-12 outlines the infrastructure improvement schemes which have been included in the forecast scenarios.

13.6.2 New zones have been coded for all the 'Near Certain' and 'More than Likely' developments outlined in Table 13-2, including access junctions for those located within the simulation network. These were coded as priority junctions unless plans have been provided by Cornwall Council indicating otherwise. Junction layouts from planning applications were available for a number of developments including Willow Green, Maiden Green and Langarth in Truro. These were coded into the model as signalised junctions as per the planning applications.

Table 13-12 Infrastructure improvement schemes for inclusion in the forecast modelling

		DM		DS7A Option	
Scheme	**Status**	**2023**	**2038**	**2023**	**2038**
A30 Temple	Committed	Y	Y	Y	Y
Newquay Strategic Route	Growth Deal Funding Allocated	Y	Y	Y	Y
Truro - Northern Access Road	Committed	Y	Y	Y	Y
Truro - Threemilestone	Under Construction	Y	Y	Y	Y
Truro - Treliske Roundabout	Growth Deal Funding Allocated	Y	Y	Y	Y
Truro - Arch Hill	Growth Deal Funding	Y	Y	Y	Y
St. Erth	NA - Junction schemes in buffer network				
Loggans Moor	NA - Junction schemes in buffer network				
A38 Island Shop	NA - Junction schemes in buffer network				
A38 Carkeel Signalised scheme	NA - Junction schemes in buffer network				
Callywith Gate, Bodmin	NA - Junction schemes in buffer network				
A38 Carminnow Cross, Bodmin	NA - Junction schemes in buffer network				
A39 Treluswell, Falmouth	NA - Junction schemes in buffer network				
Do Something (Option 7A) A30 Chiverton to				Y	Y

13.6.3 The Do Something (Option 7A) Chiverton to Carland Cross scheme plans are found in Appendix F. The dual carriageway standard in both schemes has been coded using the Dual 2-Lane All Purpose (D2AP) Speed Flow Curve[20], detailed in Table 13-13.

Table 13-13 Speed Flow Curve

Road class	Free flow speed (kph)	Breakdown speed (kph)	Saturation flow (PCU/hr)	Power
D2AP	112	73	4199	2.7

13.6.4 It is proposed that as part of the dualling of the A30, Chiverton and Carland Cross will become all movement grade separated junctions. The grade separated layout for Chiverton is proposed to be a gyratory. An indicative layout can be found in Appendix F. For the proposed Chiverton layout, one lane approaches flaring to three entry lanes have been assumed for each arm of both roundabouts with the exception of the two off slips which assume there will be two approach lanes that flare to three lanes on entry. The grade separated layout at Carland Cross is proposed to be two roundabouts linked in a dumbbell arrangement. It assumes two lanes on the roundabout and its approaches.

13.6.5 The following saturation flows shown in Table 13-14 have been used when coding roundabout entries. These are in line with those presented in Table 12 of *Regional Traffic Models Network Coding Manual Version 0.8 (December 2015).*

Table 13-14 Roundabout saturation flows

Entry lanes	Sat flow (PCU)
1	1100
2	2200
3	3320

13.6.6 All the merges were coded using the ‘M’ marker, while taking into account the willingness of drivers to move away from the lane where the merging takes place to accommodate merging traffic (APRESV “Aprés Vous” parameter at default value of 1.0).

Generalised cost parameters

13.6.7 The generalised cost parameters used to assign traffic in the forecast years 2023 and 2038 are detailed in Table 13-15 and Table 13-16 respectively and are taken from the TAG Databook, March 2017. An average network speed of 54 kph has been assumed in the calculation of the PPK parameters.

[20] Regional Traffic Models Network Coding Manual, v0.8, December 2015

Table 13-15 2023 Generalised cost parameters by time period

User Class	Cost (pence)	Car (Emp Bus)	Car (Commute)	Car (other)	LGV	HGV
Neutral Month AM Peak	PPM	33.70	22.60	15.59	23.82	24.18
	PPK	11.91	5.39	5.39	12.78	49.67
Neutral Month Interpeak	PPM	34.54	22.97	16.61	23.82	24.18
	PPK	11.91	5.39	5.39	12.78	49.67
Neutral Month PM Peak	PPM	34.19	22.68	16.33	23.82	24.18
	PPK	11.91	5.39	5.39	12.78	49.67

Table 13-16 2038 Generalised cost parameters by time period

User Class	Cost (pence)	Car (Emp Bus)	Car (Commute)	Car (other)	LGV	HGV
Neutral Month AM Peak	PPM	45.42	30.46	21.01	32.10	32.59
	PPK	11.52	5.06	5.06	12.88	53.21
Neutral Month Interpeak	PPM	46.54	30.95	22.38	32.10	32.59
	PPK	11.52	5.06	5.06	12.88	53.21
Neutral Month PM Peak	PPM	46.07	30.56	22.01	32.10	32.59
	PPK	11.52	5.06	5.06	12.88	53.21

13.7 Uncertainty in Forecasting

13.7.1 Along with the core scenario a range of sensitivity tests have been developed to account for future uncertainty.

13.7.2 TAG Unit M4 recommends producing high and low reference traffic growth scenarios to account for uncertainties over demographic, economic and behavioural trends. These scenarios are calculated using a range about the core scenario growth forecast of +/- 2.5% for traffic forecasts one year ahead of the model base year, rising with the square root of the number of years to +/- 15% for forecasts 36 years ahead.

13.8 Forecast Time Periods and Years

13.8.1 The forecast years are 2023 (scheme opening year) and 2038 (scheme design year). The forecast time periods are shown in Table 13-17.

Table 13-17 Forecast model time periods

Time period	Modelled period
Neutral Month AM Peak	Average hour 07:00 – 10:00
Neutral Month Interpeak	Average hour 10:00 – 16:00
Neutral Month PM Peak	Average hour 16:00 – 19:00

14 Supply and Reference Case Demand Forecasts

14.1 Demand Components of the Core, High and Low Benefit Scenarios

Core scenario

14.1.1 All developments considered “Near certain” or “More than likely” have been included. The development totals for each town are shown in Table 13-2. The growth in the core scenario is constrained to TEMPRO growth, using the methodology detailed earlier in this report.

High benefit scenario

14.1.2 An adjustment of 7.07% in 2023 and 11.99% in 2038 has been applied to each cell of the core scenario reference case matrix referenced in Section 4. These percentages have been calculated using the formula from WebTAG M4 (November 2014):

$$\pm 2.5\% \times \sqrt{n}$$

where n = years ahead of the base year

Low benefit scenario

14.1.3 An adjustment of -7.07% in 2023 and -11.99% in 2038 has been applied to each cell of the core scenario reference case matrix.

14.2 Supply Components of the Core, High and Low Benefit Scenarios

14.2.1 The infrastructure improvements listed in Table 4-13 have been included in the Do Minimum model.

14.2.2 One Do Something scheme has been taken forward to PCF Stage 3 - Do Something (Option 7A) (the Preferred Route scheme). The Do Something model includes the proposed scheme. This proposal includes dual carriageway between Chiverton and Carland Cross with grade separated junctions at these locations and at Chybucca where there will be west facing slips only. The existing A30 will be maintained as a route for local traffic. The Do Something Scheme is shown in Appendix F.

14.2.3 No further infrastructure improvements outside of those included in the Do Minimum scenario are included in these scenarios.

14.3 Construction of Reference Case Matrices

14.3.1 Table 14-1 shows the constrained forecast matrix totals by year and time period. 2015 base year matrix totals have been provided for reference.

Table 14-1 Reference case forecast matrix totals

Scenario	UC1	UC2	UC3	UC4	UC5	TOTAL	Total % Increase from 2015
2015							
AM	4,689	5,991	8,022	2,524	1,474	22,700	
IP	3,906	4,274	9,407	2,390	1,272	21,249	
PM	3,662	5,909	10,491	2,695	1,226	23,982	
2023							
AM	4,684	6,554	8,554	3,055	1,548	24,394	7%
IP	3,907	4,382	10,452	2,882	1,336	22,959	8%
PM	3,618	6,307	11,231	3,260	1,287	25,704	7%
2038							
AM	4,818	7,494	9,484	4,101	1,726	27,624	22%
IP	4,082	4,765	11,970	3,869	1,490	26,176	23%
PM	3,708	7,108	12,453	4,377	1,436	29,083	21%

15 Equilibrium Demand Forecasts

15.1 Overview

15.1.1 Variable Demand Modelling has been carried out at this stage of the scheme assessment as agreed in the PCF Stage 3 Appraisal Specification Report (HA551502-WSP-GEN-0000-RE-TR-00009-P03).

15.1.2 The demand model is an incremental type of model (also known as a “pivot-point” model) as recommended in WebTAG. The demand response in the model is therefore, a function of relative changes in cost between a forecast and comparator scenario.

15.1.3 The Department for Transport’s DIADEM software programme (Version 5) has been used to specify and operate the demand model processes.

15.1.4 The Stage 3 LMVR (HA551502-WSP-GEN-0000-RE-TR-0013-P04) details the results of the realism tests.

15.2 Demand Responses

15.2.1 The PCF Stage 3 Appraisal Specification Report describes in detail the responses that WebTAG recommends, and also provides the justification for excluding certain responses in this study.

15.2.2 The demand responses that have been included in the model are listed below:

- Distribution
- Trip Frequency

15.2.3 The individual responses within the demand model use a hierarchical logit formulation that allows each response to have a different relative level of sensitivity. In this case, where only two responses were modelled, the hierarchy is relatively simple as shown in Table 15-1. The distribution response will form the lowest level (as this is the most sensitive response) while the frequency response sits above and is scaled in proportion to it, in line with guidance in TAG unit M2.

Table 15-1 Response hierarchy

Position	Response	Parameter Type
Top (least sensitive)	Frequency	Theta (θ)
Bottom (most sensitive)	Distribution	Lambda (λ)

15.2.4 The route choice response is modelled separately in the assignment model and will provide the initial costs to be fed upwards through the hierarchy. The interface between demand and supply models and the required composition of cost at each level of the hierarchy was controlled by DIADEM.

15.3 Trip Purposes

15.3.1 The assignment model trip matrices are segmented into vehicle types and trip purposes as shown in Table 15-2 enable the model to represent a variation in generalised cost for different types of trip.

Table 15-2 Trip purpose

User class	Vehicle type	Trip purpose	Demand responses	DIADEM demand segment
1	Car	Business	Frequency Distribution – Origin constrained	1
2		Commuting	Frequency Distribution – Doubly constrained	2
3		Other	Frequency Distribution – Origin constrained	3
4	LGV		Fixed	-
5	HGV		Fixed	-

15.3.2 All goods vehicle trips remain fixed and not subject to the effects of variable demand. It was not necessary to freeze certain movements in the car demand segments where demand response is not required

15.4 Model Parameters

15.4.1 Illustrative parameter values from WebTAG were used as a starting point and these were subsequently calibrated through trial and error during the realism tests. Further information on the realism testing is available in section 7.3 of the PCF Stage 3 LMVR.

15.4.2 The initial parameters used for the distribution model based on the guidance from WebTAG Unit M2, Table 5.1, and the final input parameters for the realism testing, are as shown in Table 15-3.

Table 15-3 Model input parameters

Demand segment	Input parameter (initial)		Input parameters (final)	
	λ	ϑ	λ	ϑ
Employers Business	-0.074	0.1	-0.078	0.01
Commute	-0.065	0.1	-0.07	0.125
Other	-0.084	0.1	-0.084	0.01

15.4.3 WebTAG recommends that the demand model should be run without cost damping initially, and that it should only be implemented as required during realism testing. The first iteration of the realism tests gave fuel price elasticity figures which were well outside the desired range set out by WebTAG and therefore it was considered appropriate to incorporate cost damping into subsequent runs.

15.4.4 The final cost-damping parameters used are shown in Table 15-4.

Table 15-4 Cost damping parameters

Demand segment	Cost damping parameters		
	K	α	d'
Employers Business	30	0.5	30
Commute	30	0.1	30
Other	30	0.7	30

15.5 Reference Travel Costs

15.5.1 In order to undertake the incremental modelling, it was necessary to a different comparator scenario for each of the forecast scenarios to provide relevant reference travel costs.

15.5.2 Two separate stages were required to produce the Do Minimum and Do Something forecasts.

- Do Minimum – pivoted off base model (i.e. demand model used base year costs as a comparator); and
- Do Something – pivoted off Do Minimum (i.e. demand model used future year Do Minimum costs as a comparator).

15.5.3 The model includes the key roads in across Great Britain in order to model full trip lengths as required for variable demand modelling.

15.6 Variable Demand Convergence Statistics

15.6.1 Following the completion of the variable demand modelling using DIADEM, the key convergence statistics were extracted for each forecasting scenario, year and, time period. Table 15-5 shows the percentage gap for the variable demand simulations and whether the SATURN assignment converges in each modelled period.

Table 15-5 Variable demand modelling key convergence statistics

Year	Growth scenario	Scenario	Average peak period hour	Diadem %GAP	Post Diadem SATURN Convergence (%Flows/%Gap)
2023	CORE	DM	AM	0.08%	✓
			IP		✓
			PM		✓
		DS	AM	0.08%	✓
			IP		✓
			PM		✓
	HIGH	DM	AM	0.08%	✓
			IP		✓
			PM		✓
		DS	AM	0.07%	✓
			IP		✓
			PM		✓
	LOW	DM	AM	0.10%	✓
			IP		✓
			PM		✓
		DS	AM	0.06%	✓
			IP		✓
			PM		✓
2038	CORE	DM	AM	0.09%	✓
			IP		✓
			PM		✓
		DS	AM	0.09%	✓
			IP		✓
			PM		✓
	HIGH	DM	AM	0.21%	✓
			IP		✓
			PM		✓
		DS	AM	0.08%	✓
			IP		✓
			PM		✓
	LOW	DM	AM	0.09%	✓
			IP		✓
			PM		✓
		DS	AM	0.08%	✓
			IP		✓
			PM		✓

15.6.2 The DIADEM software manages the interface between the demand and supply models and iterates between each until a suitable level of convergence has been achieved. DIADEM has been run using the “Fixed Step Length” algorithm.

15.6.3 DIADEM was configured to skim costs as an average over all paths from each assignment (essential if cost-damping is used) so it was important that the number of post-assignment “SAVEIT” loops were sufficiently high to ensure that the paths skimmed are a close match to the actual assigned paths.

15.6.4 A relative gap value of 0.1-0.2% is recommended in WebTAG as a suitable level of convergence between demand and supply and this was used as the primary stopping criteria.

15.6.5 Table 15-5 shows that all gap values are equal or lower than 0.10% except one. The 2038 high growth DM scenario has a relative gap value of 0.21%. According to WebTAG a relative gap value of 0.20% is considered acceptable. The results show that for the 2038 DM high growth scenario, the relative gap is only just over the value recommended by WebTAG. However, as this scenario is only over the recommended gap by 0.01% maintains a stable convergence at these values and converge within SATURN they are therefore deemed acceptable for use in the PCF Stage 3 appraisal.

15.6.6 All core scenario models converge in line with WebTAG and are therefore deemed acceptable for use in the PCF Stage 3 appraisal.

15.7 Impacts of Variable Demand Modelling

15.7.1 The impacts of the variable demand modelling in the Do Minimum and Do Something scenarios was assessed by comparing the post VDM assignments to those produced using the Reference Case forecast matrices. This section presents the changes in matrix totals, total simulation network travel time and total distance travelled within the simulation network.

Matrix totals

15.7.2 The totals of the matrices produced following the VDM process in Diadem were compared to those of the Reference Case. Table 15-6 shows the comparison of these totals.

Table 15-6 Comparison of matrix totals

Year	Growth scenario	Scenario	Average peak period Hour	Ref Case matrix total (pcu)	Post Diadem matrix total (pcu)	Difference (pcu)	Percentage difference
2023	CORE	DM	AM	24,394	24,474	80	0%
			IP	22,959	23,008	49	0%
			PM	25,704	25,728	24	0%
		DS	AM	24,394	24,522	128	1%
			IP	22,959	23,025	66	0%
			PM	25,704	25,827	123	0%
	HIGH	DM	AM	26,119	26,160	41	0%
			IP	24,582	24,615	33	0%
			PM	27,521	27,481	-40	0%
		DS	AM	26,119	26,277	158	1%
			IP	24,582	24,668	86	0%
			PM	27,521	27,619	98	0%
	LOW	DM	AM	22,670	22,776	106	0%
			IP	21,336	21,396	60	0%
			PM	23,887	23,961	74	0%
		DS	AM	22,670	22,843	173	1%
			IP	21,336	21,429	93	0%
			PM	23,887	24,007	120	1%
2038	CORE	DM	AM	27,624	27,769	145	1%
			IP	26,176	26,281	105	0%
			PM	29,083	29,092	9	0%
		DS	AM	27,624	28,028	404	1%
			IP	26,176	26,357	181	1%
			PM	29,083	29,300	217	1%
	HIGH	DM	AM	30,936	30,979	43	0%
			IP	29,315	29,366	51	0%
			PM	32,570	32,413	-157	0%
		DS	AM	30,936	31,200	264	1%
			IP	29,315	29,484	169	1%
			PM	32,570	32,635	65	0%
	LOW	DM	AM	24,312	24,521	209	1%
			IP	23,038	23,171	133	1%
			PM	25,596	25,730	134	1%
		DS	AM	24,312	24,632	320	1%
			IP	23,038	23,223	185	1%
			PM	25,596	25,857	261	1%

15.7.3 The table shows that the VDM process results in only minor matrix total changes with a maximum change of ±1% of the Reference Case matrix total for the relevant peak. Although mode choice has not been explicitly modelled, the trip frequency response acts as proxy - see Section 7.2.5 of the PCF Stage 3 LMVR (HA551502-WSP-GEN-0000-RE-TR-0013-P04). It should be noted that the modelled time periods represent the average peak period hour rather than a peak hour which reduces the impact of peak spreading.

Total travel time

15.7.4 A comparison of the total travel time on the simulation network has been undertaken to assess changes in travel time between the Reference Case and the variable demand modelling. Table 15-7 outlines the results of this comparison for the core scenario.

Table 15-7 Comparison of total simulation network travel time

Year	Growth scenario	Scenario	Average peak period hour	Ref case simulation network total travel time (pcu*hrs)	Post Diadem simulation network total travel time (pcu*hrs)	Difference (pcu*hrs)	Percentage difference
2023	CORE	DM	AM	4,492	4,529	37	1%
			IP	4,060	4,106	47	1%
			PM	5,218	5,220	3	0%
		DS	AM	4,079	4,271	192	5%
			IP	3,778	3,940	163	4%
			PM	4,616	4,882	266	6%
2038		DM	AM	5,842	5,809	-33	-1%
			IP	5,094	5,200	106	2%
			PM	7,056	6,763	-293	-4%
		DS	AM	4,970	5,593	623	13%
			IP	4,512	4,843	331	7%
			PM	5,892	6,369	477	8%

15.7.5 As expected, the total travel time has changed following the VDM process. Table 15-7 shows that there is some change in the total travel time on the network. Changes in the Do Minimum scenarios are between -4% and +2% and in the Do Something scenarios changes are between 4% and 11%. The VDM causes an increase in total travel time in the Do Something scenarios.

15.7.6 In the 2023 DM simulation network changes to the total travel time post DIADEM are negligible in all three time periods. In the 2038 DM PM scenario – the most congested scenario - the variable demand modelling reduces the distance and travel time, which is a reasonable response. In all cases, apart from the 2038 DS AM peak, the changes are within 8%. It is considered that the variable demand responses in the core scenario are acceptable.

Total distance travelled

15.7.7 Total travel distance is expected to change following the VDM process within Diadem. Table 15-8 outlines the comparison between the Reference Case and the Post Diadem models.

Table 15-8 Comparison of total distance travelled within the simulation network

Year	Growth scenario	Scenario	Average peak period hour	Ref case simulation network total distance travelled (pcu*km)	Post Diadem simulation network total distance travelled (pcu*km)	Difference (pcu*km)	Percentage difference
2023	CORE	DM	AM	268,186	271,704	3,518	1%
			IP	251,276	254,769	3,492	1%
			PM	287,086	288,277	1,191	0%
		DS	AM	271,439	286,400	14,962	6%
			IP	254,605	267,828	13,223	5%
			PM	291,479	309,295	17,815	6%
2038		DM	AM	314,172	320,919	6,747	2%
			IP	294,935	302,771	7,836	3%
			PM	336,523	334,790	-1,734	-1%
		DS	AM	320,560	356,070	35,510	11%
			IP	299,155	323,903	24,748	8%
			PM	342,868	372,286	29,419	9%

15.7.8 Table 15-8 shows that there is an increase in total distance travelled in all but one of the scenarios following the VDM process (2038 DM PM). The changes in the 2023 scenarios are between 0% and 6%. In 2038, all of the scenarios show differences are between -1% and 11%. This is thought to be acceptable as with the scheme in place, users may use a longer route if it will reduce their overall travel time.

15.7.9 The 2038 DM simulation network distance travelled post DIADEM is lower than the reference case in the PM peak. The congestion in the Do Minimum scenario causes the variable demand to reduce the distance travelled, which is a reasonable response. In all cases, the changes are within 11%. It is considered that the variable demand responses in the core scenario are acceptable.

15.7.10 The changes in total trips, total simulation network travel time and total simulation travel distance as a result of the variable demand process as considered reasonable. The variable demand forecasts are therefore considered robust for the purposes of the PCF Stage 3 assessment.

16 Forecast Results

16.1 Assignment Convergence Criteria

16.1.1 Convergence is required in order to provide stable, consistent and robust model results and to differentiate between real changes and those associated with differing degrees of convergence. The convergence criteria guidance from TAG has been used and is shown in Table 16-1.

Table 16-1 Convergence criteria

Measure of convergence	Base model acceptable values
Delta and %GAP	Less than 0.1% or at least stable with convergence fully
Percentage of links with flow change (P) < 1%	Four consecutive iterations greater than 98%
Percentage of links with cost change (P2) < 1%	Four consecutive iterations greater than 98%
Source: TAG Unit M3.1 Highway Assignment Modelling | Table 4	

16.2 Core Scenario: Convergence

16.2.1 Table 16-2 to Table 16-5 show the convergence results for each of the Core scenarios.

Table 16-2 2023 DM convergence results

Year	Time period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 consecutive iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2023 DM	AM Peak	98.4	PASS	0.003	PASS
		98.5			
		98.7			
		98.9			
	Interpeak	99.1	PASS	0.001	PASS
		98.3			
		98.4			
		98.2			
	PM Peak	98.5	PASS	0.001	PASS
		98.5			
		98.5			
		98.5			

Table 16-3 2023 DS7A convergence results

Year	Time period	% of Links with flow change (P) < 1%	Acceptability (Final 4 consecutive iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2023 DS7A	AM Peak	98.0	**PASS**	0.001	**PASS**
		98.1			
		98.5			
		98.4			
	Interpeak	98.9	**PASS**	0.001	**PASS**
		99.3			
		99.0			
		99.3			
	PM Peak	98.6	**PASS**	0.011	**PASS**
		98.7			
		98.1			
		98.4			

Table 16-4 2038 DM convergence results

Year	Time period	% of Links with flow change (P) < 1%	Acceptability (Final 4 consecutive iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2038 DM	AM Peak	99.2	PASS	0.006	PASS
		99.0			
		98.7			
		98.7			
	Interpeak	98.5	PASS	0.006	PASS
		98.6			
		98.4			
		98.2			
	PM Peak	98.8	PASS	0.016	PASS
		98.2			
		98.2			
		98.6			

Table 16-5 2038 DS7A convergence results

Year	Time period	% of Links with flow change (P) < 1%	Acceptability (Final 4 consecutive iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2038 DM	AM Peak	98.8	PASS	0.002	PASS
		98.4			
		98.5			
		98.1			
	Interpeak	98.3	PASS	0.002	PASS
		98.5			
		98.7			
		98.7			
	PM Peak	98.7	PASS	0.013	PASS
		98.6			
		98.1			
		98.6			

16.3 Core Scenario: Journey Times

16.3.1 Changes in journey time with the scheme in place were assessed to understand the impact of the scheme. Table 16-6 shows the journey times between Chiverton Cross and Carland Cross on the A30 with and without the scheme in place. The journey times have been taken from a point east of Carland Cross to a point west of Chiverton. This ensure that journey time benefits from the upgrade of these two junctions is included in the assessment.

Table 16-6 Journey times between Chiverton and Carland Cross

Direction	Peak	Journey Times (mm:ss)			
		2023 DM	2023 DS	2038 DM	2038 DS
Westbound	AM	13:10	07:01	15:59	07:16
	IP	12:28	06:56	13:50	07:08
	PM	12:56	07:02	14:46	07:13
Eastbound	AM	13:04	07:03	16:36	07:23
	IP	11:41	07:00	15:04	07:14
	PM	13:01	07:02	18:32	07:34

16.3.2 The table shows that the journey times reduce significantly in the Do Something scenario. This is expected, given the increase in speed limit and capacity.

16.4 Core Scenario: Traffic Flows (All Vehicles including HGVs)

16.4.1 The key links within the model have been analysed to understand the changes in traffic volume at various locations within the model. The full link flow analysis and link saturation including the A390, A39, A3075 and other parts of the A30 is found in Appendix D.

16.4.2 The A30 on either side and within the study area has been analysed to understand the effect of the scheme on traffic flows on the A30 at this point. Table 16-7 to Table 16-9 shows the results of this analysis.

Table 16-7 AM peak A30 link flows in the vicinity of the scheme

Site location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,302	1,472	1,677	1,662	2,278
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,652	1,831	1,992	2,013	2,477
EB, A30, Between Zelah and Carland Cross	EB	792	898	1,293	1,083	1,870
WB, A30, Between Zelah and Carland Cross	WB	933	1,024	1,427	1,113	1,848
EB, A30, Between Redruth and Scorrier	EB	1,527	1,804	1,844	2,040	2,163
WB, A30, Between Redruth and Scorrier	WB	1,321	1,470	1,499	1,695	1,867
WB, A30, Between Scorrier and Chiverton	WB	1,490	1,797	1,990	1,967	2,407
EB, A30, Between Scorrier and Chiverton	EB	1,434	1,550	1,653	1,818	2,135
EB, A30, Between Chybucca and Marazanvose	EB	837	931	1,293	1,117	1,870
WB, A30, Between Chybucca and Marazanvose	WB	900	988	1,426	1,097	1,848

Table 16-8 IP peak A30 link flows in the vicinity of the scheme

Site location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,317	1,503	1,693	1,723	2,256
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,349	1,523	1,672	1,809	2,029
EB, A30, Between Zelah and Carland Cross	EB	752	858	1,245	1,178	1,686
WB, A30, Between Zelah and Carland Cross	WB	836	920	1,189	1,042	1,554
EB, A30, Between Redruth and Scorrier	EB	1,269	1,479	1,537	1,782	1,851
WB, A30, Between Redruth and Scorrier	WB	1,411	1,612	1,594	1,885	2,003
WB, A30, Between Scorrier and Chiverton	WB	1,354	1,501	1,686	1,809	2,099
EB, A30, Between Scorrier and Chiverton	EB	1,572	1,725	1,814	2,050	2,336
EB, A30, Between Chybucca and Marazanvose	EB	745	846	1,245	1,177	1,686
WB, A30, Between Chybucca and Marazanvose	WB	819	909	1,189	1,068	1,554

Table 16-9 PM peak A30 link flows in the vicinity of the scheme

Site location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,553	1,669	2,279	1,761	2,944
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,460	1,642	1,861	1,918	2,191
EB, A30, Between Zelah and Carland Cross	EB	841	1,046	1,568	1,267	2,156
WB, A30, Between Zelah and Carland Cross	WB	874	955	1,351	1,109	1,692
EB, A30, Between Redruth and Scorrier	EB	1,237	1,424	1,492	1,602	1,975
WB, A30, Between Redruth and Scorrier	WB	1,671	1,774	1,866	1,863	1,970
WB, A30, Between Scorrier and Chiverton	WB	1,451	1,634	1,832	1,775	2,345
EB, A30, Between Scorrier and Chiverton	EB	1,966	2,030	2,195	2,129	2,337
EB, A30, Between Chybucca and Marazanvose	EB	846	1,053	1,568	1,244	2,156
WB, A30, Between Chybucca and Marazanvose	WB	887	973	1,351	1,180	1,692

16.4.3 The tables show that there is an increase in traffic on the A30 between 2015, 2023 and 2038. There is also an increase in traffic to the immediate west and to east of the scheme in all time periods. The traffic flows in the do minimum scenario are constrained by the capacity of the current single carriageway A30 which accounts for the large increase in flow with the scheme in place. In addition, traffic reroutes from local routes such as the A3075 and accesses the A30 at Chiverton and Carland Cross.

16.5 Core Scenario: Network Reassignment Effects

16.5.1 The scheme is expected to reroute traffic that previously could have used the A30 between Chiverton and Carland Cross, but did not. To analyse the extent of this rerouting, the traffic flows on the key routes to and from the A30 have been assessed. These routes include the A39, A3075 and the A390.

16.5.2 Table 16-10 to Table 16-12 shows the results of this analysis.

Table 16-10 AM peak key route link flows in the vicinity of the scheme

Site location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
A3075 Between Chiverton and B3284	NB	368	439	332	589	388
A3075 Between Chiverton and B3284	SB	440	492	502	598	608
A39, Between Truro and Carland Cross Rbt	NB	470	511	331	496	407
A39, Between Truro and Carland Cross Rbt	SB	605	697	499	693	732
A39, Between Truro and Carnon Downs	NB	915	979	927	1,117	1,049
A39, Between Truro and Carnon Downs	SB	744	807	784	858	869
A390, Between Chiverton and Threemilestone	EB	839	1,102	1,019	1,096	1,137
A390, Between Chiverton and Threemilestone	WB	635	652	548	856	709
A390, Between Treliske Hospital and Truro	EB	1,001	1,119	836	1,214	1,032
A390, Between Treliske Hospital and Truro	WB	1,134	1,171	982	1,235	1,093
A390, Between Truro and Probus	EB	478	557	526	688	577
A390, Between Truro and Probus	WB	826	865	875	886	943
B3284, Between Shortlanesend and Truro	NB	229	281	424	323	475
B3284, Between Shortlanesend and Truro	SB	552	528	797	530	818
Chacewater Hill between Threemilestone and Chacewater	EB	582	651	671	867	845
Chacewater Hill between Threemilestone and Chacewater	WB	129	188	226	233	279

Table 16-11 IP peak key route link flows in the vicinity of the scheme

Site location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
A3075 Between Chiverton and B3284	NB	426	486	409	632	466
A3075 Between Chiverton and B3284	SB	410	449	451	563	552
A39, Between Truro and Carland Cross Rbt	NB	581	655	421	496	558
A39, Between Truro and Carland Cross Rbt	SB	504	557	419	608	444
A39, Between Truro and Carnon Downs	NB	845	924	813	952	862
A39, Between Truro and Carnon Downs	SB	772	828	779	877	770
A390, Between Chiverton and Threemilestone	EB	727	687	627	796	758
A390, Between Chiverton and Threemilestone	WB	872	917	594	1,170	801
A390, Between Treliske Hospital and Truro	EB	1,120	1,118	877	1,190	978
A390, Between Treliske Hospital and Truro	WB	1,077	1,113	876	1,233	1,007
A390, Between Truro and Probus	EB	635	692	666	832	752
A390, Between Truro and Probus	WB	583	607	586	646	628
B3284, Between Shortlanesend and Truro	NB	363	449	659	536	725
B3284, Between Shortlanesend and Truro	SB	328	434	604	435	650
Chacewater Hill between Threemilestone and Chacewater	EB	303	366	395	498	511

Chacewater Hill between Threemilestone and Chacewater	WB	284	313	398	394	442

Table 16-12 PM peak key route link flows in the vicinity of the scheme

Site location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
A3075 Between Chiverton and B3284	NB	628	687	509	767	599
A3075 Between Chiverton and B3284	SB	427	486	473	636	564
A39, Between Truro and Carland Cross Rbt	NB	656	565	651	444	785
A39, Between Truro and Carland Cross Rbt	SB	453	518	434	568	511
A39, Between Truro and Carnon Downs	NB	882	873	791	868	782
A39, Between Truro and Carnon Downs	SB	921	995	894	1,075	910
A390, Between Chiverton and Threemilestone	EB	538	623	531	649	673
A390, Between Chiverton and Threemilestone	WB	1,255	1,298	810	1,294	774
A390, Between Treliske Hospital and Truro	EB	1,077	1,156	971	1,245	1,011
A390, Between Treliske Hospital and Truro	WB	1,123	1,159	930	1,236	1,072
A390, Between Truro and Probus	EB	952	939	945	943	951
A390, Between Truro and Probus	WB	554	599	539	586	576
B3284, Between Shortlanesend and Truro	NB	557	632	740	711	757
B3284, Between Shortlanesend and Truro	SB	464	402	574	444	614
Chacewater Hill between Threemilestone and Chacewater	EB	178	240	261	354	272
Chacewater Hill between Threemilestone and Chacewater	WB	615	616	676	801	867

16.5.3 The A390 between Treliske Hospital and Truro shows a reduction with the scheme in place. The opposite effect can be found in Shortlanesend, which has an increase in traffic. This is likely due to the presence of the west facing slips at Chybucca making the route via Shortlanesend more attractive for trips to access central Truro.

16.5.4 A decrease in traffic flow can also be seen on the A3075 Northbound, A390 between Chiverton Cross and Threemilestone and the A39 between Truro and Carnon Downs. This is caused by trips that previously used these routes to go to large centres of attraction like Newquay and Truro, now using the scheme, to reduce their travel times.

16.5.5 Analysis of the routing within the model confirms that trips from areas such as Falmouth, Penryn and Helston reroute to access the A30 to the west of Chiverton Cross rather than travel via the A39 when the scheme is in place. The same way, A3075 shows a reduction in trips due to trips to Newquay that previously used this route are using junctions to the east of the scheme such as Summercourt to access the A30 earlier when the scheme is in place. This behaviour is considered a reasonable response to the implementation of the scheme.

16.6 Core Scenario: Network Performance Effects

16.6.1 Table 16-13 and Table 16-14 show the network summary statistics for the forecast models.

Table 16-13 2023 Network performance statistics

Scenario	Time Period	Trips (PCUs)	Time (hours)	Distance (km)	Average. Speed (kph)	Transient Queue (PCUs)
DM	AM Peak	24,474	11,571	804,183	70	751
	Interpeak	23,009	10,589	746,618	71	608
	PM Peak	25,728	11,266	730,998	65	901
DS7A	AM Peak	24,561	11,322	819,842	72	601
	Interpeak	23,050	10,415	759,246	73	524
	PM Peak	25,841	10,954	754,500	69	746

Table 16-14 2038 Network performance statistics

Scenario	Time Period	Trips (PCUs)	Time (hours)	Distance (km)	Average. Speed (kph)	Transient Queue (PCUs)
DM	AM Peak	27,769	14,663	991,085	68	1045
	Interpeak	26,281	13,444	929,257	69	888
	PM Peak	29,092	14,068	866,581	62	1325
DS7A	AM Peak	28,028	14,263	1,014,004	71	833
	Interpeak	26,357	13,041	947,351	73	696
	PM Peak	29,300	13,740	908,479	66	1058

16.6.2 The total journey time and total queue have all decreased in both the 2023 and 2038 Do Something models, compared to the respective Do Minimum models. The average speed has increased compared to the Do Minimum scenarios. The results show the significant improvements to network performance provided by the scheme.

16.7 High and Low Benefits Scenario: Comparison with Core Scenario

Convergence

16.7.1 Table 16-15 to Table 16-18 shows the convergence results for each of the Low Growth scenarios.

Table 16-15 2023 DM low growth convergence results

Year	Time Period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 Consecutive Iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2023 DM LOW	AM Peak	94.1	PASS	0.002	PASS
		98.4			
		98.8			
		98.2			
	Interpeak	99.1	PASS	0.002	PASS
		99.2			
		99.1			
		98.3			
	PM Peak	98.7	PASS	0.011	PASS
		94.5			
		98.7			
		98.4			

Table 16-16 2023 DS7A low growth convergence results

Year	Time Period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 Consecutive Iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2023 DS7A LOW	AM Peak	98.4	PASS	0.001	PASS
		99.0			
		98.4			
		98.1			
	Interpeak	98.9	PASS	0.000	PASS
		98.4			
		98.1			
		98.6			
	PM Peak	98.8	PASS	0.012	PASS
		98.8			
		98.4			
		98.6			

Table 16-17 2038 DM low growth convergence results

Year	Time Period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 Consecutive Iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2038 DM LOW	AM Peak	98.0	PASS	0.010	PASS
		98.3			
		98.5			
		98.1			
	Interpeak	99.0	PASS	0.003	PASS
		98.8			
		98.5			
		98.1			
	PM Peak	98.8	PASS	0.018	PASS
		98.3			
		99.0			
		98.3			

Table 16-18 2038 DS7A low growth convergence results

Year	Time Period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 Consecutive Iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2038 DS7A LOW	AM Peak	98.4	PASS	0.002	PASS
		98.5			
		98.6			
		98.6			
	Interpeak	99.1	PASS	0.001	PASS
		99.1			
		99.4			
		99.0			
	PM Peak	99.1	PASS	0.026	PASS
		99.3			
		98.8			
		98.1			

16.7.2 The tables show that the Low Growth scenario models all converge and meet the TAG thresholds.

16.7.3 Table 16-19 to Table 16-22 shows the convergence results for each of the High Growth scenarios.

Table 16-19 2023 DM high growth convergence results

Year	Time Period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 Consecutive Iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2023 DM HIGH	AM Peak	98.5	PASS	0.002	PASS
		98.7			
		98.4			
		98.1			
	Interpeak	99.1	PASS	0.001	PASS
		98.3			
		98.5			
		98.2			
	PM Peak	98.4	PASS	0.009	PASS
		98.7			
		98.4			
		98.5			

Table 16-20 2023 DS7A high growth convergence results

Year	Time Period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 Consecutive Iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2023 DS7A HIGH	AM Peak	98.4	PASS	0.002	PASS
		98.2			
		98.1			
		98.3			
	Interpeak	98.9	PASS	0.001	PASS
		98.8			
		98.7			
		98.4			
	PM Peak	98.2	PASS	0.024	PASS
		98.3			
		98.3			
		98.5			

Table 16-21 2038 DM high growth convergence results

Year	Time Period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 Consecutive Iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2038DM HIGH	AM Peak	98.3	PASS	0.003	PASS
		98.3			
		98.2			
		98.1			
	Interpeak	98.8	PASS	0.009	PASS
		98.1			
		98.3			
		98.3			
	PM Peak	98.5	PASS	0.013	PASS
		98.1			
		98.0			
		98.4			

Table 16-22 2038 DS7A high growth convergence results

Year	Time Period	% of Links with Flow Change (P) < 1%	Acceptability (Final 4 Consecutive Iterations > 98%)	Delta (δ)	Acceptability (< 0.1%)
2038 DS7A HIGH	AM Peak	99.0	PASS	0.005	PASS
		99.0			
		98.7			
		98.3			
	Interpeak	98.8	PASS	0.004	PASS
		98.8			
		98.7			
		98.1			
	PM Peak	98.3	PASS	0.024	PASS
		98.7			
		98.3			
		98.2			

16.7.4 The tables show that the High and Low Growth scenarios all converge in both assessment years.

Network performance

16.7.5 Table 16-23 and Table 16-24 show the network summary statistics for the low growth scenario models.

Table 16-23 2023 Low growth network performance statistics

Scenario	Time Period	Trips (PCUs)	Time (hours)	Distance (km)	Average. Speed (kph)	Transient Queue (PCUs)
DM	AM Peak	22,776	10,617	748,040	71	621
	Interpeak	21,396	9,755	694,432	71	518
	PM Peak	23,961	10,294	682,147	66	766
DS7A	AM Peak	22,843	10,429	761,066	73	514
	Interpeak	21,429	9,623	705,696	73	456
	PM Peak	24,007	10,059	701,545	70	634

Table 16-24 2038 Low growth network performance statistics

Scenario	Time Period	Trips (PCUs)	Time (hours)	Distance (km)	Average. Speed (kph)	Transient Queue (PCUs)
DM	AM Peak	24,521	12,541	872,741	70	791
	Interpeak	23,171	11,594	820,295	71	652
	PM Peak	25,730	11,923	772,391	65	970
DS7A	AM Peak	24,633	12,192	892,036	73	609
	Interpeak	23,223	11,358	835,666	74	539
	PM Peak	25,857	11,553	799,675	69	771

16.7.6 The Low Growth performance statistics show that the total transient queues, journey time and distance decrease resulting in lower benefits compared to the Core Growth scenario.

16.7.7 Table 16-25 and Table 16-26 show the network summary statistics for the High Growth forecast models.

Table 16-25 2023 High growth network performance statistics

Scenario	Time Period	Trips (PCUs)	Time (hours)	Distance (km)	Average. Speed (kph)	Transient Queue (PCUs)
DM	AM Peak	26,160	12,576	859,828	68	872
	Interpeak	24,615	11,450	798,736	70	714
	PM Peak	27,481	12,303	779,167	63	1068
DS7A	AM Peak	26,277	12.245	879,567	72	694
	Interpeak	24,668	11,233	813,751	72	600
	PM Peak	27,619	11,912	806,271	68	881

Table 16-26 2038 High growth network performance statistics

Scenario	Time Period	Trips (PCUs)	Time (hours)	Distance (km)	Average. Speed (kph)	Transient Queue (PCUs)
DM	AM Peak	30,979	16,969	1,108,879	65	1335
	Interpeak	29,366	15,441	1,037,183	67	1192
	PM Peak	32,413	16,495	961,948	58	1665
DS7A	AM Peak	31,200	16,209	1,140,020	70	1027
	Interpeak	29,484	14,869	1,064,281	72	881
	PM Peak	32,635	15,795	1,010,379	64	841

16.7.8 The tables show that the total transient queues, journey time and distance increase compared to the Core Growth scenario. Queuing in particular has increased significantly. There are higher journey time savings with the scheme in place.

Traffic flow comparison

16.7.9 Table 16-27 to Table 16-29 show the A30 flows on key links within the vicinity of the scheme.

Table 16-27 AM peak A30 link flows in the vicinity of the scheme in the low growth scenario

Site Location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,302	1,404	1,553	1,581	2,026
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,652	1,718	1,868	1,924	2,114
EB, A30, Between Zelah and Carland Cross Rbt	EB	792	856	1,176	998	1,602
WB, A30, Between Zelah and Carland Cross Rbt	WB	933	982	1,326	1,066	1,564
EB, A30, Between Redruth and Scorrier	EB	1,527	1,719	1,748	1,925	1,962
WB, A30, Between Redruth and Scorrier	WB	1,321	1,372	1,400	1,568	1,630
WB, A30, Between Scorrier and Chiverton	WB	1,490	1,686	1,877	1,911	2,178
EB, A30, Between Scorrier and Chiverton	EB	1,434	1,447	1,541	1,679	1,848
EB, A30, Between Chybucca and Marazanvose	EB	837	888	1,176	1,033	1,602
WB, A30, Between Chybucca and Marazanvose	WB	900	945	1,326	1,036	1,564

Table 16-28 IP peak A30 link flows in the vicinity of the scheme in the low growth scenario

Site Location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,317	1,421	1,564	1,626	2,000
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,349	1,426	1,576	1,638	1,803
EB, A30, Between Zelah and Carland Cross Rbt	EB	752	797	1,134	991	1,490
WB, A30, Between Zelah and Carland Cross Rbt	WB	836	878	1,112	979	1,341
EB, A30, Between Redruth and Scorrier	EB	1,269	1,377	1,419	1,595	1,637
WB, A30, Between Redruth and Scorrier	WB	1,411	1,529	1,488	1,717	1,752
WB, A30, Between Scorrier and Chiverton	WB	1,354	1,402	1,544	1,685	1,869
EB, A30, Between Scorrier and Chiverton	EB	1,572	1,620	1,680	1,857	2,022
EB, A30, Between Chybucca and Marazanvose	EB	745	787	1,134	985	1,490
WB, A30, Between Chybucca and Marazanvose	WB	819	864	1,112	969	1,341

Table 16-29 PM peak A30 link flows in the vicinity of the scheme in the low growth scenario

Site Location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,553	1,614	2,067	1,745	2,579
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,460	1,532	1,755	1,793	1,981
EB, A30, Between Zelah and Carland Cross Rbt	EB	841	921	1,413	1,190	1,854
WB, A30, Between Zelah and Carland Cross Rbt	WB	874	906	1,272	1,016	1,488
EB, A30, Between Redruth and Scorrier	EB	1,237	1,313	1,365	1,520	1,622
WB, A30, Between Redruth and Scorrier	WB	1,671	1,719	1,765	1,840	1,957
WB, A30, Between Scorrier and Chiverton	WB	1,451	1,483	1,676	1,817	2,024
EB, A30, Between Scorrier and Chiverton	EB	1,966	1,964	2,087	2,142	2,321
EB, A30, Between Chybucca and Marazanvose	EB	846	922	1,413	1,171	1,854
WB, A30, Between Chybucca and Marazanvose	WB	887	921	1,272	1,049	1,488

16.7.10 The tables show that there is a reduction in traffic volumes on the A30 in the Low Growth scenarios compared to the Core Growth scenarios. This is expected given the lower amount of traffic growth.

16.7.11 Table 16-30 to Table 16-32 show the flow on the key A30 links in the High Growth Scenarios.

Table 16-30 AM peak A30 link flows in the vicinity of the scheme in the high growth scenario

Site Location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,302	1,488	1,823	1,667	2,593
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,652	1,925	2,136	2,083	2,570
EB, A30, Between Zelah and Carland Cross Rbt	EB	792	922	1,414	1,135	2,053
WB, A30, Between Zelah and Carland Cross Rbt	WB	933	1,064	1,553	1,171	1,925
EB, A30, Between Redruth and Scorrier	EB	1,527	1,881	1,935	2,107	2,369
WB, A30, Between Redruth and Scorrier	WB	1,321	1,553	1,604	1,766	2,008
WB, A30, Between Scorrier and Chiverton	WB	1,490	1,884	2,100	2,023	2,603
EB, A30, Between Scorrier and Chiverton	EB	1,434	1,642	1,800	1,894	2,289
EB, A30, Between Chybucca and Marazanvose	EB	837	968	1,414	1,174	2,053
WB, A30, Between Chybucca and Marazanvose	WB	900	1,027	1,553	1,166	1,925

Table 16-31 IP peak A30 link flows in the vicinity of the scheme in the high growth scenario

Site Location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,317	1,554	2,111	1,715	2,633
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,349	1,616	1,950	1,934	2,247
EB, A30, Between Zelah and Carland Cross Rbt	EB	752	935	1,429	1,237	1,945
WB, A30, Between Zelah and Carland Cross Rbt	WB	836	970	1,496	1,122	1,732
EB, A30, Between Redruth and Scorrier	EB	1,269	1,578	1,774	1,892	2,073
WB, A30, Between Redruth and Scorrier	WB	1,411	1,693	2,096	2,033	2,152
WB, A30, Between Scorrier and Chiverton	WB	1,354	1,603	2,028	1,862	2,355
EB, A30, Between Scorrier and Chiverton	EB	1,572	1,838	2,411	2,203	2,505
EB, A30, Between Chybucca and Marazanvose	EB	745	929	1,429	1,250	1,945
WB, A30, Between Chybucca and Marazanvose	WB	819	959	1,496	1,209	1,732

Table 16-32 PM peak A30 link flows in the vicinity of the scheme in the high growth scenario

Site Location	Dir	2015 BASE	2023 DM	2023 DS7A	2038 DM	2038 DS7A
EB, A30, Between Carland Cross Rbt and Mitchell	EB	1,553	1,701	2,441	1,734	3,100
WB, A30, Between Carland Cross Rbt and Mitchell	WB	1,460	1,748	1,973	1,972	2,433
EB, A30, Between Zelah and Carland Cross Rbt	EB	841	1,154	1,698	1,286	2,300
WB, A30, Between Zelah and Carland Cross Rbt	WB	874	1,010	1,463	1,164	1,901
EB, A30, Between Redruth and Scorrier	EB	1,237	1,513	1,605	1,721	2,239
WB, A30, Between Redruth and Scorrier	WB	1,671	1,831	1,962	1,939	2,184
WB, A30, Between Scorrier and Chiverton	WB	1,451	1,729	1,968	1,765	2,520
EB, A30, Between Scorrier and Chiverton	EB	1,966	2,098	2,296	2,171	2,591
EB, A30, Between Chybucca and Marazanvose	EB	846	1,150	1,698	1,307	2,300
WB, A30, Between Chybucca and Marazanvose	WB	887	1,044	1,463	1,266	1,901

16.7.12 There is a general increase in trips along the A30 in the High Growth scenario compared to the Core Growth scenario. This is expected given the higher level of traffic growth.

17 Economic Appraisal Approach

17.1.1 The economic appraisal undertaken for the scheme includes monetisation of travel time benefits, vehicle operating costs, accident savings, construction and maintenance impacts, journey time reliability greenhouse gases, wider impacts. Landscape impacts have not been monetised but are assessed qualitatively in the Appraisal Summary Tables.

17.2 Economic Parameters

17.2.1 A number of economic parameters have been employed as part of the appraisal.

Annualisation factors

17.2.2 Annualisation factors are used to convert time slice hourly flows in to annual traffic flows for the purposes of the economic assessment. These factors are specific to this section of highway and they are based on ATCs from the A30 between Chiverton Cross and Carland Cross. These annualisation factors can be seen in Table 17-1

Table 17-1 Annualisation factors

Tuba Time Slice	Traffic model time period	Hours per day	Days per year	Annualisation Factor
AM Peak (7-10 weekdays)	Average hour 7:00 – 10:00	3	253	759
Interpeak (10-4 weekdays)	Average hour 10:00 – 16:00	6	253	1518
PM Peak (4-7 weekdays)	Average hour 16:00 – 19:00	3	253	759
Offpeak (07:00-19:00 all year)	Average hour 19:00 – 07:00	12	365	4,380
Weekend and Bank Holiday	Average hour 09:00 – 18:00 (Saturday)	9	52	948
	Average hour 10:00 – 18:00 (Sunday)	8		
	Average hour 10:00 – 18:00 (Bank Holiday)	8	8	
Total Hours modelled in TUBA				8,364
Total Hours in a Year				8,760

GDP per capita growth

17.2.3 This is used in order to uprate values of time in the TUBA software, for which v1.9.9 was used.

17.3 Construction Costs

Scheme construction costs

17.3.1 The Capital Costs for the scheme have been provided by Highways England Benchmark (in 2010 prices, not discounted to market prices) and are based on the latest information available for the scheme, as of December 2017. All costs have been rebased to 2010, consistent with DfT requirements, and are risk adjusted.

17.3.2 The capital costs for PCF Stage 3 are as per Table 17-2; these costs include those associated with the cost of the gas main diversion and additional land required for the diversion.

17.3.3 The cost estimate used in the cost benefit analysis is the 'most likely cost' estimate.

Table 17-2 PCF Stage 3 construction costs (provided by Benchmark in December 2017, costs shown in 2010 prices)

Cost	PCF Stage 3
Preparation	£9,211,131
Supervision	£4,059,175
Construction	£190,572,328
Lands	£20,056,174
Total	**£223,898,808**

Cost profile

17.3.4 Highways England provided a benchmark scheme cost profile shown in Table 17-3 and based on the cost categories in Table 17-2.

Table 17-3 Scheme cost profile (based on December 2017 costs)

Year	Preparation	Supervision	Construction	Land	Total
2017	2.0%	0.0%	0.0%	26.2%	2.4%
2018	44.3%	0.0%	0.0%	0.0%	1.8%
2019	46.6%	0.0%	1.1%	0.0%	2.9%
2020	7.1%	29.8%	28.5%	73.8%	31.7%
2021	0.0%	61.1%	55.0%	0.0%	47.9%
2022	0.0%	9.1%	15.4%	0.0%	13.3%
Total	**100.0%**	**100.0%**	**100.0%**	**100%**	**100.0%**

Inflation

17.3.5 Inflation has been accounted for in the Highways England cost model using its Major Projects inflation forecast.

Risk and optimism bias

17.3.6 The costs estimates include risk costs, but do not include optimism bias. It is understood that optimism bias should not be applied to the costs and instead costs are assessed inclusive of a risk allowance based on a quantitative risk assessment (QRA).

17.4 Maintenance Costs

17.4.1 Generic maintenance costs for single and dual carriageways, to represent the existing A30 and proposed new road, were calculated based on those presented in the COBA manual (Volume 13, Section 1, Part 2, Chapter 9). This provided base costs of £7400/km/year and £10,400/km/year respectively in 2002 prices, as can be seen in Table 17-4.

17.4.2 Costs were then increased to 2018 prices in line with the Consumer Price Index (CPI), and finally rebased to 2010 costs. The annual costs and the total maintenance costs used in the 60-year appraisal for each scenario are shown in Table 17-5, in addition to the difference in maintenance costs between the two scenarios.

Table 17-4 Non-traffic related maintenance costs (2002 values and prices) [reproduced from COBA manual Table 9/1]

ROAD MAINTENANCE TYPE	1	2	3	4	5	6
CARRIAGEWAY STANDARD	S2	D2AP	D3AP	D2M	D3M	D4M
COBA ROAD CLASS (see Part 5 Chapter 1)	1, 7-10, 15	2, 7-9, 11, 16-17	3, 7-9, 11, 16-17	4, 18-20	5, 18-20	6, 18-20
COST (£/km/year)	7400	10400	12900	17100	19500	19500

Table 17-5 Maintenance costs (£000's)

Item	Do Minimum Maintenance Cost	Do Something Maintenance Cost	Difference in costs between Do Minimum and Do Something Scenarios
Per year	£242.25	£340.46	£98.21
60-year appraisal	£14,534.87	£20,427.39	£5,892.52

17.5 Grants and Subsidies

17.5.1 An EU subsidy of £20 million has been provided to assist in the development and construction of this scheme. The split is 40% (£8 million towards development of the scheme) and 60% (£12 million towards construction costs).

17.6 Travel Time Benefits and Vehicle Operating Costs

17.6.1 Travel time benefits and the impact to vehicle operating costs for the proposed scheme have been assessed using TUBA (version 1.9.9) over a standard appraisal period of 60 years, as defined in WebTAG.

17.6.2 Travel time benefits from the scheme are calculated by comparing the travel costs between the Do Minimum and Do Something assignments. The time saved is then monetised and a benefit is calculated. The value of time varies based upon the purpose (e.g. an employer's business trip has a greater value than a personal business trip) and distance of the trip. The value of time is expected to increase over time due to the increase in general wages and the growth in the economy.

17.6.3 The economics input file encompasses parameters, definitions, growth rates, changes and other factors that are consistent with the TAG Data Book, March 2017 (forthcoming change November 2017). The vehicle operating costs are calculated in a similar way to the travel time benefits except that distance and time savings are used. The non-fuel benefits are calculated using the formula below:

$$\text{Non-fuel VOC} = aD + bT$$

Where:

- *D* is distance in kilometres
- T is time in seconds
- a and b are parameters defined by the user class
- The fuel benefits are calculated using the formula below:
- Fuel consumed = T/D(a+b(D/T)+c(D/T)2+d(D/T)3))
- Where D is distance in kilometres
- T is time in seconds
- a, b, c and d are parameters defined by the user class

17.7 Accident Assessment

17.7.1 Economic benefits due to accident savings following the implementation of the scheme have been assessed using COBA-LT. The entire SATURN simulation area has been used for the COBA-LT assessment to ensure the impact of the scheme is covered in relation to accidents. This network, along with Annual Average Daily Traffic flows and accident rates for major roads within the study area were needed as inputs for this process. COBA-LT has been used to derive safety benefits only. The accident rates have previously been calculated in in Section 8.2 for the existing A30 from Chiverton Cross to Carland Cross. For all remaining links, default accident rates were used. The economic benefits utilised the default accident costs and casualty costs from the COBA-LT parameters file (version 2017.1).

17.7.2 The COBA-LT assessment has been carried out as a combined link and junction assessment. COBA-LT requires that links be designated a link type; as this, along with the speed limit and length of a link, influences the accident rate of the link. The single carriageway section of the A30 in the DM scenario, the A39 and the A390 have been modelled in COBA-LT as Link Type 8 – single carriageway A road not designed to modern standards. The dual sections of the A30, including the new carriageway in the DS scenarios, has been modelled as Link Type 11 – Modern D2 Road with HS, which represents dual carriageway with two lanes in each direction designed to modern standards, with a hard strip. The majority of remaining network has been coded as Link Type 9 – Other S2 Road which represents single carriageways not designed to modern standards.

17.7.3 Annual Average Daily Traffic (AADT) flows for input into the COBA-LT assessment were derived by combining AM, inter-peak and PM average hour flows from the

SATURN model. As the model uses average peak hours the factors to convert average peak hour to peak period were simply the number of hours within that period. A further factor of 1.07 (derived from TRADS data on the A30 between Chiverton Cross and Carland Cross) was applied to convert from 12 hour neutral month weekday flow to annual average daily traffic (AADT) flow, as shown in the equation below:

$$AADT = \left((3 \times AM) + (6 \times IP) + (3 \times PM)\right) \times 1.07$$

17.8 Incident Delay and Travel Time Variability

17.8.1 The impact of the scheme upon reliability has been assessed, where reliability refers to journey time variability. WebTAG states that for journeys predominantly on single carriageways outside urban areas it is not possible to estimate monetised reliability benefits. This assessment therefore uses changes in 'stress', the ratio of annual average daily traffic (AADT) to Congestion Reference Flow (CRF), as a proxy to changes in reliability, as recommended by WebTAG. Stress has been calculated for the section of single carriageway with and without the scheme.

17.8.2 To calculate journey time reliability, it was considered appropriate to use the stress based approach using flows from the traffic forecasting model (as detailed in WebTAG A1.3). This is in-line with the methodology agreed in the PCF Stage 3 Appraisal Specification Report (HA551502-WSP-GEN-0000-RE-TR-0009-P03).

17.8.3 In accordance with DMRB Volume 5, section 1, Part 3 the CRF has been calculated using the following formula:

CRF = CAPACITY * NL* Wf * 100/PkF * 100/PkD * AADT/AAWT

Where:

- CAPACITY is the maximum hourly lane throughout; NL is the number of lanes per direction;
- Wf is a Width Factor
- PkF is the proportion (percentage) of the total daily flow (2-way) that occurs in the peak hour; PkD is the directional split (percentage) of the peak hour flow;
- AADT is the Annual Average Daily Traffic flow on the link; and
- AAWT is the Annual Average Weekday Traffic flow on the link.

Table 17-6 Reliability assessment criteria

Assessment Value	Impact	Description
Greater than 3 million	Largely Beneficial	Usually large flow routes with moderate or high differences in stress
Between 1 and 3 million	Moderately Beneficial	Moderate flow routes with moderate differences in stress
Between 200 thousand and 1 million	Slightly Beneficial	High or moderate flow routes with small differences in stress or low flow routes with high or moderate differences in stress
Less than 200 thousand	Neutral	

17.8.4 The difference between the Do Minimum and Do Something stresses has been calculated, with the minimum stress being 75% and the maximum being 125%. The percentage difference is then multiplied by the Do Something AADT. This gives an overall assessment of the reliability of the scheme. The impacts are measured using the criteria outlined in Table 17-6.

17.8.5 WebTAG states that for journeys predominantly on single carriageways outside urban areas it is not possible to estimate monetised reliability benefits. However, paragraph 3.7 of the *Value for Money Advice Note for Local Decision Makers* by the Department for Transport[21] states that '*Reliability benefits have previously been estimated in the DfT by applying uplifts of 5%, 10% and 20% of time savings. These* provide an indicative measure of reliability benefits to reflect Slight, Moderate or Large impacts respectively'.

17.8.6 For the PCF Stage 3, reliability benefits have been monetised by assessing whether the impacts are slight, moderate or large and applying a factor of 5%, 10% or 20% to the time savings calculated in TUBA. Reliability benefits will be included in the adjusted BCR outlined in Section 18.10 of this report.

17.9 Construction and Maintenance

17.9.1 Delays to transport users during construction and maintenance of the A30 Chiverton to Carland Cross scheme have been assessed using the SATURN traffic model and a TUBA model. In addition to the 60-year appraisal, TUBA models have been developed to cover the construction and maintenance phases:

Construction phase (3 years)

17.9.2 This TUBA model has used a network coded specifically to represent the network conditions during the construction phase and currently is scheduled for 2020 to 2022.

17.9.3 The impact of construction on the road network was only assessed during the years 2020 to 2022 which is when the scheme is planned to be constructed. The TUBA model therefore only compared a network that represented the construction phase against the Do Minimum.

17.9.4 It has been assumed that during the construction phase there would be 1-lane running in both directions on the A30 at all times. The maximum speed assumed through the site was 40mph and that lanes would be reduced to a width of 3.25m. This would apply to the entire section of the A30 for the entire construction period. The decision has been made to apply the speed limit for the entire section to remove any confusion for motorists.

17.9.5 The model scenarios and traffic matrices used in the TUBA model are summarised below in Table 17-7:

[21] Available at: https://www.gov.uk/government/uploads/s ystem/uploads/attachment_data/file/267296/vfm-advice-local-decision-makers.pdf

Table 17-7 Construction assessment scenarios

Modelled Years	Do Minimum Network Used	Do Minimum Traffic Matrices Used	Construction Network Used	Construction Traffic Matrices Used
2020	2020 Do Minimum	2020 Do Minimum Variable Demand	2020 Construction	2020 Do Minimum Variable Demand
2021	2021 Do Minimum	2021 Do Minimum Variable Demand	2021 Construction	2021 Do Minimum Variable Demand
2022	2022 Do Minimum	2022 Do Minimum Variable Demand	2022 Construction	2022 Do Minimum Variable Demand

17.9.6 As can be seen from Table 17-7 bespoke matrices and networks have been developed for each of the construction years to improve the accuracy of the modelling and ensure that the impact of the construction is accurately reflected in the TUBA output.

17.9.7 The matrices have been developed by subtracting the 2015 base matrix from the 2023 matrix and then portioning the difference between the matrices, dependent on the year being modelled, and adding this to the 2015 base matrix.

17.9.8 The generalised costs for the network were updated to reflect the model year and are calculated using the March 2017 WebTAG Databook.

17.9.9 The annualisation factors used in the construction assessment are summarised in Table 17-8.

Table 17-8 Construction assessment annualisation factors

Tuba Time Slice	Annualisation Factor
AM Peak (7-10 weekdays)	759
Interpeak (10-4 weekdays)	1518
PM Peak (4-7 weekdays)	759

17.9.10 The weekend/bank holiday and off-peak periods have not been included in the construction impacts assessment due to the lower level of traffic flows during these periods, but during these periods the Traffic Management will be the same as per the peak periods

Maintenance phases (over 60 years)

17.9.11 This TUBA model has accounted for the difference in maintenance between the Do Minimum and Do Something scenarios. The TUBA model has used networks coded specifically to represent the appropriate traffic management in place for the maintenance for the Do Minimum and Do Something scenarios.

17.9.12 The maintenance schedule for a single carriageway has been assumed in Table 17-9, using guidance taken from the QUADRO manual, DMRB volume 14.

Table 17-9 Maintenance works assumptions

Year	Type of works	Days per kilometre	Total days (both directions)
2023	Thin Surfacing	4	56
2033	Overlay	12	168
2043	Thin Surfacing	4	56
2053	Overlay	12	168
2063	Thin Surfacing	4	56
2073	Overlay	12	168
2083	Thin Surfacing	4	56

17.9.13 The number of days of maintenance stated above is per kilometre of road in both directions. For the purposes of this assessment, the maintenance schedule was assumed to be the same for the scheme after 2033 as this is when maintenance is scheduled to start on the new section of carriageway.

17.9.14 The section of A30 that requires additional maintenance is approximately 14 kilometres in length and from this profile it has been calculated that there is approximately 56 days of maintenance for thin surfacing and 168 days for a complete overlay. Over the course of the 60 year assessment period, there are approximately 12 days of maintenance per year. The annualisation factors reflect this profile accordingly.

Table 17-10 Maintenance assessment annualisation factors

Tuba Time Slice	Annualisation Factor
AM Peak (7-10 weekdays)	36
Interpeak (10-4 weekdays)	73
PM Peak (4-7 weekdays)	36

17.9.15 The annualisation factors in Table 17-10 are based upon the assumption of 12.1 days of maintenance per year and are rounded to the nearest whole number.

17.9.16 For the maintenance phases, the following assumptions were made for the TUBA model:

- During the maintenance periods in the Do Minimum scenario there would be shuttle running on the A30 with traffic signals controlling the opposing flows;
- Intergreens were calculated using the maximum length of site works of 300 metres (Traffic Signs Manual Chapter 8);
- No Maintenance is to be carried out in the first 10 years on the section of A30 in the Do Something scenario;
- During maintenance in the Do Something scenario there would be 1-lane contraflow in each direction over a 5km stretch of the new A30, with reduced speed and capacity.

17.9.17 The years specified in the assessment are 2024, 2033, 2034 and 2038. These were stated as the maintenance would be expected to start on the DS network during 2033. Therefore, the model networks and matrices used in the TUBA model are summarised below:

Table 17-11 Maintenance assessment scenario

Modelled Years	Do Minimum Network Used	Do Minimum Traffic Matrices Used	Do Something Network Used	Do Something Traffic Matrices Used
2024	2024 Do Minimum Maintenance	2024 Do Minimum Variable Demand	2024 Do Something (Option 7A)	2024 Do Something (Option 7A) Variable Demand
2033	2033 Do Minimum Maintenance	2033 Do Minimum Variable Demand	2033 Do Something (Option 7A)	2033 Do Something (Option 7A) Variable Demand
2034	2034 Do Minimum Maintenance	2034 Do Minimum Variable Demand	2034 Do Something (Option 7A)	2034 Do Something (Option 7A) Variable Demand
2038	2038 Do Minimum Maintenance	2038 Do Minimum Variable Demand	2038 Do Something (Option 7A)	2038 Do Something (Option 7A) Variable Demand

17.9.18 As with the construction modelling bespoke networks and matrices have been developed for modelling the maintenance years. For 2024, 2033 and 2034 the matrices have been developed by subtracting the 2023 matrix from the 2038 matrices and then portioning the difference, based on the model year, and adding to the 2023 matrices.

17.9.19 Generalised costs have been updated specifically for each model year based on the March 2017 WebTAG Databook.

17.10 Noise Impacts

17.10.1 The Design Manual for Roads and Bridges (DMRB) is the regulatory standard for the design of a new road or improvements to an existing road. In particular, Volume 11 Section 3 Part 7: HD 213/11 Revision 1 sets out the method for assessing noise and vibration associated with road traffic. HD 213/11 provides guidance on the selection of the scheme assessment area and the relevant assessment years.

17.10.2 HD 213/11 requires that road traffic noise is calculated under the method described in Calculation of Road Traffic Noise (CRTN). This describes a procedure for determining the level of noise from the highway based upon the traffic flow parameters, road surface, propagation distance, screening, intervening ground cover and topographical features between the highway and receptor. This is the accepted methodology to quantify traffic noise levels for use with highway noise assessment procedures.

17.10.3 Traffic data was provided from the traffic model for the DM and DS scenarios for the 2023 and 2038 assessment years. Ordinance Survey data was utilised for the existing road alignment, in addition to the topographical contour levels and buildings datasets.

17.10.4 The monetisation of the noise impacts of the scheme has been completed in line with TAG unit A3 – Environmental Impact Appraisal.

17.11 Air Quality Impacts

17.11.1 DMRB Volume 11 Section 3, Part 1: HA207/07 sets out the guidance for assessing the impacts on air quality as a result of highways scheme. This includes both regional and local air quality assessments.

17.11.2 The air quality study area has been defined following guidance contained in HA207/07. It comprises: all land within 200m of the centre line of the existing road; land within 200m of the centre line of the new road; and land within 200m of any other 'affected roads'.

17.11.3 The Affected Road Network (ARN) was identified by the criteria published in HA207/07, based on changes between Do Minimum and Do Something scenarios. A road is in the ARN if one or more of the following criteria are true:

- Road alignment will change by 5m or more;
- Daily traffic flows will change by >=1,000 AADT;
- Heavy Duty Vehicle (HDV) flows will change by >=200 AADT;
- Daily average speed will change by >=10 kph; and
- Peak hour speed will change by >=20 kph.

17.11.4 For the regional air quality assessment, the ARN is defined as those links in the Traffic Reliability Area (TRA) which meet any of the criteria below in the scheme opening year or design year (+15 years):

- Daily traffic flows will change by 10% AADT or more;
- HGV flows will change by 10% AADT or more; and
- Daily average speed will change by 20km/hr or more.

17.11.5 Traffic data was provided from the traffic model for the DM and DS scenarios for the 2023 and 2038 assessment years to enable the completion of the assessment.

17.11.6 The monetisation of the noise impacts of the scheme has been completed in line with TAG unit A3 – Environmental Impact Appraisal.

17.12 Greenhouse Gases

17.12.1 DMRB HA 207/07 and other guidance documents have been used to assess changes to user carbon (i.e. the tailpipe emissions from vehicles using the scheme) between the DM and DS scenarios.

17.12.2 The study area covers the entire simulation area of the traffic model. This wider boundary captures the user emissions from the scheme, but also those arising from the outlying road network, and vehicle movements that have been indirectly influenced by the scheme (positively and negatively). Unlike the Air Quality study area, the assessment of user carbon includes the total emissions across the model, irrespective of presence and location of receptors.

17.12.3 Traffic data was provided from the traffic model for the DM and DS scenarios for the 2023 and 2038 assessment years to enable the completion of the assessment.

17.12.4 The monetisation of the greenhouse gas impacts of the scheme has been completed in line with TAG unit A3 – Environmental Impact Appraisal.

17.13 Wider Impacts

17.13.1 Wider impacts are identified in TAG guidance (Unit A2.1) and can be included in an 'adjusted' BCR calculation. Due to the nature of this scheme a more complete assessment of wider impacts is considered to be of only marginal value.

17.13.2 The following wider impacts will be included:

- WI2 – Output change in imperfectly competitive agglomeration impact markets

17.13.3 In markets which are dominated by a few suppliers, prices may be above and the quantity below that which would occur in competitive markets. Transport investment may induce a price reduction and increase in the quantity supplied, through its impact upon firms' cost base.

17.13.4 Other wider impacts, including Agglomeration (WI1) and Increase tax revenue from labour supply (WI3) have not been assessed. The rural nature of the scheme and likely scale of these impacts, makes such an assessment of only limited use.

17.13.5 The calculation for this Wider Impact advised in WebTAG is a 10% uplift in business user benefits.

17.14 Landscape Impacts

17.14.1 These have not been monetised as part of PCF Stage 3 though have instead been assessed qualitatively in the Appraisal Summary Tables (AST).

17.15 Sensitivity Testing

17.15.1 Sensitivity tests have been undertaken based on Low and High Traffic growth. For more information on the development of these matrices and network performance please see Sections 14, 15 and 16 of this report.

18 Economic Appraisal Results

18.1 Travel Time and Vehicle Operating Costs

18.1.1 All benefits and costs in the following tables are in £000, discounted to 2010 prices and in 2010 prices.

Benefits by journey purpose

18.1.2 Table 18-1 shows the total benefits over the 60 year appraisal period split into benefit type and split between trip purposes.

Table 18-1 Benefits by journey purpose (£000s)

Scenario	Purpose	Travel Time	VOC Fuel	VOC Non-fuel	Indirect Tax	Total
Do Something (Option 7A)	Business	270,065	-53,107	6,719	37,537	261,214
	Commuting	202,914	-5,139	-31,285	21,807	188,297
	Other	235,486	-15,509	-29,794	23,665	213,848
	Total	708,465	-73,755	-54,360	83,009	663,359

18.1.3 The table shows that the majority of benefits created by the scheme are travel time benefits. This shows that the scheme provides faster journey times along the A30 and has reduced travel time costs. The majority of the benefits are for business trips, which is as expected.

18.1.4 The level of benefits generated for commuting trips is relatively low when compared to the total benefits. This is due to a combination of a much lower value of time for commuting trips when compared to business user trips and also that there was a low number of commuting trips observed using the A30 between Chiverton Cross and Carland Cross.

18.1.5 Analysis undertaken as part of the PCF Stage 3 Local Model Validation Report (HA551502-WSP-GEN-0000-RE-TR-0013-P04) showed that there was a lower than the national average proportion of commuting trips within the vicinity of the scheme according to data taken from the RSI on the A30 to the west of Chybucca undertaken in support of this scheme. It is expected that trips accessing Truro, which represents the main employment draw in close proximity to the scheme, will use either the A39 (if accessing Truro from the east) or the A390 or Chacewater Hill if they are originating to the west of Truro.

Benefits by peak period

18.1.6 Table 18-2 presents the benefits by peak period.

Table 18-2 Benefits by peak period (£000s)

Scenario	Purpose	Travel Time	VOC Fuel	VOC Non-fuel	Indirect Tax	Total
Do Something (Option 7A)	AM	149,133	-15,801	-8,776	15,589	140,145
	IP	195,064	-12,999	-18,015	20,426	184,476
	PM	244,847	-25,287	-13,047	25,219	231,732
	OP	18,647	-6,732	-6,623	8,518	13,810
	WE	100,806	-12,936	-7,899	13,256	93,227
	Total	708,497	-73,755	-54,360	83,008	663,390

18.1.7 The table shows that the largest proportion of benefits are derived from the PM peak, of which travel time savings make up the majority, as has been shown in Table 18-2. This is due to greater demand for travel in the PM peak, which realises greater traffic flows on the new A30 in the DS, hence the travel time benefits are largest in the PM peak.

Benefits by travel time size saving

18.1.8 Table 18-3 presents the monetised time benefits by size of travel time savings.

Table 18-3 Benefits by travel time size saving (£000s)

Scenario	Purpose	0 to 2min	2 to 5min	> 5min
Do Something (Option 7A)	AM	36,602	69,170	179,635
	IP	41,398	66,067	110,102
	PM	48,656	68,570	136,784
	Total	126,656	203,807	426,521

18.1.9 The table shows that the majority of monetised time benefits come from travel time savings of greater than 5 minutes. Referring back to the trip length distributions in Section 11.2, for each of the three modelled time periods approximately 75% of all trip lengths are greater than 5km. With a larger proportion of longer trips due to the rural character of many areas of Cornwall, the potential for larger travel time savings on these longer trips can be realised.

Benefits Over 60 years

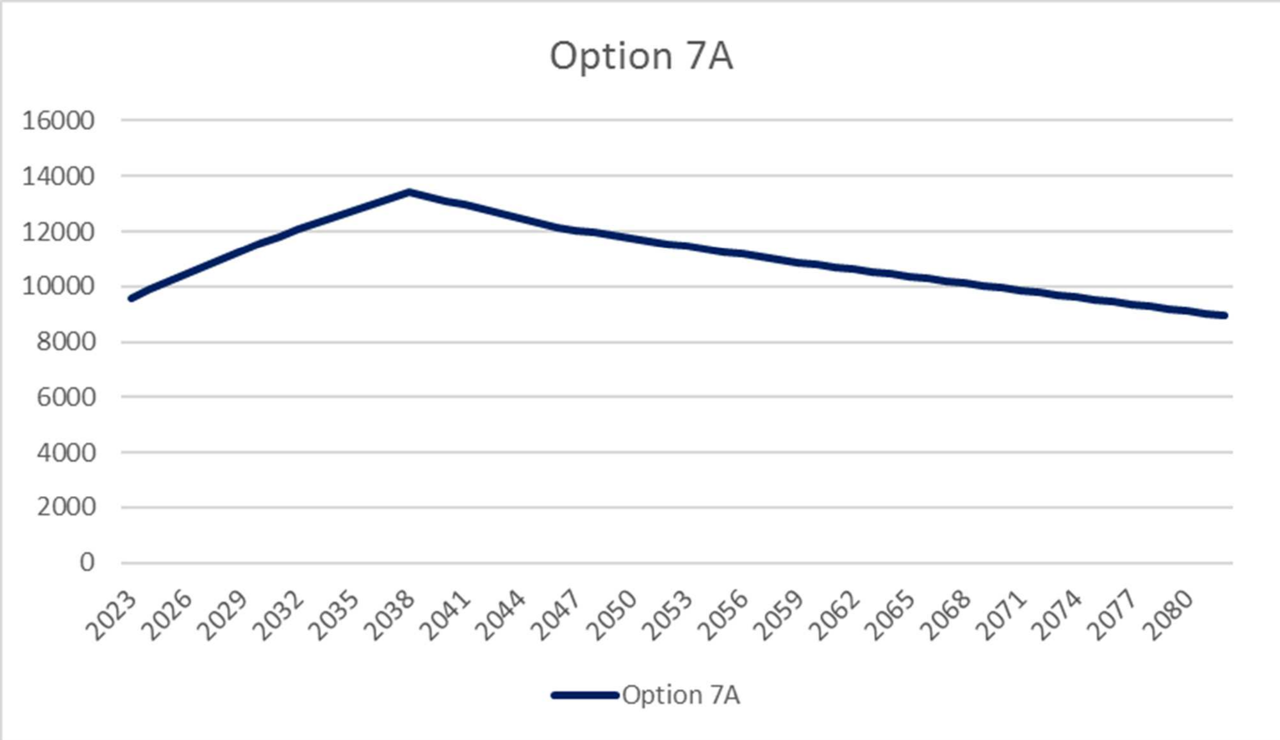

Figure 18-1 Benefits over the 60 year appraisal period (£000s)

18.1.10 Figure 18-1 shows the benefits for each individual year over the 60 year appraisal period. The figure shows that for each option the benefits increase between the scheme opening year, 2023, and the scheme design year, 2038. Thereafter, no further growth is applied and the total amount of benefits per year reduces every year until 2081 due to the discounting process.

18.2 Accidents

18.2.1 Table 18-4 presents the COBA-LT results for the scheme option in the three growth scenarios.

Table 18-4 COBA-LT results

Scenario		Low	Core	High
Do Minimum	Casualties			
	Fatal	155	169	180
	Serious	1357	1483	1587
	Slight	10830	11821	12650
	Cost (£000)	£456,527.6	£497,576.1	£531,871.6
Do Something (Option 7A)	Casualties			
	Fatal	130	144	157
	Serious	1176	1308	1417
	Slight	9683	10783	11681
	Cost (£000)	£399,589.6	£443,636.0	£480,025.7

Table 18-5 Safety benefits

Scenario		Low	Core	High
Do Something (Option 7A)	Accident Saving	865	772	719
	Benefit (£000)	£56,938.0	£53,940.1	£51,845.9

18.2.2 The results show that the scheme would provide benefits in terms of accident savings in all growth scenarios and that the scheme meets the safety target set in the scheme objectives.

18.3 Construction and Maintenance

Table 18-6 Construction and maintenance benefits (£000s)

Modelled Years	Construction	Maintenance	Total
Economic Efficiency: Commuter Users	-6,381	6,723	342
Economic Efficiency: Other Users	-5,679	7,577	1,898
Economic Efficiency: Business Users and Providers	-6,241	9,767	3,526
Wider Public Finances (Indirect Taxation)	-1,056	2,665	1,609
Present Value of Benefits (PVB)	-19,357	26,732	7,375

18.3.1 The construction phase produces a disbenefit of £19,357K due to the reduction in speed along the section of the A30 during the road works.

18.3.2 The maintenance phase produces a benefit of £26,732K. In the DM scenario shuttle working with traffic signals is necessary because there is only one lane in each direction. In the DS scenario, the new dual carriageway allows there to be one lane operating continuously in each direction during maintenance and so does not create as much delay as the DM scenario. Therefore, it is of benefit to have the A30 as a dual carriageway for maintenance purposes.

18.4 Environmental Impacts

18.4.1 The monetised environmental impacts are presented in Table 18-7. These impacts have been provided by the PCF Stage 3 Environmental Impact Assessment and undertaken in accordance with the methodology outlined in Section 17.9 to 17.13.

Table 18-7 Monetised environmental impacts

Scenario	Core
Noise	£552,880
Local Air Quality	£20,273,369
Greenhouse Gases	£71,687,778

18.4.2 The results of the noise quality assessment show that the scheme will provide an overall benefit with a net present value of £552,880. Although the number of properties realising an increase in daytime noise levels (168) is greater than those experiencing a reduction (93), the calculation shows an overall benefit because there would be a substantial number of properties receiving larger noise reductions within the higher noise bands. The majority of these properties benefit from the alleviation of traffic along the existing A30 Chiverton to Carland Cross corridor, and the proposed alignment of the new A30 Chiverton to Carland Cross scheme corridor. Ameliorative measures to reduce the impact of the new A30 Chiverton to Carland Cross corridor upon properties that would have realised the larger increases in noise from a new traffic noise source, have been mitigated by both vertical realignment of sections of highway into cuttings, and the inclusion of noise barriers, in the form of Cornish Hedges and timber barriers.

18.4.3 The local air quality assessment shows there are no predicted exceedances of the annual mean NO2 and PM10 objective at any receptor location, which results in monetised benefits of £2,684,945 from reductions in PM10 concentrations and £17,588,424 from reductions in NOx emissions. There are no significant impacts predicted to occur as a result of the scheme, which would provide a cumulative benefit of £20,273,369 from improvements to air quality.

18.4.4 The regional greenhouse gas assessment shows a predicted decrease in CO2 over a 60-year period of 1,724 kT, which results in a monetised benefit of £71,687,778.

18.5 Incident Delay and Travel Time Variability

18.5.1 The journey time reliability assessment used the traffic flows from the opening year 2023 for the Do Minimum and Do Something (Option 7A) scenarios. Table 18-8 shows the values used to calculate the congestion reference.

Table 18-8 Congestion reference flows input

Input	Do Minimum	Do Something (Option 7A)
CRF	22,828	75,907
CAPACITY	1,238	1,910
NL	1	2
Wf	0.998	1
PkF	9	9
PkD	57	53
AADT	23,107	32,465
AAWT	24,229	34,041

18.5.2 The congestion reference flows have been used to assess the stress on the A30 in the Do Minimum and Do Something scenarios. The stress has a maximum of 125% and a minimum of 75%. Therefore, the maximum the difference can be is 50%.

Table 18-9 Reliability assessment

Scenario		Core
Do Minimum	Stress (%)	101%
Do Something (Option 7A)	Stress (%)	43%
	Difference (%)	26%
	AADT (vehs)	34,041
	Overall Impact	**844,090**
		Slight Beneficial
	Monetised Benefits (£000s)	**£35,423**

18.5.3 The overall assessment value for the scheme is under 1,000,000; therefore, the scheme is assessed as having a slight beneficial impact upon reliability.

18.5.4 As a result of the slight beneficial impact on journey time reliability, an uplift of 5% of the travel time savings has been included in the adjusted BCR in Section 18.10 of this report. The travel time benefits are £708,465,000 and therefore the monetised journey time reliability benefits are £35,423,000.

18.6 Wider Impacts

18.6.1 The wider impacts of the scheme are shown in Table 18-10.

Table 18-10 Wider impacts assessment (£000)

Scenario	Core
Wider impact – Output change in imperfectly competitive markets	27,007

18.7 Transport Economic Efficiency Table

18.7.1 The Transport Economic Efficiency (TEE) table provides a summary of the travel time and vehicle operating cost benefits. The benefits are summarised by trip purpose. This includes the benefits generated from the main TUBA assessment, maintenance and construction scenarios. The TEE table for the core growth scenario for the scheme is shown in Figure 18-2.

Economic Efficiency of the Transport System (TEE)

Non-business: Commuting	**ALL MODES**		**ROAD**	
User benefits	**TOTAL**		**Private Cars and LGVs**	
Travel time	202,914		202,914	
Vehicle operating costs	-36,423		-36,423	
User charges	0		0	
During Construction & Maintenance	342		342	
NET NON-BUSINESS BENEFITS: COMMUTING	166,833	*(1a)*	166,833	
Non-business: Other	**ALL MODES**		**ROAD**	
User benefits	**TOTAL**		**Private Cars and LGVs**	
Travel time	235,486		235,486	
Vehicle operating costs	-45,303		-45,303	
User charges	0		0	
During Construction & Maintenance	1,898		1,898	
NET NON-BUSINESS BENEFITS: OTHER	192,081	*(1b)*	192,081	
Business				
User benefits			**Road Personal**	**Road Freight**
Travel time	270,065		49,376	220,689
Vehicle operating costs	-46,388		370	-46,758
User charges	0		0	0
During Construction & Maintenance	3,526		443	3,083
Subtotal	227,203	*(2)*	50,189	177,014
Private sector provider impacts				
Revenue	0			
Operating costs	0			
Investment costs	0			
Grant/subsidy	0			
Subtotal	0	*(3)*		
Other business impacts				
Developer contributions	0	*(4)*	0	
NET BUSINESS IMPACT	227,203	*(5) = (2) + (3) + (4)*		
TOTAL				
Present Value of Transport Economic Efficiency Benefits (TEE)	586,117	*(6) = (1a) + (1b) + (5)*		

Notes: Benefits appear as positive numbers, w hile costs appear as negative numbers.
discounted

Figure 18-2 Transport economic efficiency table – Core scenario (£000s)

18.8 Public Accounts Table

18.8.1 The Public Accounts (PA) table details the source of the scheme costs and have been summarised by local and central government. The PA table for the core growth scenario for the scheme is shown in Figure 18-3.

Public Accounts (PA) Table

	ALL MODES TOTAL		ROAD INFRASTRUCTURE
Local Government Funding			
Revenue	0		0
Operating Costs	0		0
Investment Costs	0		0
Developer and Other Contributions	0		0
Grant/Subsidy Payments	0		0
NET IMPACT	0	*(7)*	0
Central Government Funding: Transport			
Revenue	0		0
Operating costs	5,893		5,893
Investment Costs	185,088		185,088
Developer and Other Contributions	0		0
Grant/Subsidy Payments	0		0
NET IMPACT	190,981	*(8)*	190,981
Central Government Funding: Non-Transport			
Indirect Tax Revenues	-84,617	*(9)*	-84,617
TOTALS			
Broad Transport Budget	190,981	*(10) = (7) + (8)*	
Wider Public Finances	-84,617	*(11) = (9)*	

Notes: Costs appear as positive numbers, w hile revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

Figure 18-3 Public accounts table – Core scenario (£000s)

18.9 Analysis of Monetised Costs and Benefits Table

18.9.1 The benefits from each individual assessment have been totalled to create the Present Value Benefits (PVB) of the scheme. They have been summarised in the Analysis of Monetised Costs and Benefits (AMCB) table along with the PVC and the BCR. The AMCB table for the core growth scenario for the scheme is shown in Figure 18-4.

Analysis of Monetised Costs and Benefits		
Noise	553	*(12)*
Local Air Quality	20,273	*(13)*
Greenhouse Gases	71,688	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents	53,940	*(17)*
Economic Efficiency: Consumer Users (Commuting)	166,833	*(1a)*
Economic Efficiency: Consumer Users (Other)	192,081	*(1b)*
Economic Efficiency: Business Users and Providers	227,203	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	84,617	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	817,188	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	190,981	*(10)*
Present Value of Costs (see notes) (PVC)	190,981	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	626,207	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	4.28	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Figure 18-4 Analysis of monetised costs and benefits table – Core scenario (£000s)

18.9.2 The results show that the scheme provides significant benefits to transport users, resulting from the significant improvement in the performance of the A30 provided by the scheme. The scheme produces a BCR in excess of 4 which represents Very High Value for Money.

18.9.3 The results also show that PVB has increased when compared to the PCF Stage 2 assessment. This increase is attributable to changes in the forecast years and a model that takes more account of local traffic on single lane roads. Furthermore, the environmental impact assessment has reported strong benefits from noise, local air quality and greenhouse gas assessments. The PCF Stage 3 appraisal uses TUBA 1.9.9 and values from WebTAG Data Book March 2017.

18.9.4 The AMCB tables for the High and Low growth scenarios are included in Appendix G.

18.10 Adjusted Benefit Cost Ratio

18.10.1 In addition to those categories included in the AMCB table in Section 18.9, the BCR can be further adjusted to account for changes to journey time reliability and wider impact benefits that are not included in the AMCB table. Table 18-11 outlines the initial BCR reported in the AMCB and the adjusted BCR.

Table 18-11 Adjusted benefit cost ratio

	PVB Present Value of Benefits (£000s)	PVC Present Value of Costs (£000s)	NPV Net Present Value (£000s)	BCR
Initial BCR	817,188	190,981	626,207	4.28
Adjusted BCR	879,618		688,637	4.61

18.10.2 The table shows that including the monetised journey time reliability benefits and wider impacts results in a BCR of 4.61. The adjusted BCR represents Very High Value for Money.

19 Summary and Conclusion

19.1 Document Summary

19.1.1 The purpose of this report is to present the transport modelling and economic appraisal work which has been completed to support the DCO submission for the scheme.

19.1.2 The work completed is a complex process which has been completed over a number of stages. The findings and conclusions of the detailed work are presented as follows:

19.1.3 Section 1 documents the work undertaken prior to PCF Stage 3 and economic outcomes for each of the prior stages.

19.1.4 Sections 3 to 8 presents the observed transport data used in the assessment of the scheme through the model development process, the calibration/validation stages and as part of the economic assessment of the scheme

19.1.5 Sections 9 to 12 document the work undertaken to develop and calibrate/validate the PCF Stage 3 base year transport model. A summary of the model calibration/validation is provided.

19.1.6 Sections 13 to 16 document the work undertaken to develop the forecast year transport model, the forecast year impacts resulting from the scheme, and the assessments undertaken for variable demand and high/low growth scenarios.

19.1.7 Sections 17 and 18 present the economic assessment work undertaken for the scheme.

19.2 Conclusion

19.2.1 In summary the calibration and validation statistics demonstrate the transport model is fit for purpose in line with WebTAG criteria for testing the A30 Chiverton to Carland Cross scheme. Economic assessment of the scheme undertaken using outputs from the transport model in line with WebTAG criteria shows it is a very high value for money scheme which will provide significant benefits to road users and residents of Cornwall.

Appendices

Appendix A Breakdown of Calibration and Screenline Link Traffic Flows

Appendix B Validation Junction Counts

Appendix C Origin Destination Trees

Appendix D Validation Journey Time Route Data

Appendix E Validation Link and Screenline Traffic Flows

Appendix F Scheme Do Something (Option 7A) Plans

Appendix G High and Low Growth AMCB Tables

Appendix H ComMA Summary

Appendix I ComMA Data Annex

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