

Appendix K: TfGM HFAS Report

DRAFT

Client **Transport for Greater Manchester**
Report **TfGM HFAS Report 2259**
Project **Northern Gateway Transport Model**
Subject **SATURN Model Review**

This report summarises our review of the Northern Gateway Transport Model base model. The SATURN model, developed by WSP, is for use in testing relating to the Northern Gateway developments near the current Heywood Distribution Park.

This Note Rep 2259 Northern Gateway - Saturn Model Review v2.0.docx

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Version	Comments	Date	Approve
0.1	First draft	06.09.24	SC
1.0	Second draft	02.10.24	SC
1.1	Updated draft following TfGM comments	05.11.24	SC
2.0	Final draft following additional TfGM comments	27.11.24	SC

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Nov 2024	TfGM	Robert Paddison / Bury Council and Rochdale Council

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1. Introduction

- 1.1 The Joint Venture (JV) commissioned WSP to develop a traffic model to aid in the assessment the Northern Gateway development site and to feed into the Transport Assessment. The model was developed in SATURN using the existing Greater Manchester SATURN Model (GMSM) 2019 base as a basis for the Northern Gateway Transport Model (NGTM) base model which was developed for a 2022 base year. The NGTM strategic model was developed by WSP in conjunction with a more detailed Vissim model.
- 1.2 TfGM has commissioned HFAS on behalf of Bury Council and Rochdale Council to review the NGTM Base Model in order to provide confidence to the districts that the model is fit for purpose for forecasting. The model has been developed to assess the Northern Gateway development sites to provide evidence for the Transport Assessments and to provide forecast traffic flows to feed into a VISSIM micro-simulation model for the SRN and local district network. As such, our review focuses on the key model network in the Heywood Distribution Park area.
- 1.3 This report details the review including checks on the network coding, matrices and the model validation detailed in the LMVR.

2. Model Files and Scope of Review

WSP Model Files

2.1 The following NGTM 2022 files were provided by WSP as part of this review:

- All model files for each modelled time period including .dat network and include files, .UFM final matrices, .UFS/.UFC/.UFO model assignment files, and other associated model run files.
- Motorway cal/val (v2) spreadsheet summarising the flow validation for the motorway counts.
- NGTM 2022 Base year model key results document outlining the link flow calibration/validation (for screenlines and cordons), journey time validation, and impacts of matrix estimation statistics against TAG criteria.
- Local Model Validation Report (LMVR) and associated Appendices outlining the suitability of the model in Accordance with TAG criteria.

2.2 The NGTM is a highway only model developed using SATURN version 11.05.05H. It builds upon the GSM 2019 base year model that was supplied to WSP to form the basis of the NGTM 2022 base year model. The GSM coding has been retained and enhanced in the NGTM particularly in the area of interest around the Heywood Distribution Park.

2.3 Separate versions of the NGTM have been built representing an average weekday during the model year. Base models have been developed for the following time periods to ensure consistency with the peak periods used in the GM Model Suite:

- Morning Peak Hour (08:00-09:00)
- Average Inter-Peak Hour (10:00-16:00)
- Evening Peak Hour (17:00-18:00)

2.4 The NGTM models include five 'user classes' as follows:

- Car - Commute
- Car - Employers Business
- Car - Other
- Light Goods Vehicle (LGV)
- Other Goods Vehicle (OGV)

Scope of review

- 2.5 The NGTM base model has been checked in order to provide confidence to the districts that the model is fit for purpose. The review includes checks on the network itself, the matrices used and the calibration/validation of the model.
- 2.6 Checks to be carried out include network including checking:
- Crow-fly distance against coded distances and check link lengths are the same in both directions.
 - Coding is the same across time periods in terms of network structure.
 - Checking for zero flows on non-minor links.
 - Checking for any unusually large delays at nodes.
- 2.7 Further general network spot checks including:
- Checking junction coding relative to the Greater Manchester Saturn Model (GMSM)
 - saturation flows
 - stacking capacities
 - assigned flows
 - lane numbers
 - RFC (ratio of flow/capacity)
- 2.8 The model validation has been reviewed, including:
- Updated generalised costs.
 - Check model convergence.
 - Check the suitability of data used for validation in particular screenline and cordon modelled flows used in matrix estimation and independent cordon and screenline and counts by vehicle type and time period.
 - Check methods used for calibration and validation, for example any 'matrix estimation' techniques.
 - Checks on zone-to-zone routing to ensure they are sensible.
 - Check modelled and surveyed journey times along routes (end to end route times), by vehicle type if separate speed/flow relationships have been used for light and heavy vehicles, and by time period.
 - Check calibration and validation relative to TAG criteria.

2.9 A broad comparison check between the NGTM matrices and those in the GSM has been carried out including checking that changes brought about by matrix estimation (ME) are within TAG guidance. Impacts of ME checks should include:

- Scatter plots of matrix zonal cell values, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R2 values).
- Scatter plots of zonal trip ends, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R2 values).
- Trip length distributions, prior to and post matrix estimation, with means and standard deviations.
- Sector to sector level matrices, prior to and post matrix estimation, with absolute and percentage changes.

3. NGTM Review

- 3.1 The NGTM model files and LMVR have been reviewed with the following findings.
- 3.2 The NGTM was developed using SATURN version 11.05.05H while the GSM, which the NGTM is based on, uses version 11.3.12U. For consistency we normally recommend using the same version as the original model, though we have checked the impact of using the more recent version of SATURN by running the NGTM assignments using version 11.3.12U for all three modelled time periods. The outcome showed some minor link flow differences in the area of interest but none of significance that would cause concern (i.e. flow differences were generally below +/- 50 pcus and much less on minor links).

General Coding Checks

- 3.3 The coding checks are focused on the model network in the vicinity of the Heywood Distribution Park where WSP has applied updates. The area of interest is shown in Figure 1 below and checks are focused on this area. The changes include the addition of new zones in the area of interest and the use of speed flow curves for setting the link speeds/capacities (on links longer than 100 m). For the NGTM, WSP has adopted the same speed flow curves used in the RTM (Regional Transport Model) and an inspection of the values suggests they are robust and appropriate for use in the NGTM.

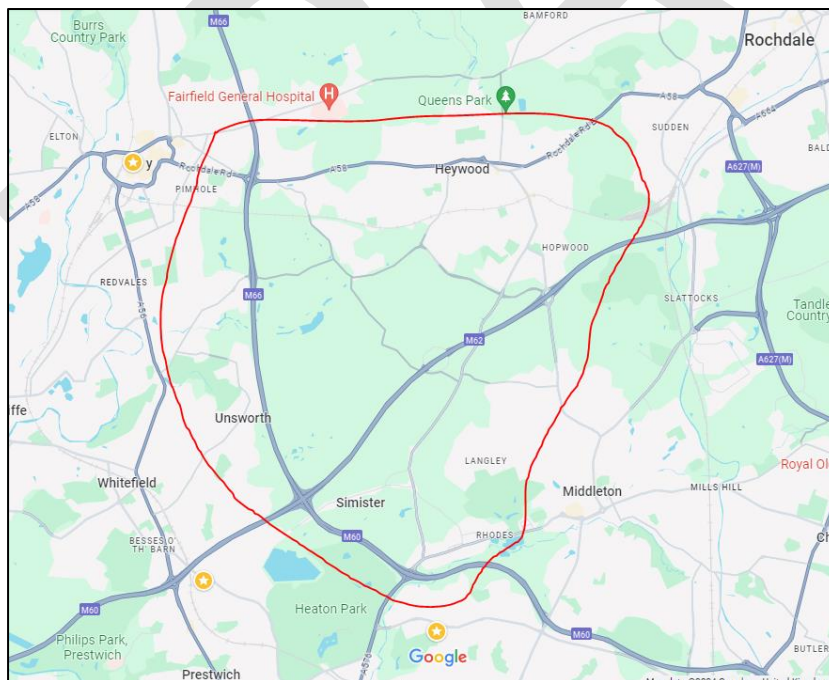


Figure 1: Northern Gateway Traffic Model – Area of interest

- 3.4 A check of the **crow-fly** distance indicates that the link length lengths have been coded correctly at updated nodes in the area of interest with no inconsistency in opposite directions.
- 3.5 A check of the **network structure** across time periods indicates that the coding is consistent apart from alternative speed flow curves used to calibrate sections of the M60 (anticlockwise between J18 – J20) and M60 (northbound between J2 – J4). In the PM peak model revised speed flow curves have been used on these sections to lower the link speeds on this congested section of the motorway network. The changes are noted by WSP in the SFC update file and appear reasonable with the exception of the northbound section of the M60 between J19 and J18 in the evening peak hour. Here speeds of 35 kph have been used in the speed flow curve coding, as shown in Figure 2. Presumably this has been done to reflect the congested conditions on this section of motorway. While it is recognised that reflecting delay and congestion on motorways/dual carriageways can be difficult in SATURN, it is unrealistic as a free flow speed. Ideally alternative methods should be used to model congestion on this section given there is a risk that it may result in an overestimation of delay on this section of motorway (and potentially unrealistic rerouting) in the forecast scenarios.

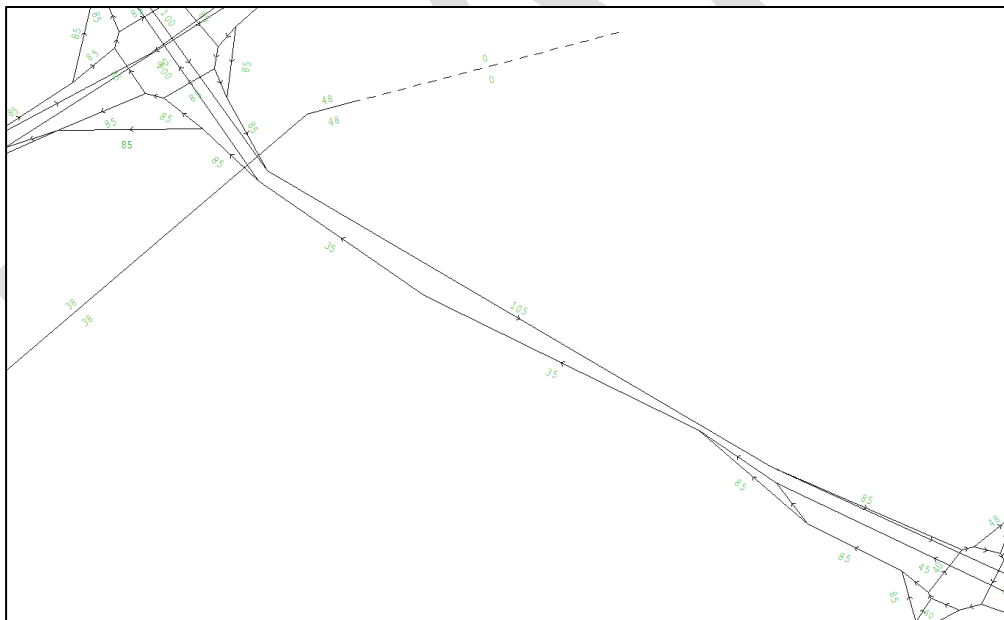


Figure 2: NGTM Free flow speeds in the evening peak hour (M60 J18 – J19)

- 3.6 The network structure is broadly consistent with the GSM, the main change being the addition of micro-zones within the Heywood area and the inclusion of the Birch Services on the M62 between J18 – J19.

- 3.7 Generally, the model flows appear sensible across all time periods with higher flows on major links while there are no **zero flows** on non-minor links within the area of interest.
- 3.8 A check on the **delays at nodes** and links indicates that there are few unusually large delays in the area of interest. The only apparent issue is in the morning peak hour at B6222 Rochdale Road/Rough Hill Lane signalised junction (node 5617). Here the green time on Rochdale Road (eastern arm) has been reduced by 10 seconds (compared to the GSM) resulting in a significant increase in delay on this approach of about 3 minutes. It is likely that this has been done for journey time calibration purposes but appears unrealistic given the small delays on the other junction arms.

Spot Checks

- 3.9 General junction coding checks indicate that the main change is the inclusion of speed flow curves on links in the Heywood Road area as shown in Figure 3.

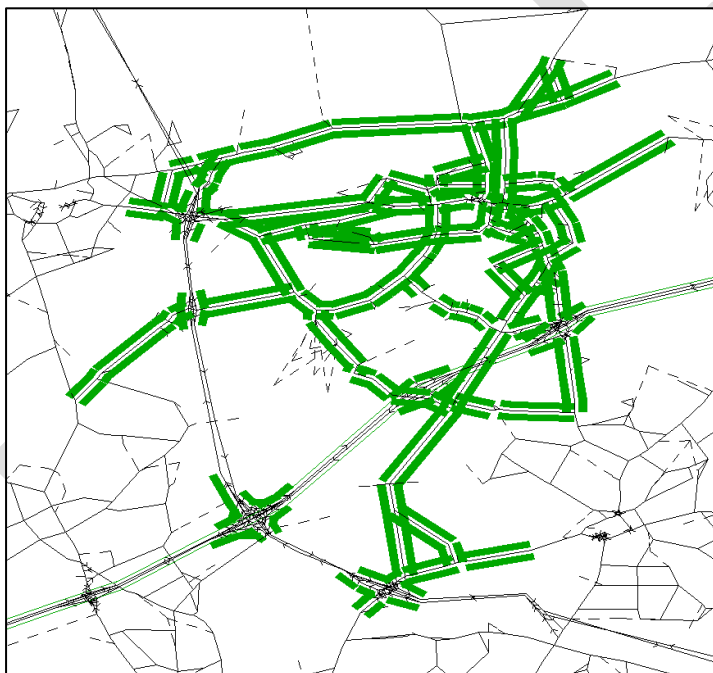


Figure 3: NRTM Extent of speed flow curve coding

- 3.10 **Signal timings** have been adjusted at various signalised junctions in the area of interest. It is unclear whether these changes are based on observed data or simply calibration adjustments. Also, flare F markers have been used on the approach to some junctions where there is a flare or lane gain. Whilst this is inconsistent with coding elsewhere in the GSM, the updated coding is robust.

- 3.11 A spot check of the **saturation flows, stacking capacities and assigned flows** in Heywood area suggests these are all within expected values for the three modelled time periods. Lane numbers appear to be coded correctly and are consistent with the GSM.
- 3.12 A spot check of the **RFC** (ratio of flow/capacity) values at the junction nodes in the Heywood model indicates that they are broadly sensible for all time periods as shown in Figures 4 - 6 (for the morning, inter-peak and evening peak hours). The circles in the figures are proportional to the overall RFC value at each node (or junction) and indicate that all the values are within the expected range. Note that in the inter-peak there is a node coordinate out of place on the M62 westbound between the Birch services and Simister Island. This is a minor issue but does impact on the appearance of the network when displayed in SATURN (as shown in Figure 5).

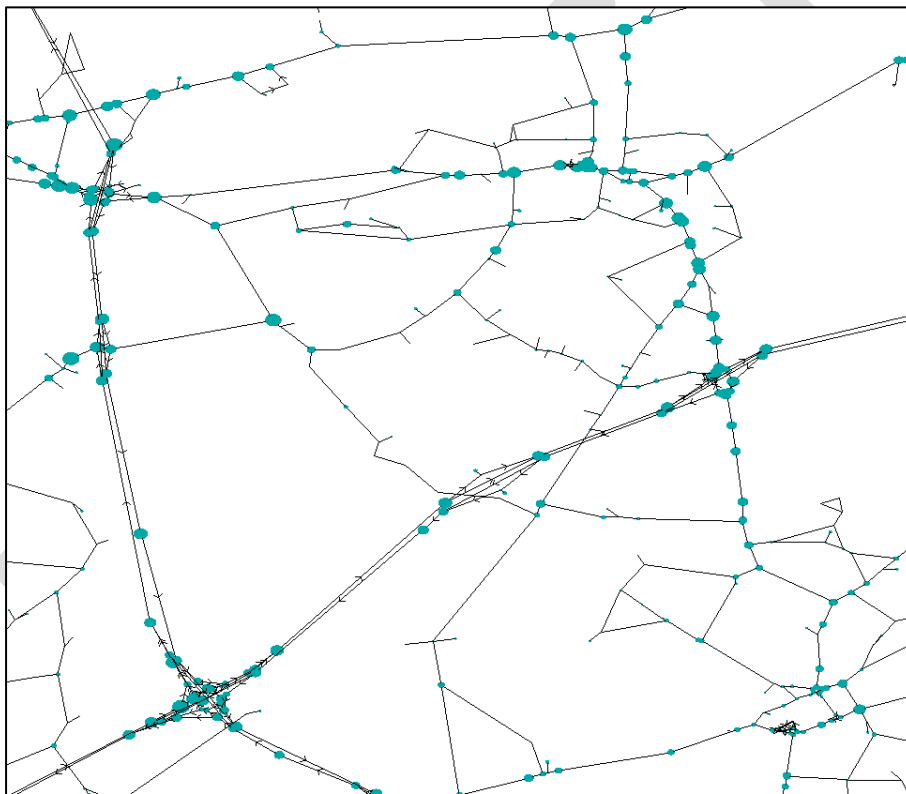


Figure 4: NGTM – RFC values for the morning peak hour

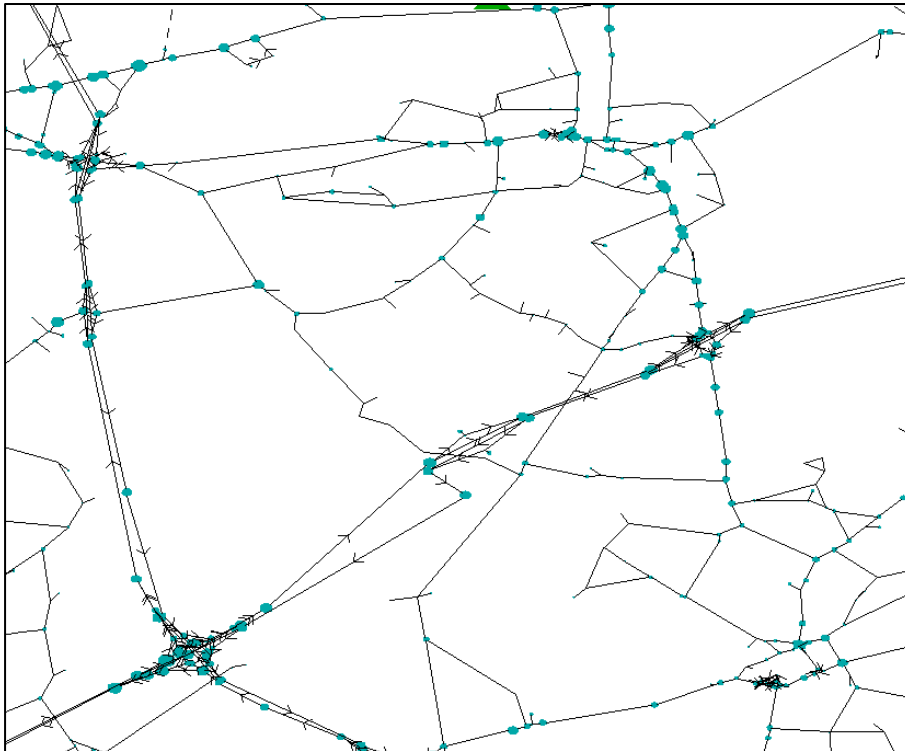


Figure 5: NGTM – RFC values for the inter-peak hour

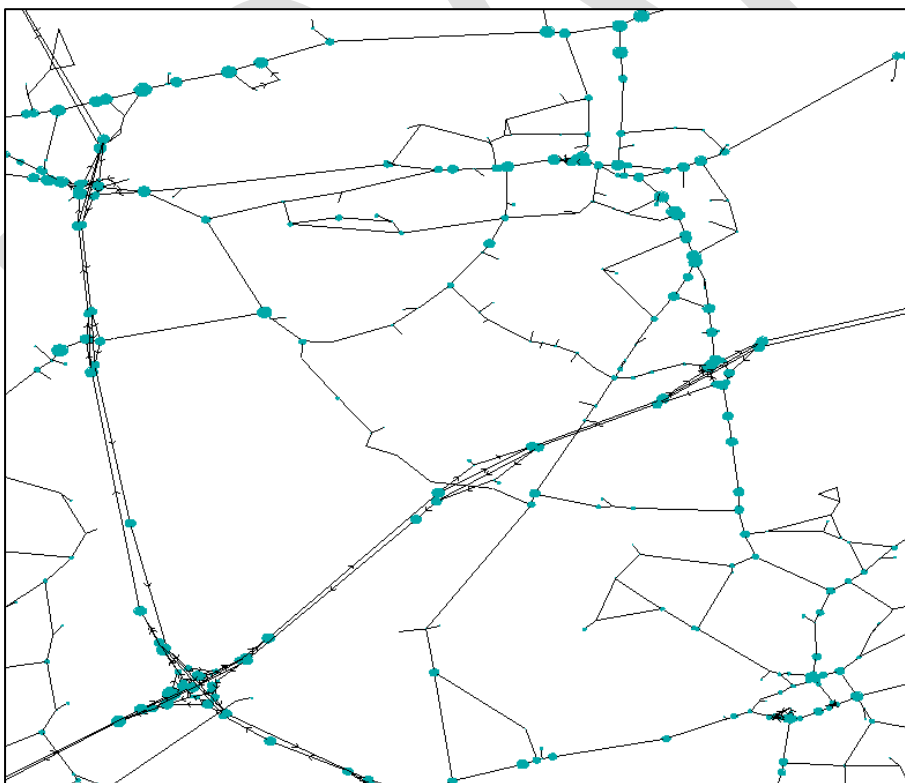


Figure 6: NGTM – RFC values for the evening peak hour

Model Route Choice

- 3.13 We have carried out a check on **route choice** in the model using the Heywood Distribution Park zone as an example origin and destination. Figures 7 – 12 show the Heywood Distribution Park origin and destination trips for the morning, inter-peak and evening peak hours for all vehicles. In addition, given that the travel patterns differ depending on the user classes, further plots showing the distribution of trips for 'Car commute' and 'HGV' are included in Appendix A (Figures A1 – A12).
- 3.14 Generally, the traffic distributions appear to be in line with expectation, with the majority of the trips (mainly HGV's) in all time periods travelling to/from the distribution park via the motorway network. Other non-goods vehicle trips (such as car commute trips) are more local, as shown in Figures A1 – A6 distribution plots (Appendix A), and are generally in line with historic census data indicating that the majority of trips are to/from GM districts (mainly Rochdale and Bury). Overall, the number of car commute trips is much lower than the HGV equivalent, indicating a smaller impact on the operation of the network. This is to be expected given that the site operates 24-hours a day and the majority of car trips are likely to be shift workers arriving/departing the site outside the modelled peak hours.
- 3.15 It is noted that the multiple new zones representing the Northern Gateway site are coded into the morning peak hour model network but do not feature in the inter-peak or evening peak hour models (as can be seen in Figures 7 – 12). The zoning system between baseline models should be consistent though this discrepancy would not impact on the traffic assignments.

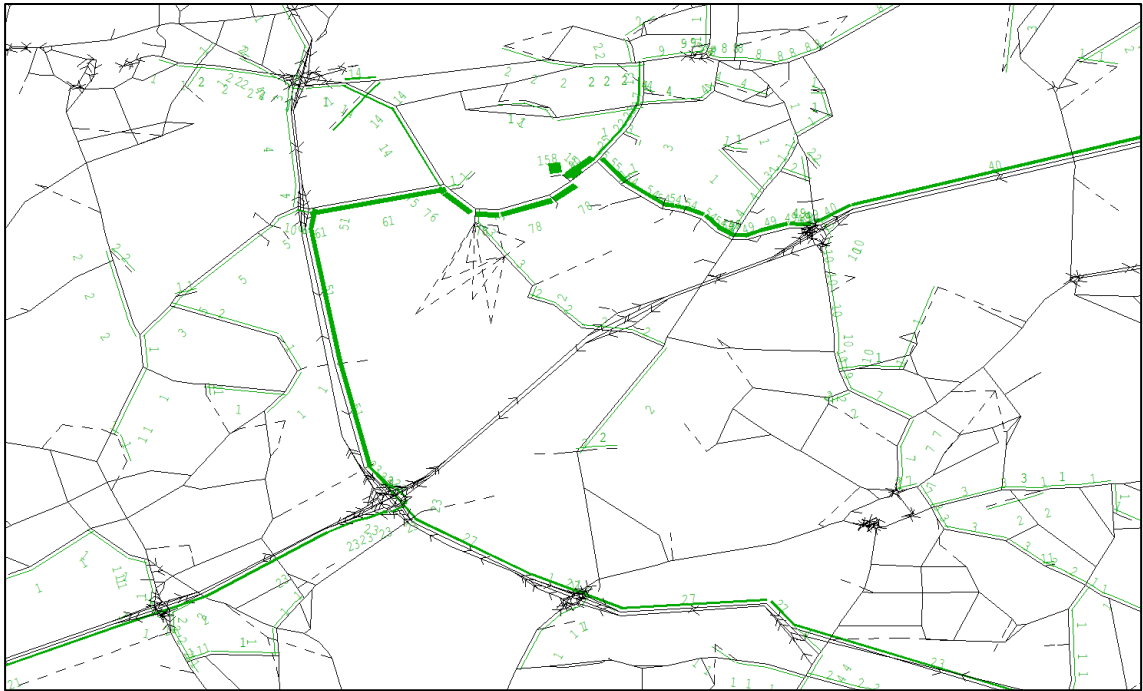


Figure 7: NGTM – Heywood Distribution Park zone - Origin trip distribution (morning peak hour)

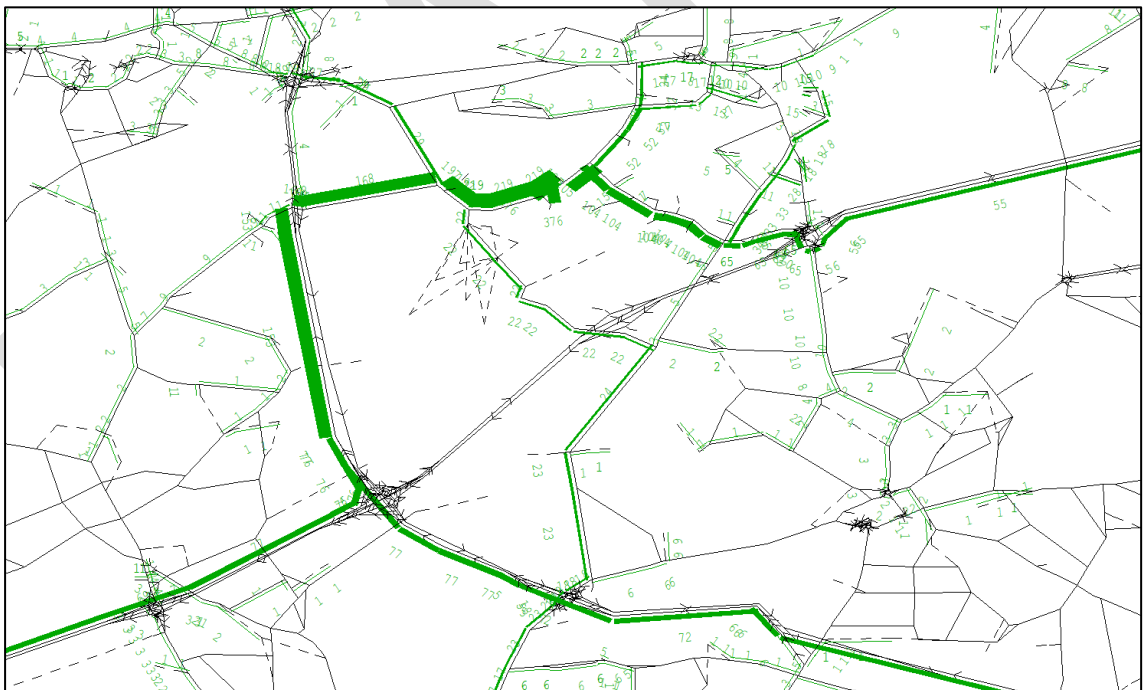


Figure 8: NGTM – Heywood Distribution Park zone - Destination trip distribution (morning peak hour)

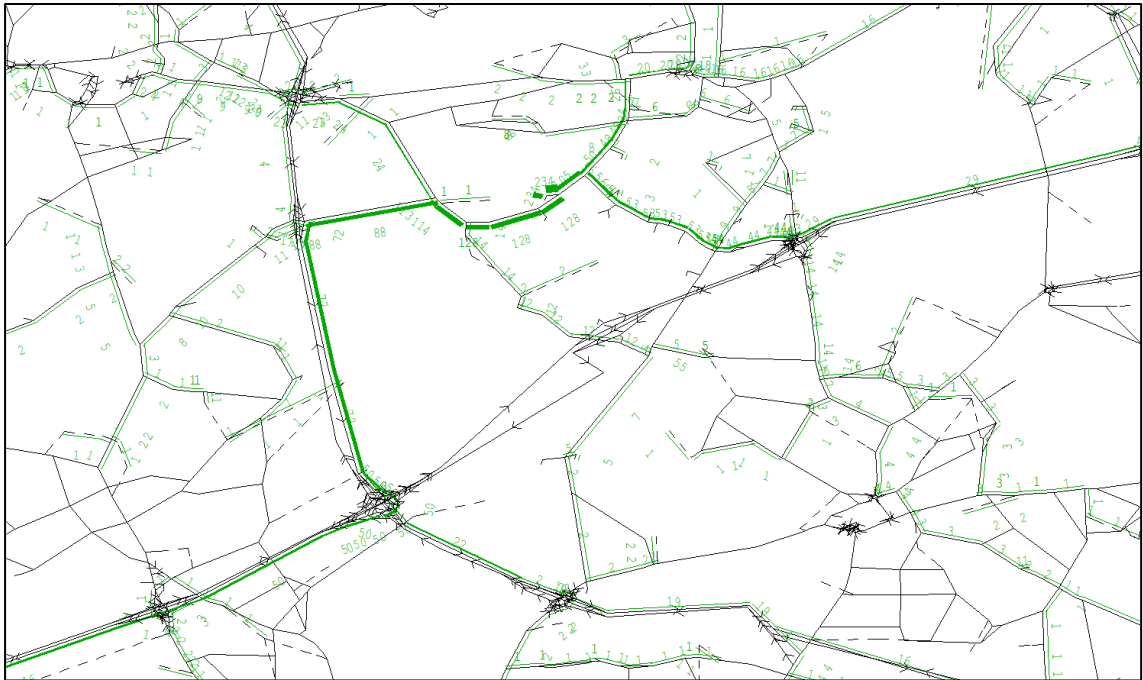


Figure 9: NGTM – Heywood Distribution Park zone - Origin trip distribution (inter-peak hour)

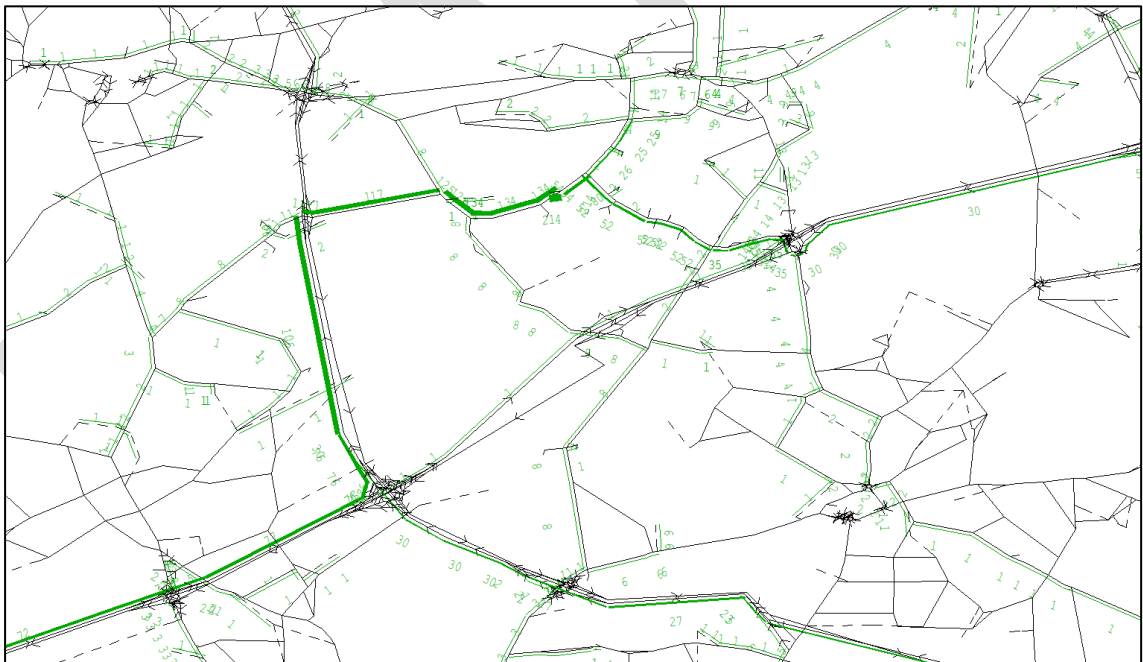


Figure 10: NGTM – Heywood Distribution Park zone - Destination trip distribution (inter-peak hour)

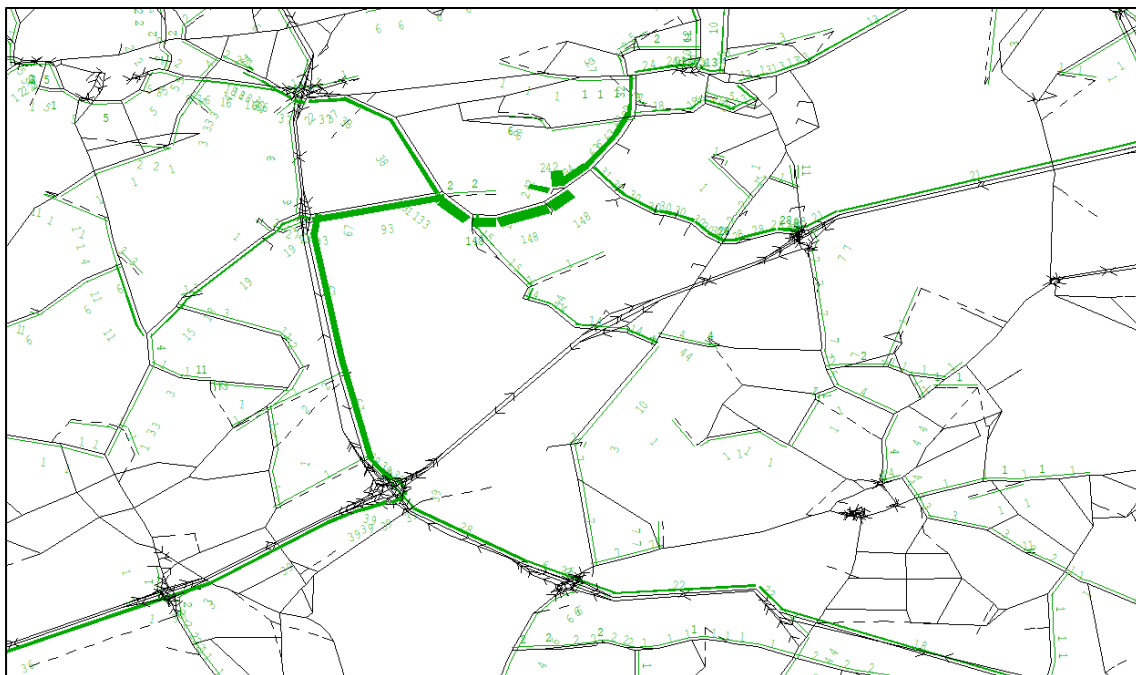


Figure 11: NGTM – Heywood Distribution Park zone - Origin trip distribution (evening peak hour)

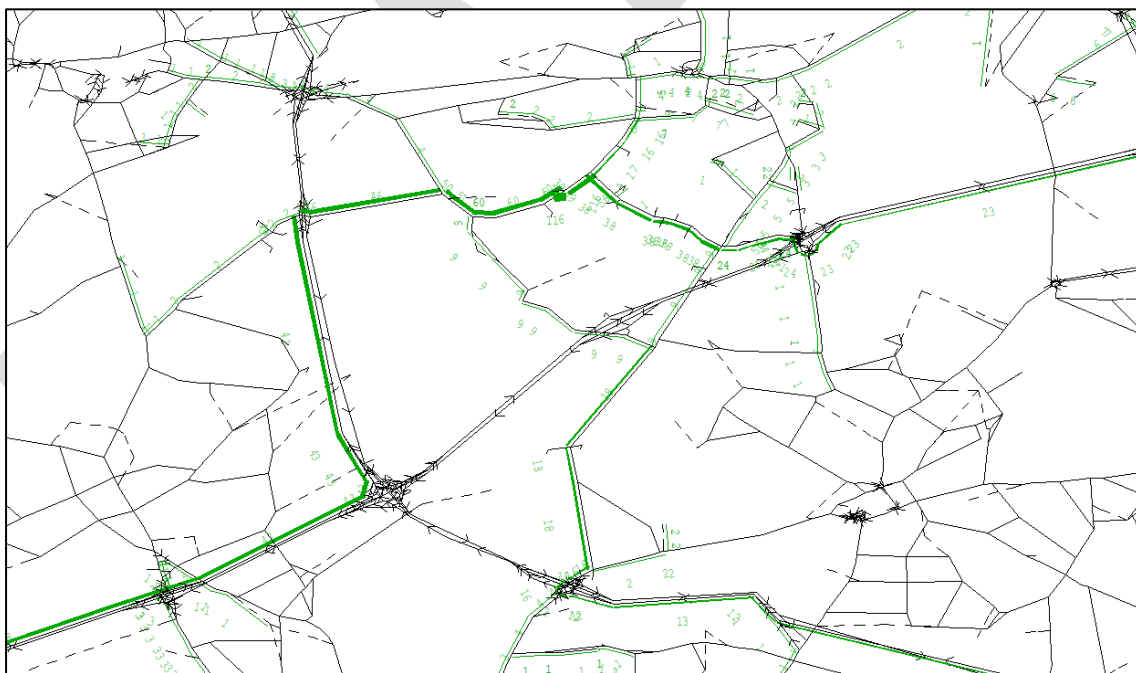


Figure 12: NGTM – Heywood Distribution Park zone - Destination trip distribution (evening peak hour)

Model Calibration/Validation

- 3.16 The LMVR details all the TAG criteria results from the NGTM 2022 Base year including:
- Traffic count data
 - Model zones
 - Impacts of matrix estimation
 - Link flow validation
 - Screenline/ cordon calibration/ validation
 - Journey time validation
- 3.17 The **generalised costs** (PPM / PPK¹) values have been updated and appear consistent with the values expected for the 2022 validated base year.
- 3.18 A wide variety of **count data sources** were used to calibrate and validate the model including newly commissioned 2022 ATC and MCC surveys along with counts from TfGM, WebTRIS and DfT. The counts were used to form a comprehensive set of screenlines and cordons across the study area. We concur with WSP's screenline and cordon definitions and the dataset split between calibration and validation. WSP's count data checks and gap analysis appear thorough and robust, though it's unclear in the LMVR whether the data has been normalised, and if so, which month has been used. Whilst this is not necessarily an issue, it should be clarified in the LMVR (section 3.7).
- 3.19 The **model zoning** is detailed in Chapter 5 of the LMVR and is based on the GSMZ zoning system developed in 2019. The zoning system is more detailed than the "parent" GSMZ zoning system with smaller zones within Heywood area compared to the rest of the GSMZ. The zones have been disaggregated further in the NGTM to better represent key generators and future development sites. Local counts were used to derive splitting factors to disaggregate the existing zones. In total an additional 37 zones have been added to the NGTM compared to the GSMZ which appears appropriate and proportionate to help improve the validation on the network in and around the Heywood area.
- 3.20 Chapter 6 on the LMVR details the process used to **develop the highway matrix**. The matrix was disaggregated in the NGTM study area using Census data and local count data, and then controlled using a gravity model approach to ensure no major changes were made to the origin/destination patterns. In addition, to ensure the HGV distribution for existing industrial sites in the study is correctly modelled (a key imperative for the NGTM), local

¹ PPM (Pence Per Minute)/ PPK (Pence Per Kilometre) – values used to convert time and distance into generalised costs.

MCC data was used to control the distribution on key routes including M66 J2 & J3, M60/M62 J19 and to/from the Birch Services on the M62. We concur with this approach which appears robust and should ensure the accurate reflection of HGV movements in the study area in the baseline model.

- 3.21 The **'prior' highway matrix development** is detailed in section 6.6 of the LMVR. The NGTM prior matrices were based on the GSM 2019 prior matrices and show that the initial validation is a good starting point for calibration with 50% of the counted links across the model having a GEH value of less than 4 in the morning peak hour, and 58% for the inter-peak and evening peak hours. TAG suggests that prior matrices should be a good fit before adjusted any further and based in the prior matrix validation, we concur that the matrices were suitable for input into the matrix estimation process.
- 3.22 The **model convergence** is detailed in Chapter 7 of the LMVR. The model has converged well and within 35, 29, and 36 assignment loops for the morning, inter-peak and evening peak hours respectively. This is well within the convergence limits and meets the TAG convergence criteria thus ensuring that modelled traffic volumes are stable.
- 3.23 The impacts of **matrix estimation** (ME) are detailed in Chapter 9 of the LMVR. Matrix estimation runs were carried out separately for car (commute, EB and other), LGV and OGV matrices for each of the modelled time periods. The NGTM ME process adopted the values which WSP has used on other studies and appear appropriate. In accordance with TAG, the impacts of ME were assessed against trip length distribution, zonal cell values, zonal trip ends and sector to sector movements, and broadly meet TAG compliance across all measures.
- 3.24 WSP has presented the overall calibration and validation flow statistics for all vehicles and cars for each modelled time period for links and the cordon and screenlines shown in Figure 13.

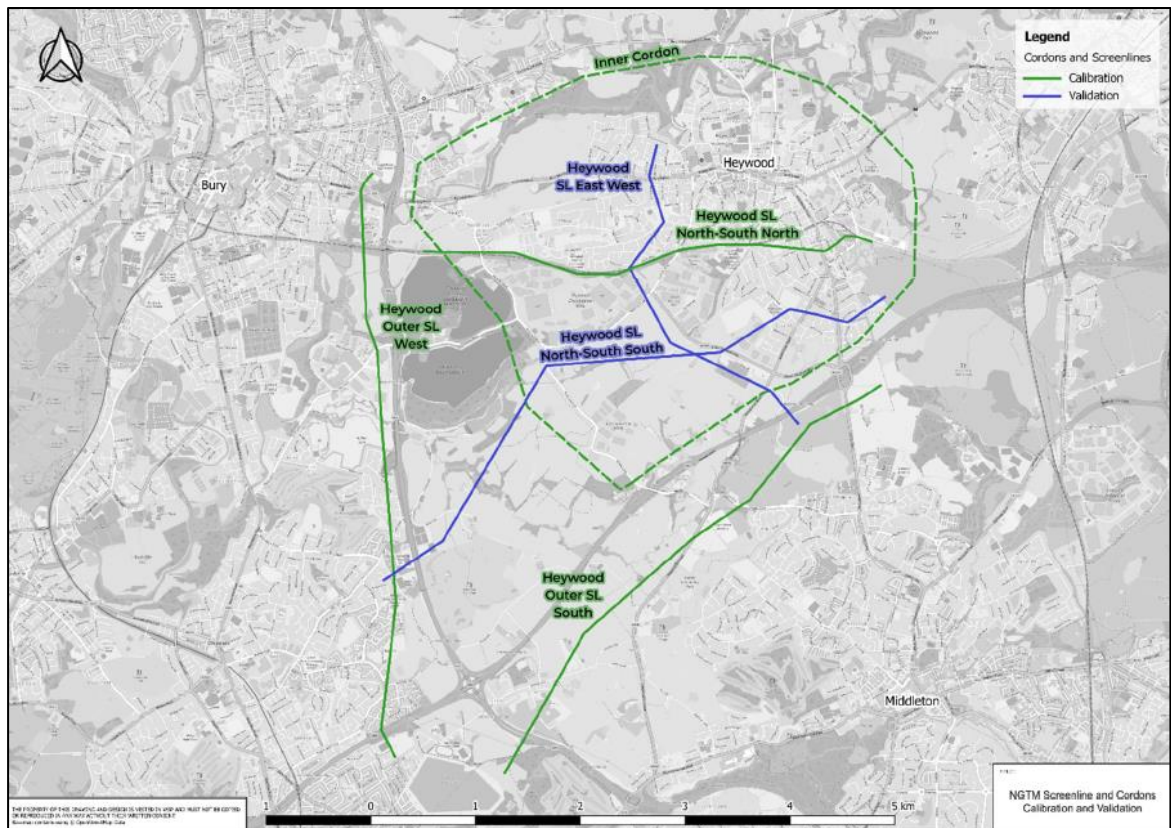


Figure 13: NGTM – Cordon and Screenlines

- 3.25 The traffic **flow calibration** is detailed in Chapter 10 of the LMVR, with detailed results presented in Appendix F. Model calibration was undertaken along the single bi-directional cordon and three bi-directional screenlines. TAG criteria is met in the majority of cases across the three modelled time periods; the only notable exception being the outbound flow on the inner cordon in the morning peak hour. Here the model flow is 10% higher than the observed but, while the model is outside TAG criteria (GEH of 6.4), this is not considered a serious issue given it is relatively close to the criteria and is more onerous to achieve than on the screenlines.
- 3.26 The traffic **flow validation** is detailed in Chapter 10.5 of the LMVR, with detailed results presented in Appendix F. Model validation was undertaken along two bi-directional screenlines. The results show that the validation is strong on the screenlines which all meet TAG criteria (GEH < 4) for cars across all time periods; only in the inter-peak for 'all vehicles' does the model not meet the criteria but is still close with a GEH < 5.
- 3.27 A further key aspect of the model is that it achieves a good **validation on the motorway** links in the study area (i.e. M66, M60, M62 and A627(M)). A range of ATC and WebTRIS count sites (shown in Figure 14; LMVR Figure 10.4) were used to calibrate and validate the motorway flows. Overall, the motorway performance is strong and meets TAG flow and GEH criteria for all time periods across 63 counts; the only motorway links showing slightly

lower performance are on the M60 in the evening peak hour though even here the criteria is almost met with 75% of links meeting TAG (85% being the target).

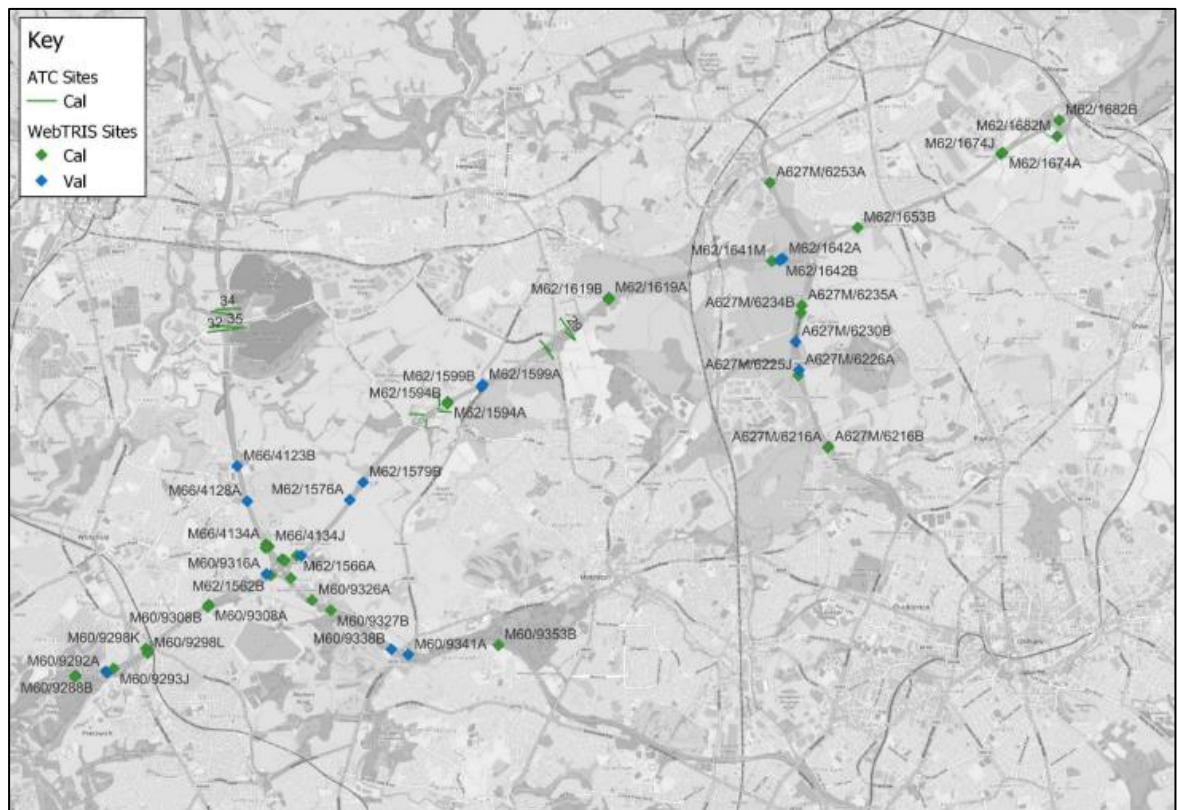


Figure 14: NGTM – Motorway cal/val count sites

- 3.28 **Journey time validation** is reported in section 10.6 of the LMVR, with cumulative profiles of the observed and modelled journey times presented in Appendix H. The observed journey times have been estimated using 2022 data from the Tom-Tom database which samples anonymised car-centric journey time data, though the sample size for the NGTM is unclear. Journey time validation has been undertaken on 10 (two-way) routes within the study area (shown in Figure 15), which are designed to replicate typical journeys within the Heywood area including the motorway links; all key routes within the study appear to be covered. The journey time validation fully meets TAG requirements in all three modelled time periods.

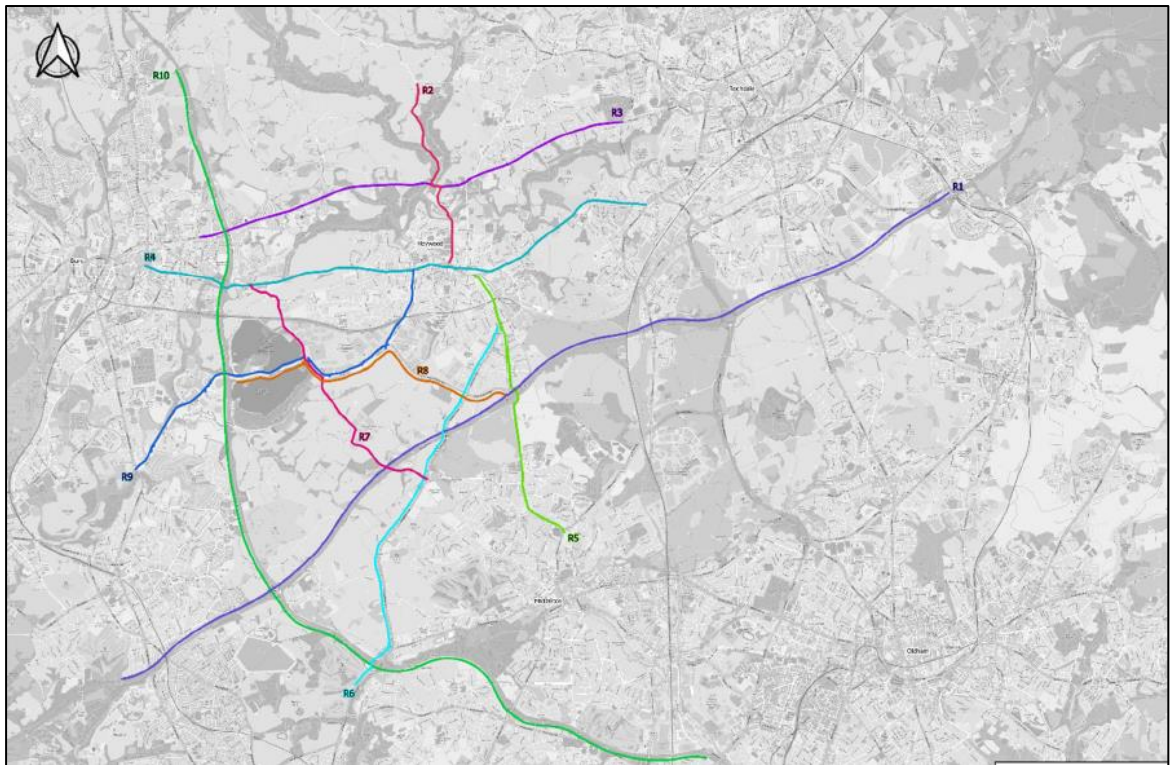


Figure 15: NGTM – Journey time routes

4. Conclusions

- 4.1 TfGM has commissioned HFAS on behalf of Bury Council and Rochdale Council to review the NGTM in order to provide confidence to the districts that the model is fit for purpose.
- 4.2 We have reviewed the model based on the files provided by WSP. These include the model files for each time period, a summary of the key validation statistics, and subsequently a full LMVR.
- 4.3 The review indicates that the approach taken to develop the NGTM 2022 base year model follows best practise as outlined within DfT TAG guidance. The results of the model calibration and validation process demonstrate that the base year traffic model provides a good representation of the current traffic demands and conditions in the Heywood study area.
- 4.4 Specifically, checks on the network structure, coding, and zoning indicate that generally the model is robust and includes all key links and zones within the study area. The model stability is good, given that it converges well across all time periods. While route choice checks suggest that the distributions of traffic within the Heywood distribution park area are realistic and proportional for the different user classes (i.e. HGV and car commute).
- 4.5 The model calibration and validation make use of a large amount of survey data and we concur with the selected cordon/screenlines used in the cal/val process. Matrix estimation was used to calibrate the model and the impacts of ME meet TAG compliance across all measures.
- 4.6 The model traffic flow validation is strong across all the bi-directional cordon and screenlines and a separate analysis of the performance on key motorway links (including M66, M60, M62 and A627(M)) shows the model mostly meets TAG criteria across all time periods. The model includes journey time validation results for key routes in the study and fully meets TAG criteria across all time periods.
- 4.7 Generally, our review indicates that NGTM 2022 baseline model is fit for purpose though there are a few areas that, while not affecting the overall robustness of the model, could be improved, including:
- Modelling of congestion on the M60 between J19 and J18 in the evening peak hour (see para 3.5).
 - Signal timing adjustment resulting in a slightly unrealistic delay at the B6222 Rochdale Road/Rough Hill Lane in the morning peak (see para 3.8).
 - Minor node coordinate issue the inter-peak model (see para 3.12).

- Slightly below TAG criteria validation for traffic flows on M60 in the evening peak hour (see para 3.27).
- Clarification in the LMVR whether the count data has been normalised, and if so, which month has been used (see para 3.17).

4.8 Notwithstanding the comments above, overall, we can have confidence in the 2022 Northern Gateway Transport Model for use in forecasting the strategic highway impacts of the Northern Gateway development sites and for use in feeding into the Transport Assessment.

4.9 It should however also be noted that, while SATURN is a recognised and robust modelling tool able to capture strategic rerouting on highways, it is a strategic (macro) model that makes a range of simplifying assumptions about reality. As such, it is not able to accurately represent the detailed interactions of traffic (such as at complex junctions) and the peak hours are less well represented given they are treated as an average. More detailed models, such as microsimulation models, would be better suited to accurately understanding network operation at the local level.

Appendix A

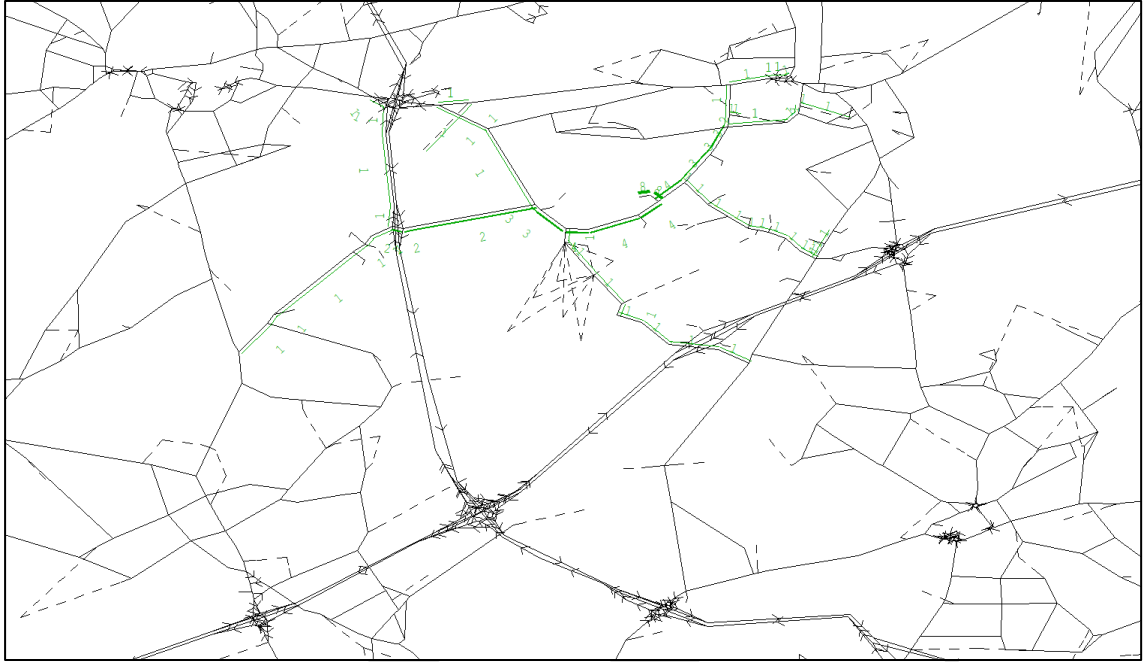


Figure A1: NGTM – Heywood Distribution Park zone – ‘Car commute’ origin trip distribution (morning peak hour)

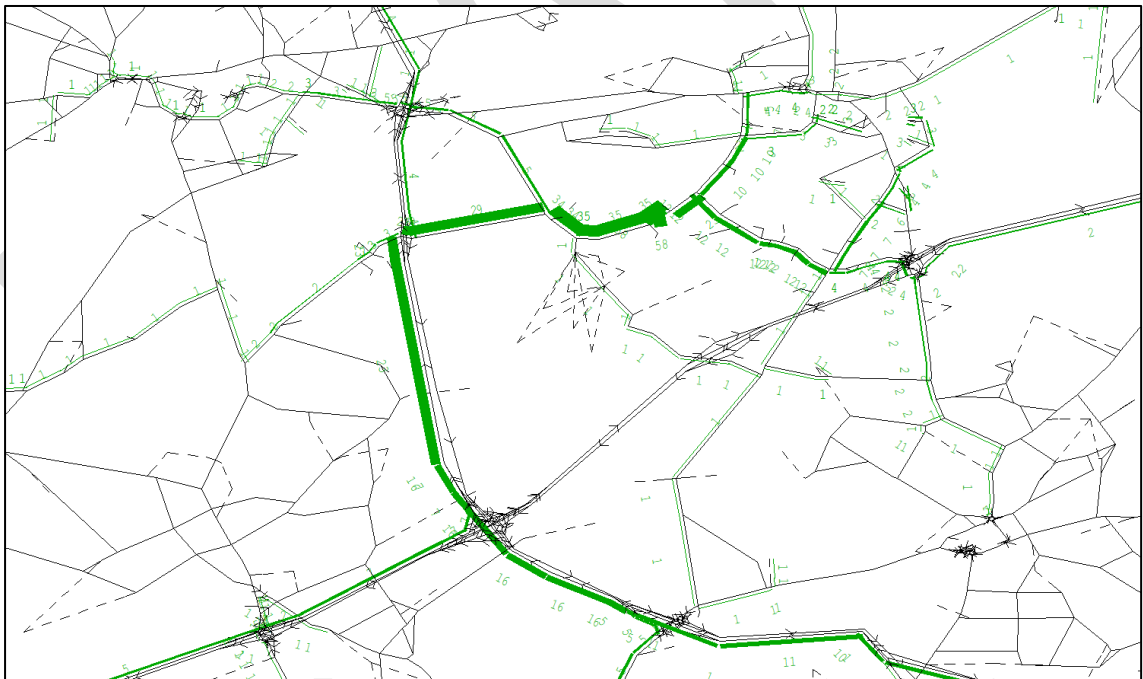


Figure A2: NGTM – Heywood Distribution Park zone – ‘Car commute’ destination trip distribution (morning peak hour)

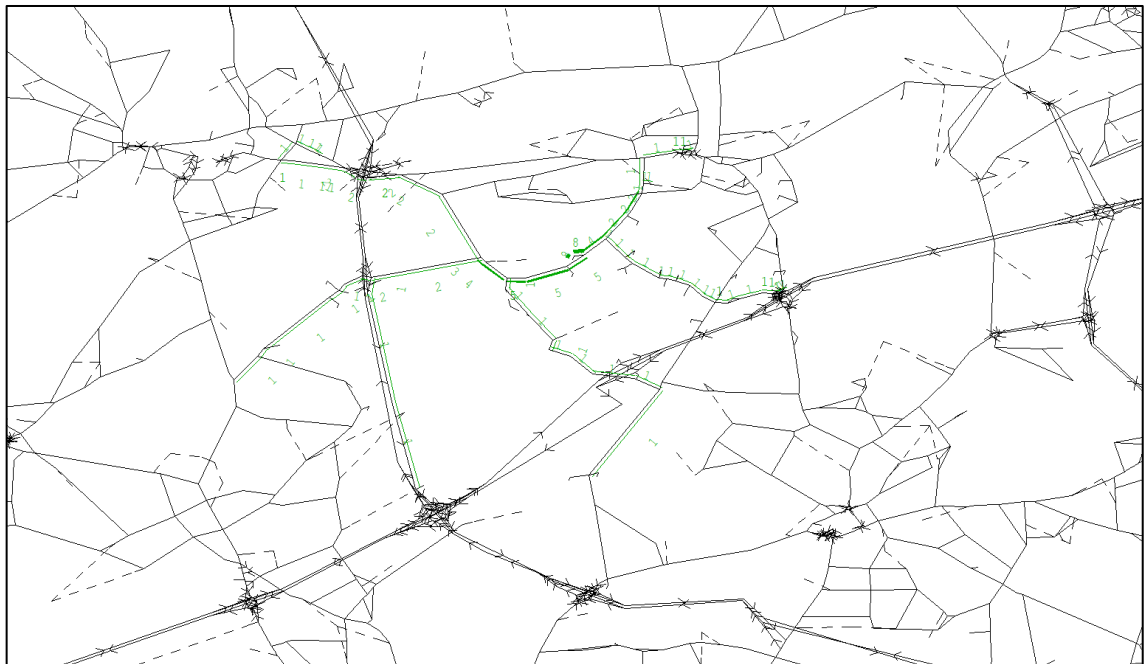


Figure A3: NGTM – Heywood Distribution Park zone – ‘Car commute’ origin trip distribution (inter-peak hour)

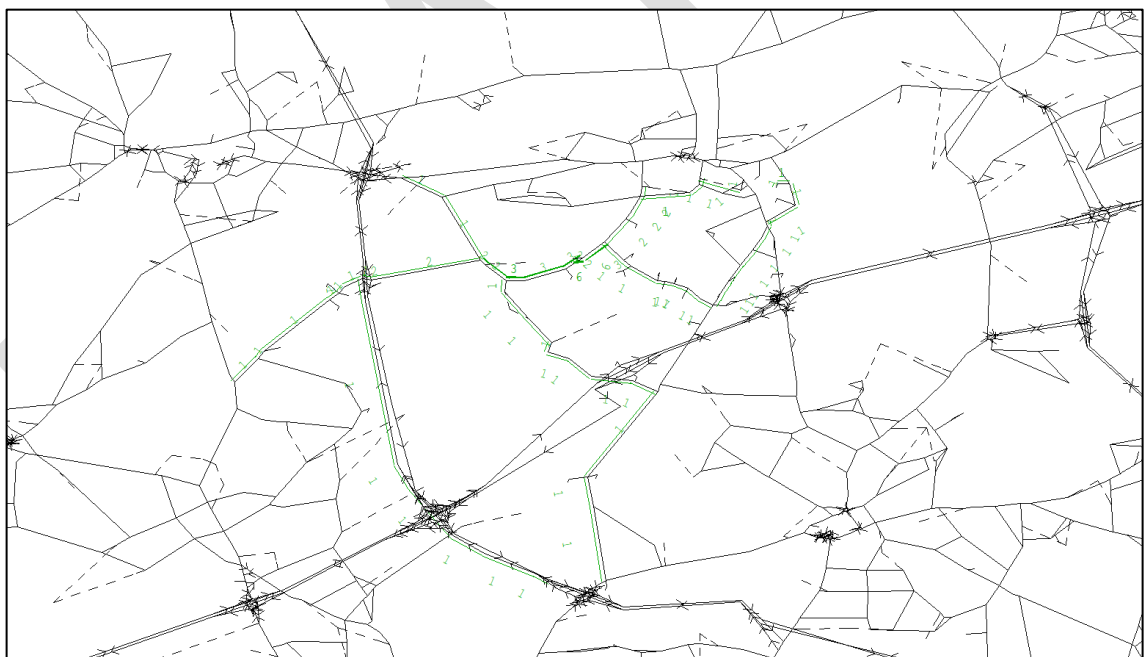


Figure A4: NGTM – Heywood Distribution Park zone – ‘Car commute’ destination trip distribution (inter-peak hour)

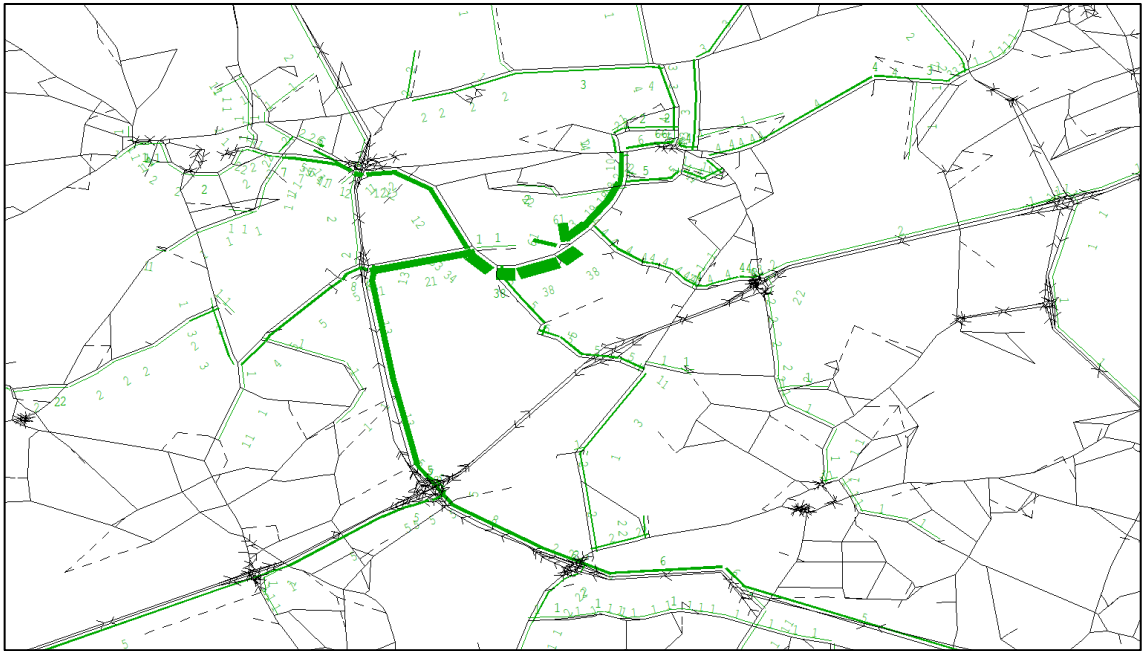


Figure A5: NGTM – Heywood Distribution Park zone – ‘Car commute’ origin trip distribution (evening peak hour)

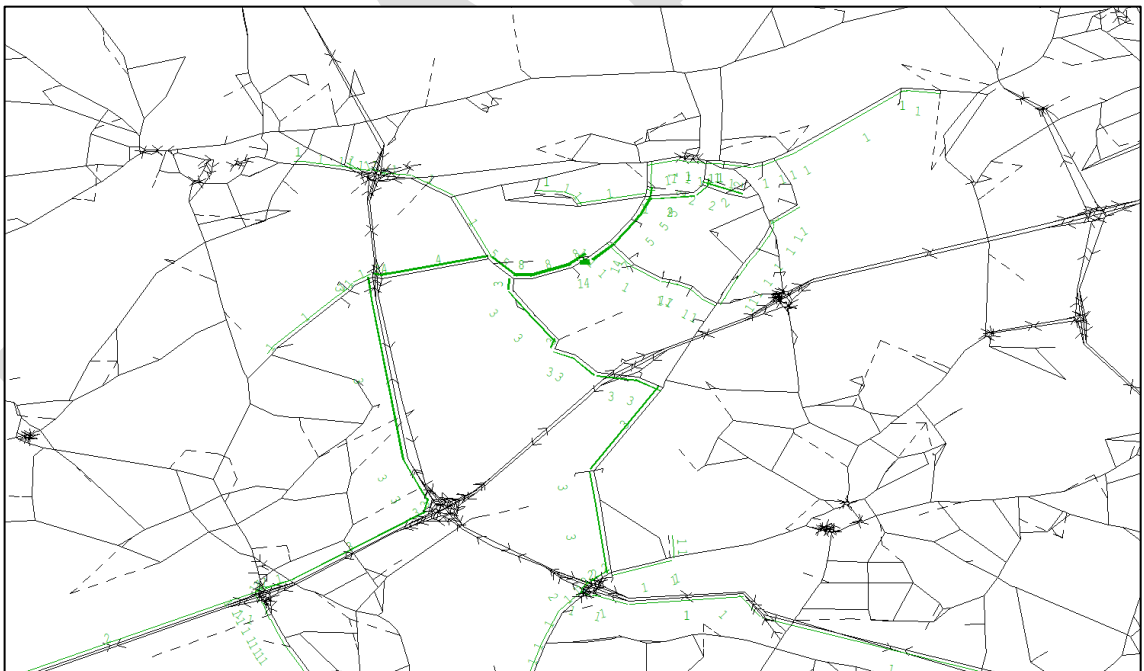


Figure A6: NGTM – Heywood Distribution Park zone – ‘Car commute’ destination trip distribution (evening peak hour)

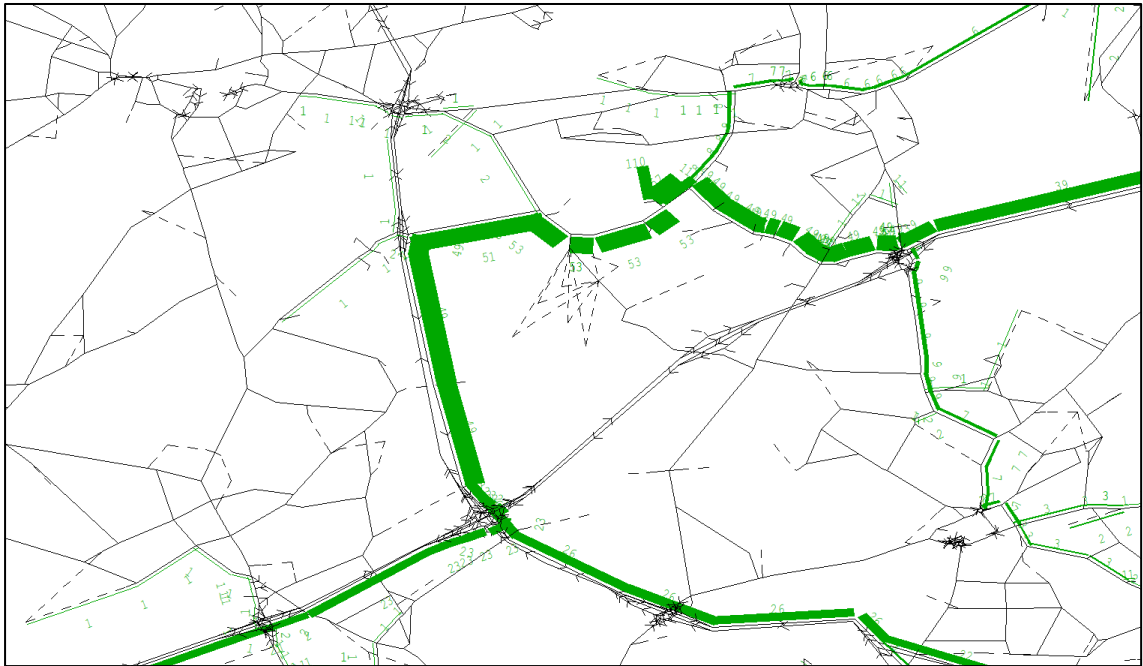


Figure A7: NGTM – Heywood Distribution Park zone – ‘HGV’ origin trip distribution (morning peak hour)

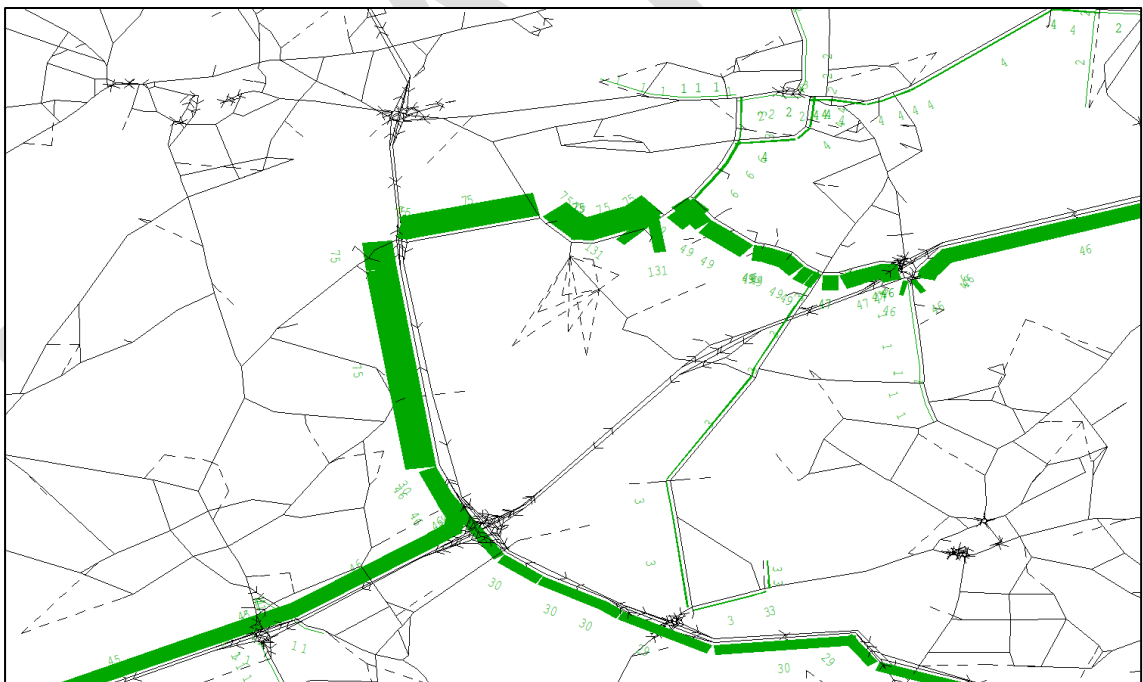


Figure A8: NGTM – Heywood Distribution Park zone – ‘HGV’ destination trip distribution (morning peak hour)

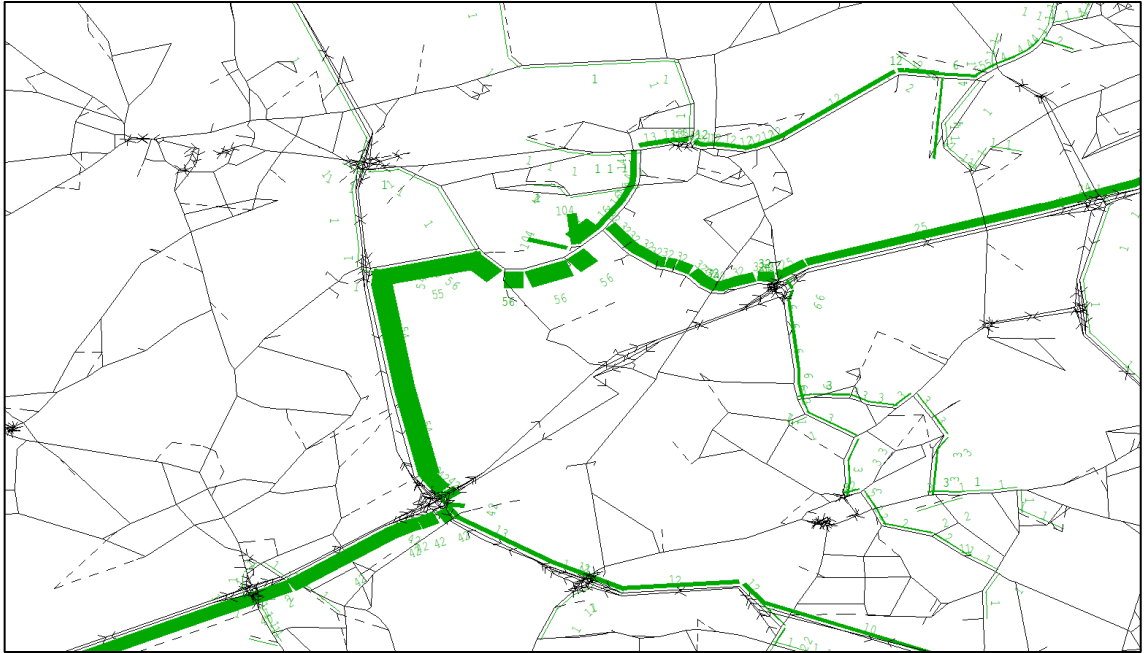


Figure A9: NGTM – Heywood Distribution Park zone – ‘HGV’ origin trip distribution (inter-peak hour)

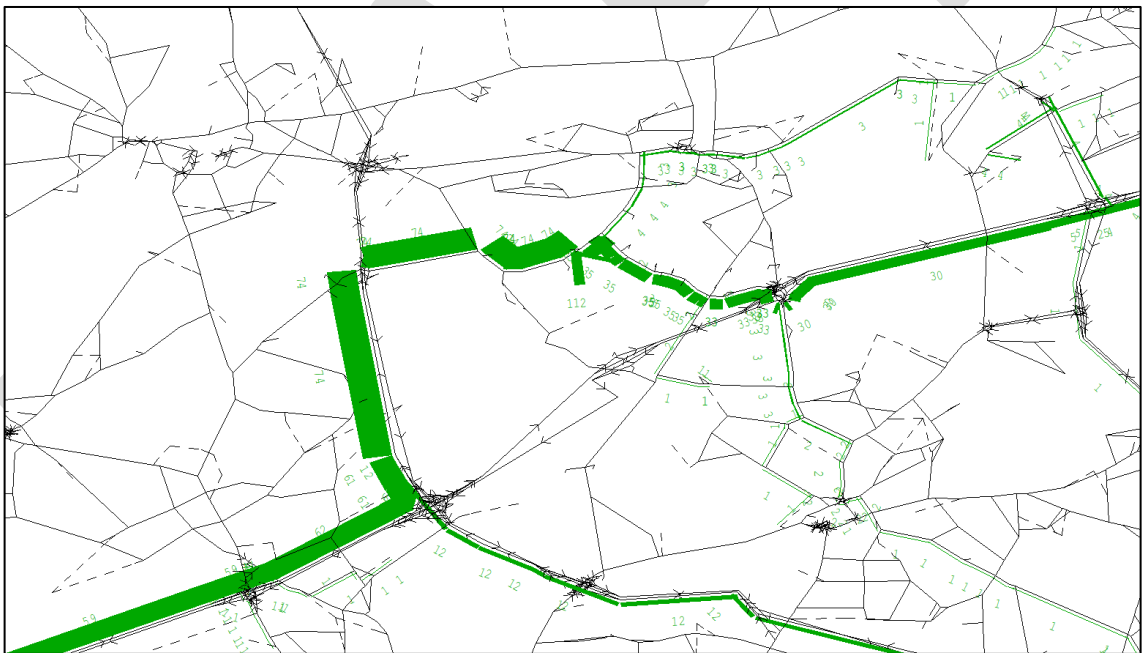


Figure A10: NGTM – Heywood Distribution Park zone – ‘HGV’ destination trip distribution (inter-peak hour)

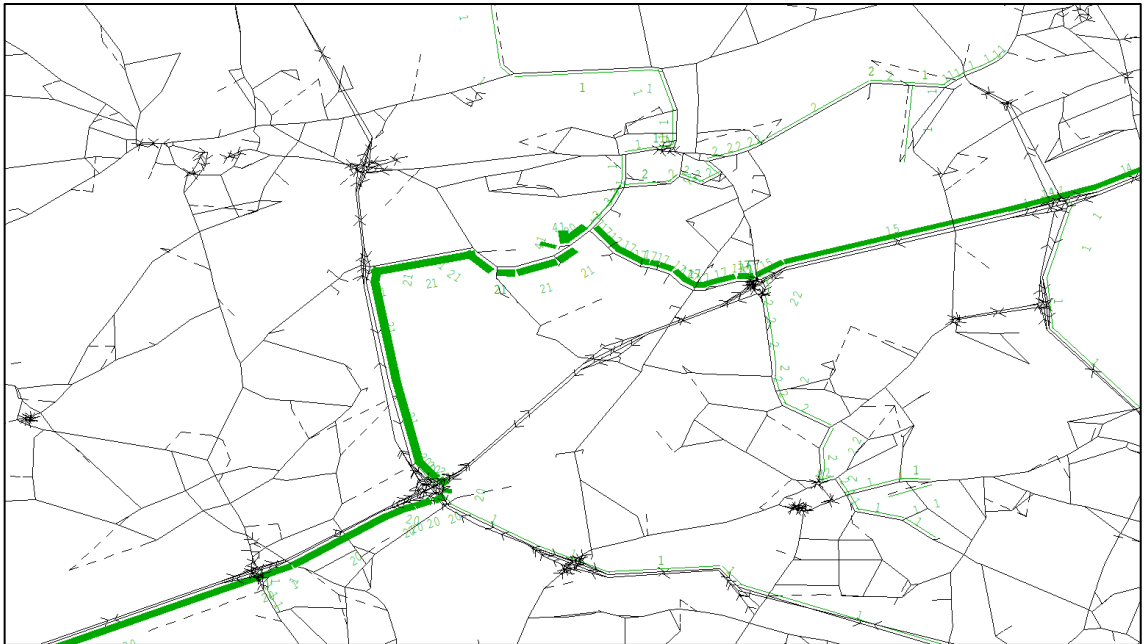


Figure A11: NGTM – Heywood Distribution Park zone – 'HGV' origin trip distribution (evening peak hour)

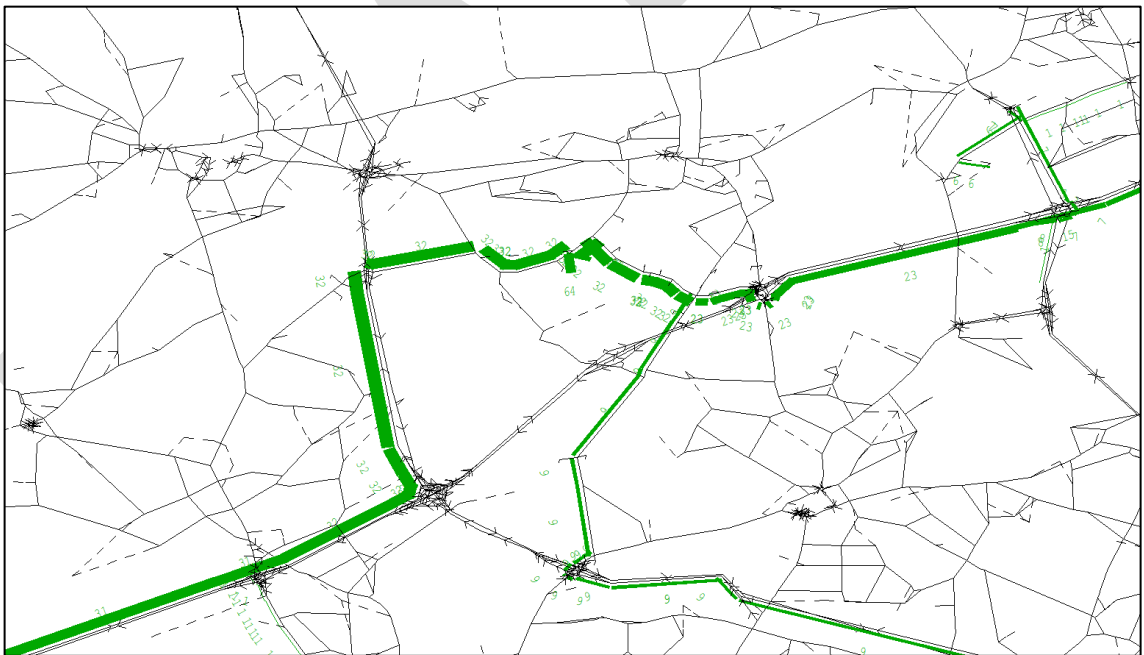


Figure A12: NGTM – Heywood Distribution Park zone – 'HGV' destination trip distribution (evening peak hour)