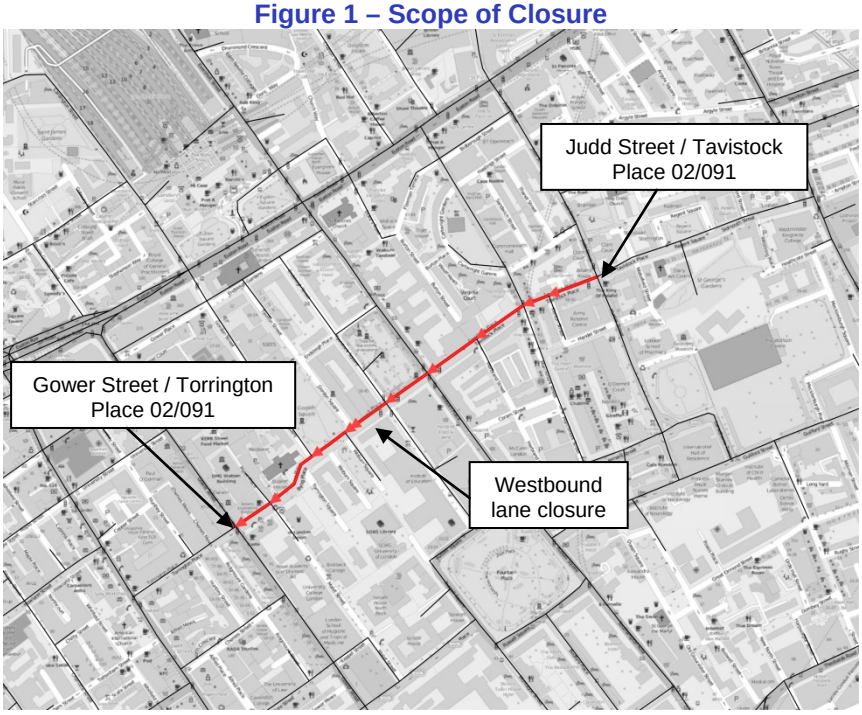
Scheme / Project	**Tavistock Place / Torrington Place – Westbound Closure between Judd Street and Gower Street**	
Client	**Andy Ulph (Outcomes Management, Centre Team)**	
ONE Base Model Version	**King's Cross / Euston Road Refined Base 2012**	
Authored:	**MIF**	**15/06/2015**
Checked:	**SB**	**19/06/2015**
Approved:	**TD**	**29/06/2015**

1. Introduction

The Operational Modelling & Visualisation Team were asked to determine the impact of closing sections of westbound carriageway along Tavistock Place, Tavistock Square, Gordon Square and Torrington Place between Judd Street, junction 02/091, and Gower Street, junction 02/089. Figure 1 highlights the location of these coding alterations:

Figure 1 – Scope of Closure



The assessments were carried out in the AM (0800-0900) and PM (1700-1800) peak period locally calibrated King's Cross / Euston Road ONE Model. This based upon the November 2012 base ONE Model, with local network and matrix refinements in the King's Cross / Euston Road area.

The lane closure was coded in the westbound direction as directed by Outcomes Management, with no alterations made to signal timings for the purposes of this initial assessment.

This report continues with the following sections:

- Section 2 – Summary of the modelling input assumptions;
- Section 3 – Summary of ONE Model coding adjustments;
- Section 4 – Comparison results with the Base models;
- Section 5 – Comparison results with the Future Base models; and
- Section 6 – Conclusions.

2. Modelling Assumptions

2.1. Strategic Models

The Operational Network Evaluator (ONE) Model is a strategic highway assignment model built in the VISUM software environment. The model is built as a simplified representation of the real world at a particular moment in time. The model has been built and calibrated to average November 2012 traffic count and journey time data. The scope and scale of the model is in line with WebTAG guidance, which states:

"Within the Area of Detailed Modelling, a relatively high level of detail will generally be appropriate. Guidelines for Developing Urban Transport Strategies (Institution of Highways and Transportation 1996) suggests that "all roads that carry significant volumes of traffic" should be included and more generally that networks "should be of sufficient extent to include all realistic choices of route available to drivers"."

Due to the nature of assignment modelling and the assumption that users of the network have perfect information when deciding on a route, the inclusion of too many smaller roads will most likely result in an unrealistic amount of rat-running. For these reasons only key strategic roads and through routes are included in a strategic model, as outlined in WebTAG.

2.2. Fixed Demand and Zoning

The demand contained in the ONE Model is fixed, with the same number of trips assigned to the network in the Base and Closure models. Over time, individuals may decide to reduce their mobility or use alternative modes – effects which are not represented in the ONE Model.

The demand in the ONE Model is based on estimates provided by Group Planning and the London Transport Study (LTS) model. Whilst in reality demand origins and destinations can be anywhere on the highway network, this behaviour is too complex to represent in a strategic model. Consequently trips are grouped into zones and load onto or exit from the network at designated locations. The point at which trips are loaded onto the network influences the routes vehicles take through the network and every effort is made to locate these points in logical locations. However it is possible that when changes are made to the network, some unrealistic local trips might be observed.

2.3. Equilibrium Assignment

The ONE Model utilises an equilibrium assignment methodology wherein it assigns trips between all origins and destinations to their least cost path and assumes that drivers have perfect network knowledge when selecting routes.

At the outset the traffic model algorithm assesses, for each origin trip, all the possible route permutations to every destination, it then selects the lowest cost route and assigns trips through the network. This infers that the trip has perfect knowledge of the delays and congestion along the each and every route and therein makes decisions about the lowest cost route before departing. Routing decisions will differ between the Base and Proposed scenarios as a result of the changes made and the point at which a new route is chosen can be some distance from the changes themselves. Consequently the impacts of reassignment can be dispersed over a large area, and evidence of 'model noise' might be observed.

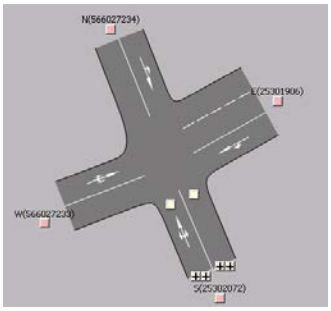
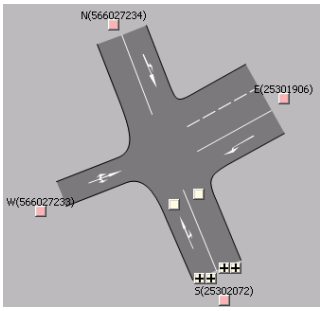
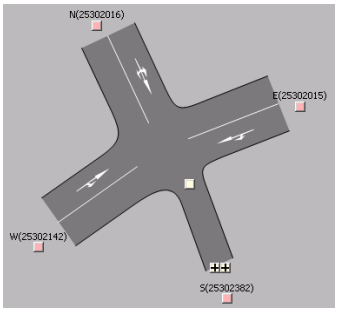
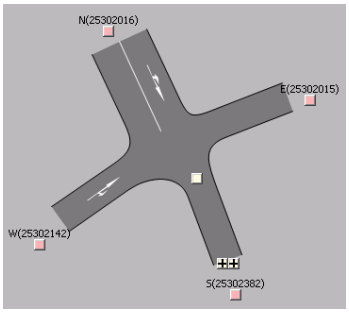
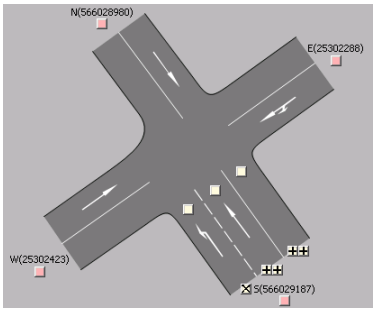
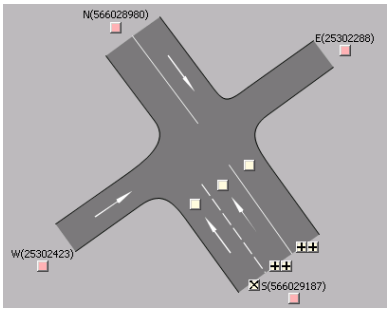
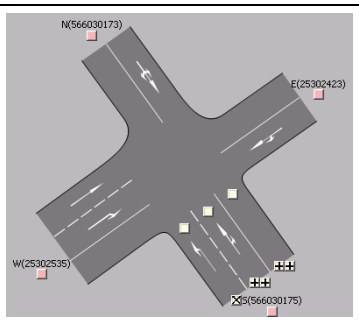
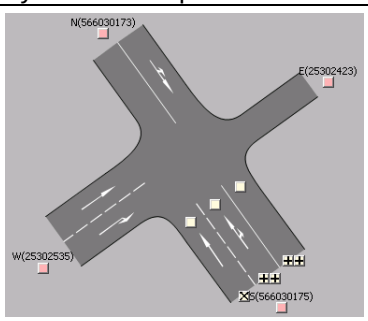
The results presented are therefore more representative of network conditions sometime after the changes have been implemented, when individuals have learned of alternative routes and chosen the one best suited to them, rather than the local (and potentially greater) effects that may occur on the first day after the changes are implemented.

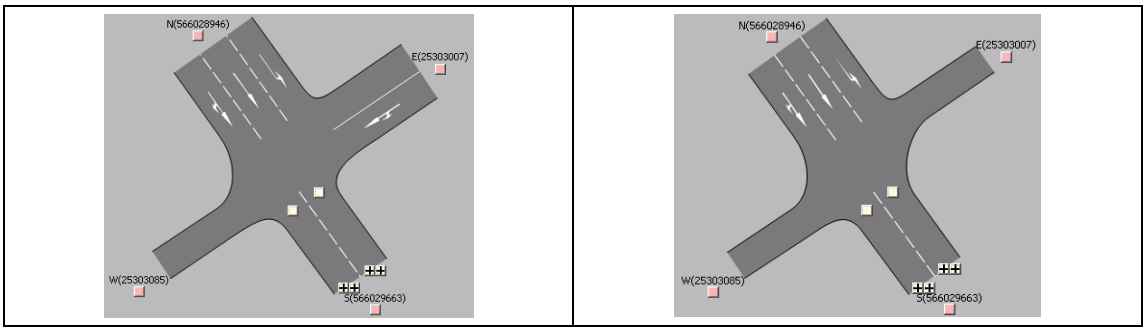
3. Coding of the Closures into the ONE Model

3.1. Road Layouts

The model links westbound between Judd Street and Gower Street, were closed to all Transport Systems and the link capacities, number of lanes and free-flow speeds set to zero. In addition, all permitted turns into and out of the closure links were prohibited, zone connections along the closure we adjusted to right in / right out arrangements. Figure 2 presents the coding assumptions at each signalised junction along the closure route.

Figure 2 – Signalised Junction Geometry Alterations

BASE	CLOSURE
02/091 Tavistock Place / Hunter Street / Judd Street	
	
02/105 Tavistock Place / Marchmont Street	
	
02/063 Woburn Place / Tavistock Square / Tavistock Place	
	
02/123 Tavistock Square / Bedford Way / Gordon Square	
	
02/089 Gower Street / Torrington Place	



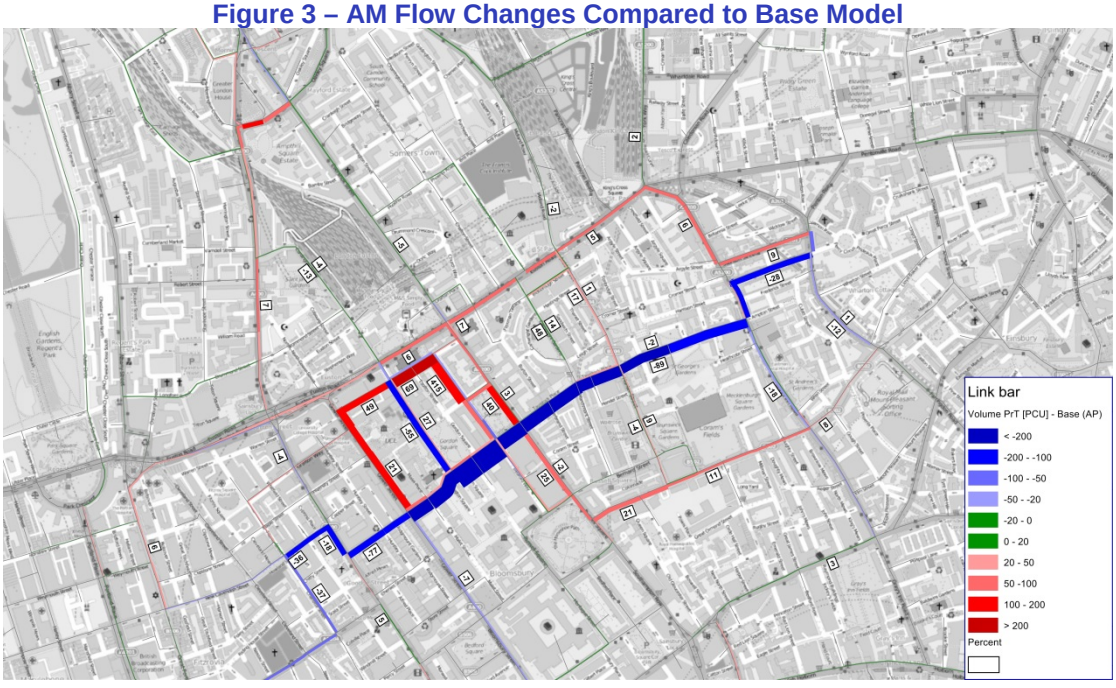
4. Results Comparison with Base Model

The results presented in this section are analysis of the impact of the road closures compared to the Base Model, which does not include committed schemes.

4.1. Flow Differences

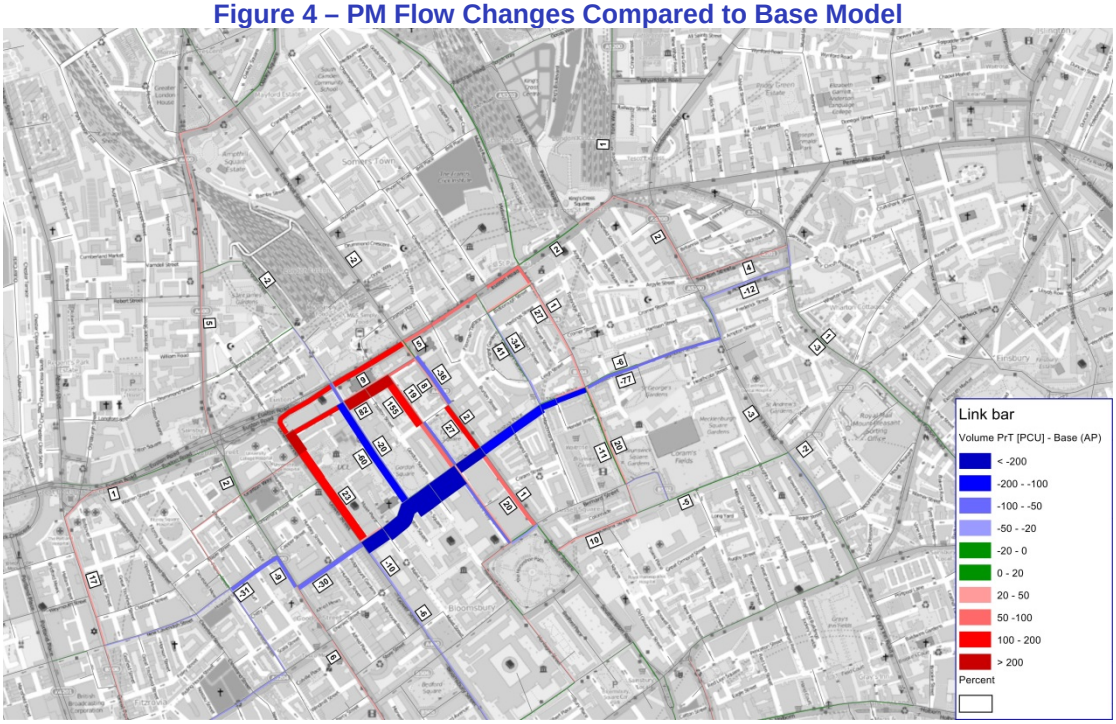
The results in Figures 3 and 4 below present the comparison of flows between the Base and Closure models, for the AM and PM Peak respectively. A blue bar indicates that there are fewer vehicles passing that section of road during the modelled time period. A red bar indicates that there are a greater number of vehicles passing (or attempting to pass through) that section of road during the modelled time period. The size and colour of the bar indicates the magnitude of the flow change. The label presents the percentage change in flow at that location. By interpreting the size of the bar along with the percentage label analysts can determine the significance of the flow change. A thin bar with a large percentage change would indicate that flows have increased but on a relatively quiet road.

Figure 3 – AM Flow Changes Compared to Base Model



The AM Peak results show that the most significant changes in vehicle throughput are westbound along parallel routes, namely Guilford Street and Euston Road. The flow difference also indicates throughput changes northbound along Gordon Street and in the Tavistock Square and Endsleigh Gardens areas; this will be further investigated in the flow reassignment analysis that follows in the next section.

Figure 4 – PM Flow Changes Compared to Base Model



The PM Peak impacts are similar to those in the AM Peak. The westbound flow throughput changes on Guilford Street and Euston are not as significant as in the AM Peak. Flow changes are demonstrated in the vicinity of Tavistock and Gordon Square and southbound along Dower Street. Slightly more vehicles have reassigned to Euston Road in the PM and the AM Peak.

4.2. Reassignment Analysis

A select link analysis ("Flow Bundle") was carried out in the Base model for the proposed closure location in order to show graphically the origins and destinations of trips that currently traverse the westbound route. Further analysis can then be undertaken in the proposed model to investigate how trips have reassignment to alternative routes. There are four steps to this analysis, they are as follows:

1. In the Base model undertake a Flow Bundle for the closed links – this will present the origin and destination of trips that currently traverse any of the links to be closed;
2. Selecting all trips from the section of the demand matrix identified by the flow bundle;
3. Present all trips between the origins and destinations selected by the flow bundle in the Base model – because some trips between a flow bundle origin and destination pair may use an alternative route in the base model;
4. Open the matrix created in 3, in the proposed model, to highlight the traffic reassignment of trips between the origin and destination pairs selected in the Flow Bundle.

Figure 5 – AM Base Flow Bundle Westbound

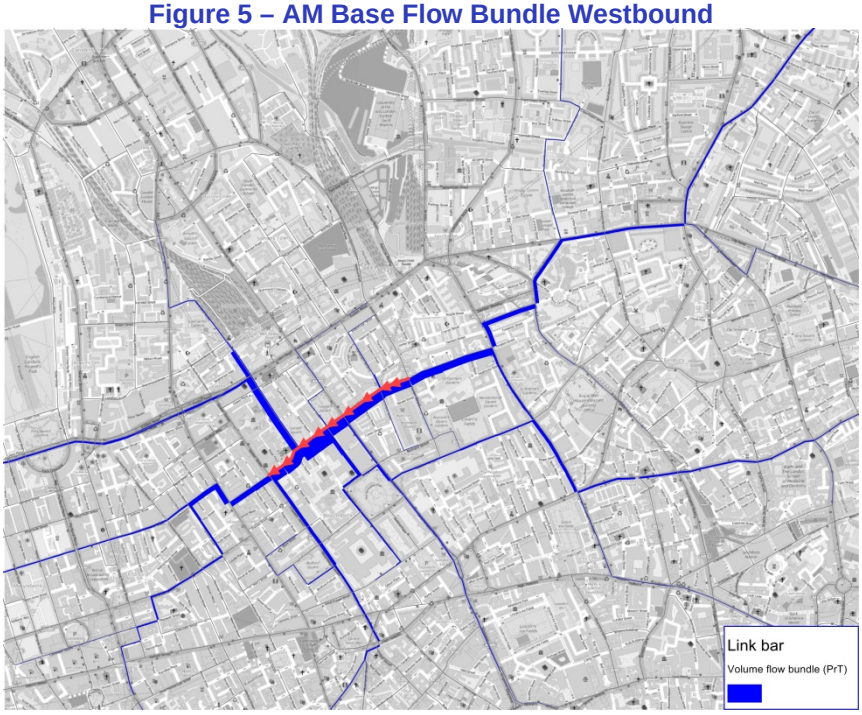


Figure 5 presents the AM Peak flow bundle, it shows the origin and destination and the volume of trips, a thicker bar means more trips, that travel along any part of the highlighted section. It highlights that trips which travel westbound have origins either in the North East and East of London, trips predominantly travel southwest bound along the A104 or westbound along Clerkenwell Road. Trip destinations are either within central London or further west towards Mayfair. There are also large flows northbound along Gordon Street. Figure 5 may not show all trips between the origins and destinations highlighted by the flow bundle, as some trips may utilise alternative routes between the same origin to destination pair.

Figure 6 – AM Base Flow Bundle All Origin and Destinations

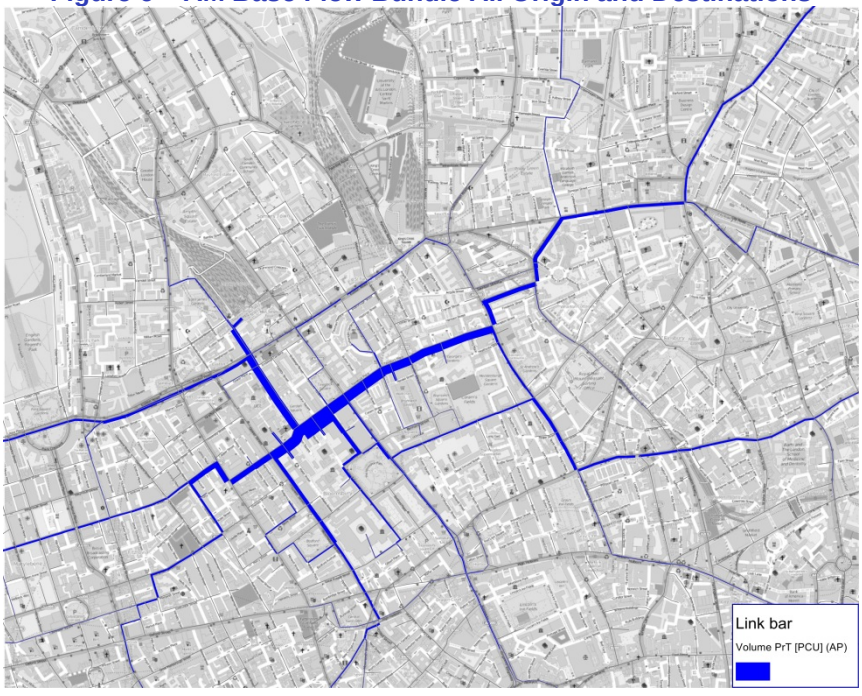


Figure 6 presents all trips between the origins and destinations highlighted in the flow bundle. It highlights that some trips route along Euston Road as an alternative.

To show where these trips have reassigned to following the road closures, the demand matrix outputted from the Base model can be opened and displayed in the Closure model, this will show the new routes trips use between the origin and destination pairs.

Figure 7 – AM Closure Flow Bundle Reassignment

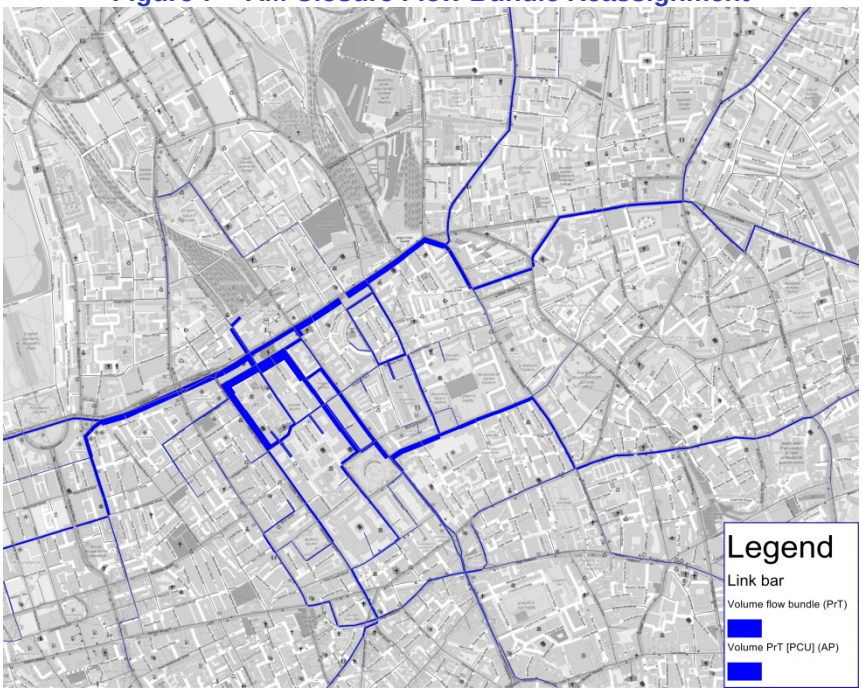


Figure 7 presents the AM peak flow reassignment. It highlights that flows have predominantly reassigned to either Euston Road or Guilford Street westbound. The reassignment around Gordon Square and Tavistock Square can be attributed to trips travelling north via Tavistock Square instead of Gordon Street and south via Gower Street instead of Gordon Street.

Figure 8 – PM Base Flow Bundle Westbound

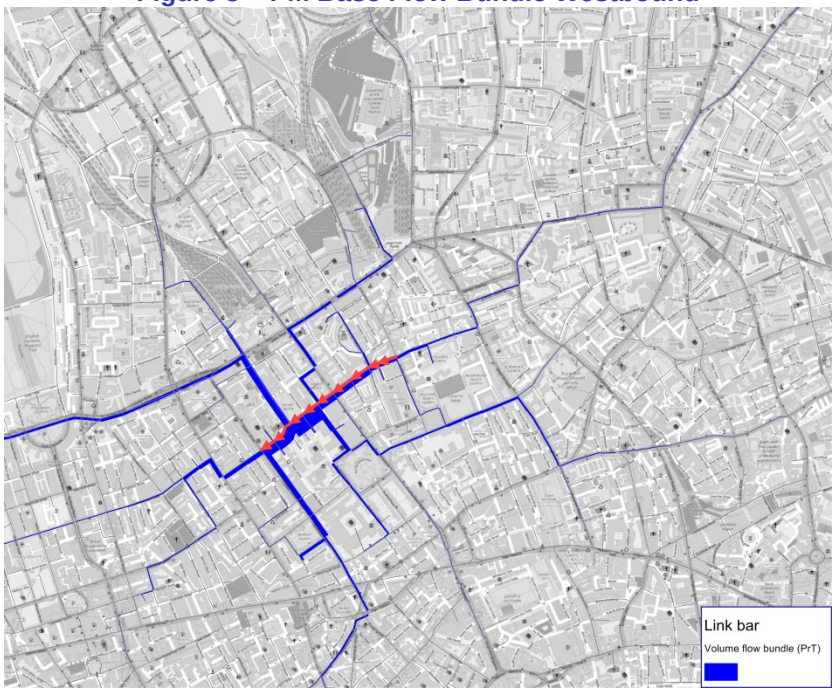


Figure 8 shows the PM Peak westbound Flow Bundle. It highlights fewer trips originating in the North and East of London, with more localised trips originating to the north of Euston Road. Destinations are predominantly to the west along Marylebone Road or to the south and Mayfair.

Figure 9 – PM Base Flow Bundle All Origin and Destinations

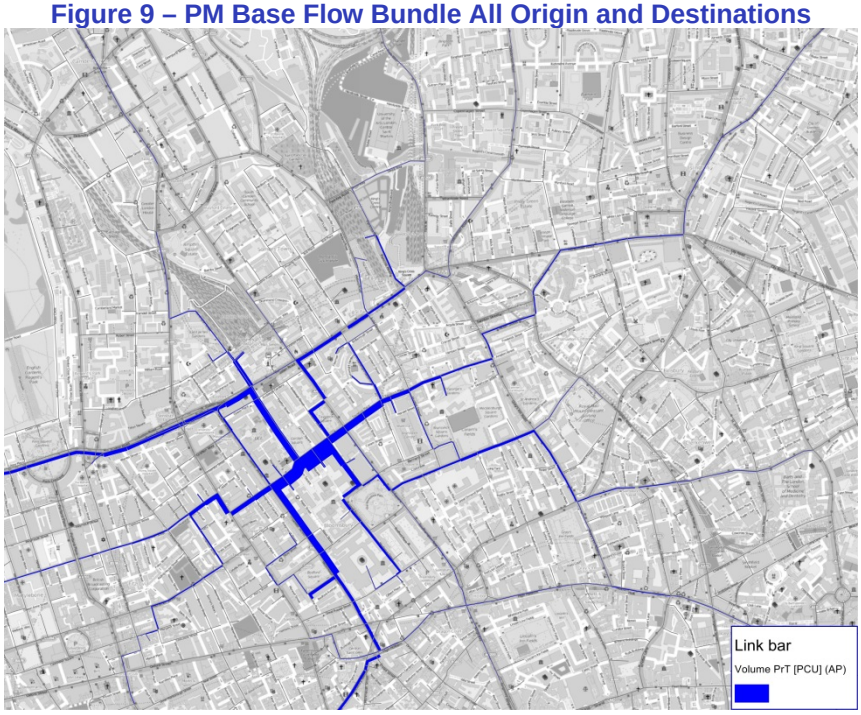


Figure 9 does not show many additional routes through the network for the origin and destination pair identified in the Flow Bundle, most notable are the flows routing via High Holborn and Euston Road. This origin – destination matrix can be opened in the Closure model to understand where trips reassign.

Figure 10 – PM Closure Flow Bundle Reassignment

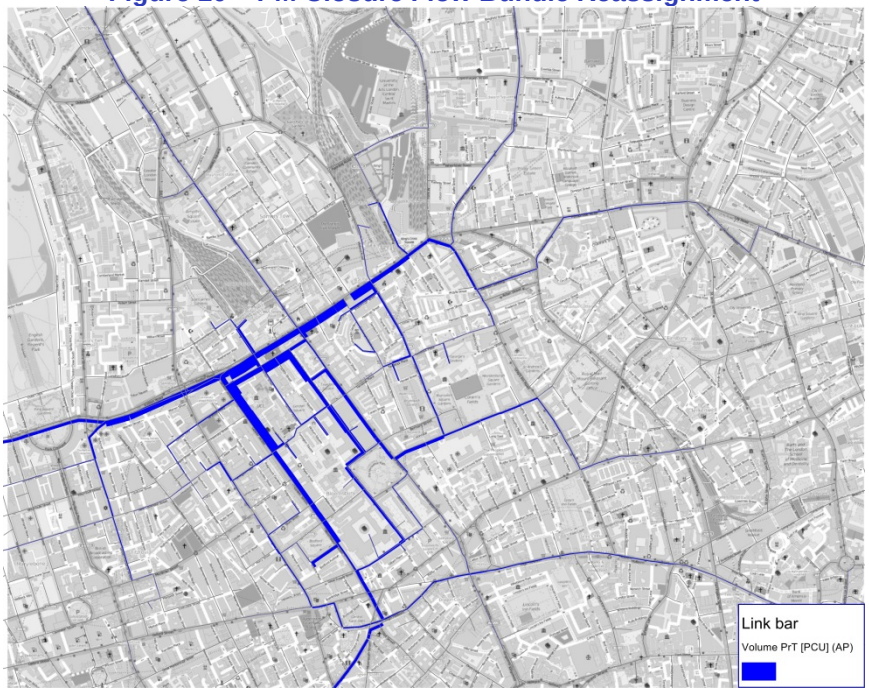


Figure 10 shows the reassignment routes of trips, it highlights more trips routing along Euston Road and southbound along Gower Street than was demonstrated in the AM peak. Higher flow throughput is also shown westbound along High Holborn.

4.3. Congestion

The ONE Model can provide an indication of where delay may be affected by the proposed westbound closure. Figure 11 and Figure 12 present the junction delay statistics in the study area. Junctions with a turn volume over capacity ratio (V/C) greater than 85% are shown as orange, and junctions with a V/C nearing 100% are shown as red. These congestion indicators are for illustration only. To properly assess congestion at junctions and links the area would require detailed micro-simulation modelling in VISSIM.

Figure 11 – AM Base Model Junction Delay

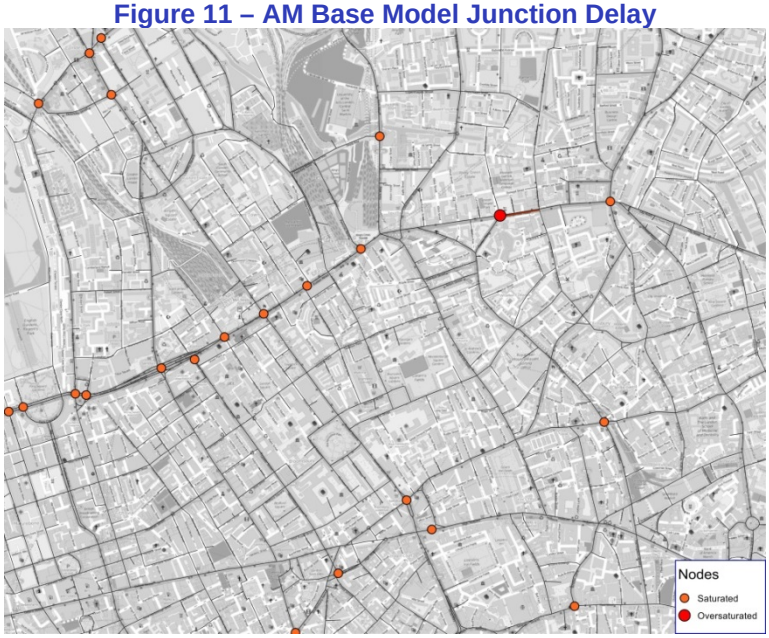


Figure 11 illustrates the junctions where a turn volume capacity ratio is greater than 85% in the AM Base model. It highlights delays at junctions along Euston Road and in the Holborn Circus area.

Figure 12 – AM Closure Model Junction Delay

Figure 12 indicates the delay statistics for the AM Closure model. It highlights that junction delays have remained relatively unchanged throughout the study area; apart from in the south where two junctions now comprise turns with a V/C ratio greater than 85%.

Figure 13 – PM Base Model Junction Delay

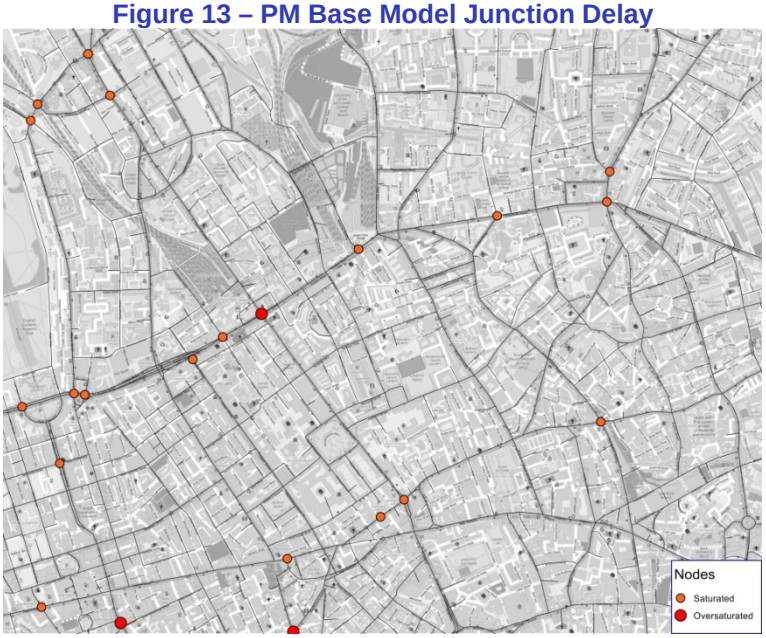


Figure 13 illustrates the junction delay information for the PM peak Base Model. It indicated delays nearing capacity at the Euston Road / Upper Woburn Place junction and at other locations along Euston Road.

Figure 14 – PM Closure Model Junction Delay

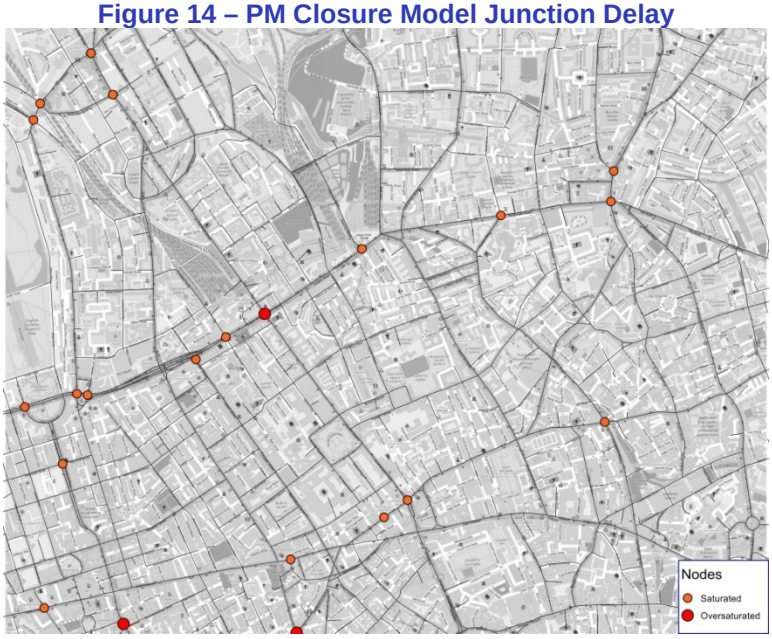


Figure 14 illustrates the junction delay information for the PM Closure Model. It indicates that turn delays have not changed at any junctions in the study area.

5. Results Comparison with Future Base

The results presented in this section are analysis of the impact of the road closures compared to the Future Base Model. The Future Base model network includes a number of committed network interventions in central London, including;

- East – West Cycle Superhighway (CSH)
- North – South Cycle Superhighway
- Aldgate Gyratory
- Caledonian Road (Better Junctions)
- Camberwell TC
- Swiss Cottage
- CSH Route 2 (Upgrade)
- CSH Route 5 (Inner)
- Old Street
- Baker Street
- Lambeth Roundabout (South)
- Lambeth Roundabout (North)
- Westminster Bridge Roundabout (S)
- Haymarket 2-way
- King's Cross Interim
- NOVA Victoria
- Oval
- Shoreditch
- West End Project (Option A)
- Elephant and Castle
- Lewisham Gyratory

5.1. Flow Differences – Base Compared with Future Base

The first step to understanding the impact of the road closures in the Future Base is to obtain an appreciation of the network impact between the Base and Future Base. Figure 15 and Figure 16 present, for the AM and PM respectively, the change in flow throughput between the Base and Future Base. The flow comparisons present how traffic throughput along particular links has altered.

Figure 15 – AM Flow Changes Base Compared to Future Base

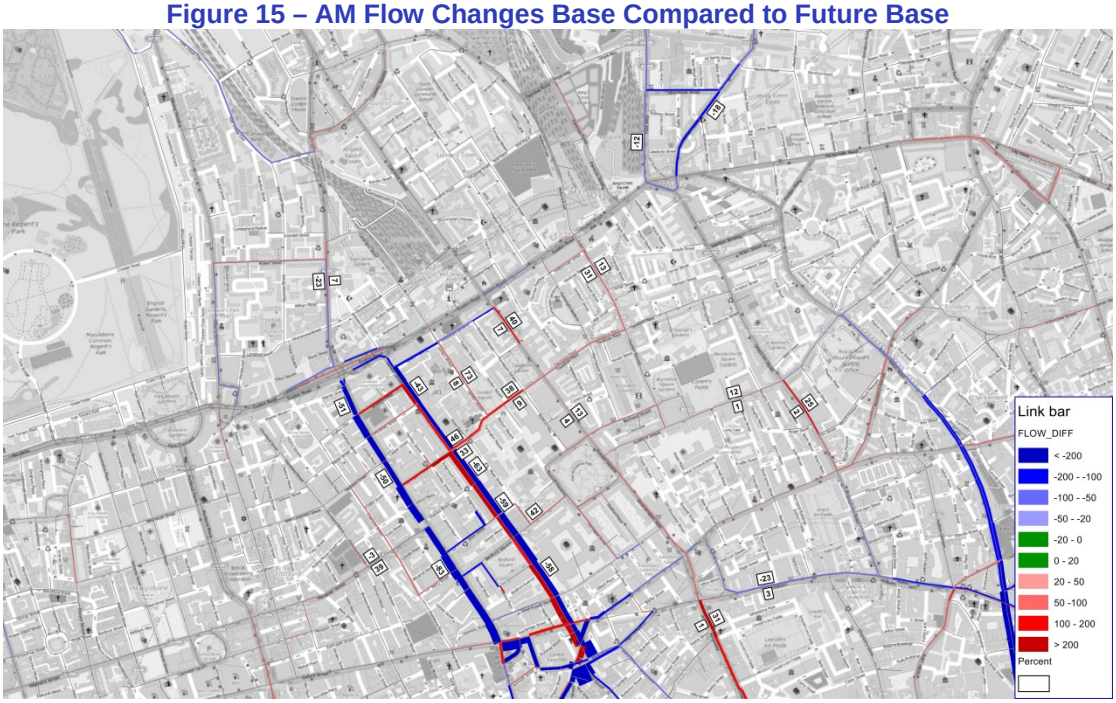


Figure 15 presents the network impacts of the Future Base schemes in the vicinity of the proposed closure, in the AM peak. It highlights the rerouting of vehicles as a result of the West End Project (WEP). The impacts are most evident for the North to South movements as throughput has shifted northbound from Tottenham Court Road to Gower Street; the impacts on east to west movements are marginal.

Figure 16 – PM Flow Changes Base Compared to Future Base

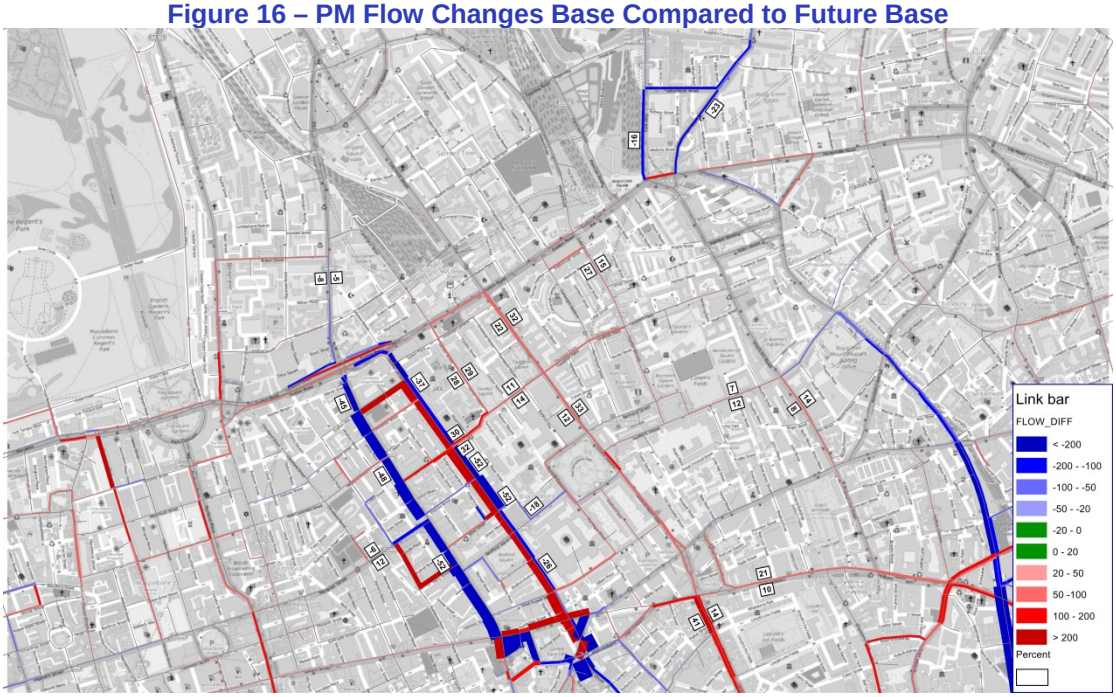


Figure 16 shows the impacts of the Future Base schemes in the PM Peak. The pattern of trip redistribution is similar to the AM Peak. Flow throughput has predominantly increased in the north to south direction.

5.2. Flow Differences – Future Base Compared with Future Closure

The Future Base model had the road closures coded as per the assumptions presented in Section 3 above, to create a model referred to hereafter as Future Closure. The following presents the flow difference, reassignment and congestions impacts of the closure considering the implementation of surrounding schemes.

Figure 17 – AM Flow Changes Future Base Compared with Future Closure

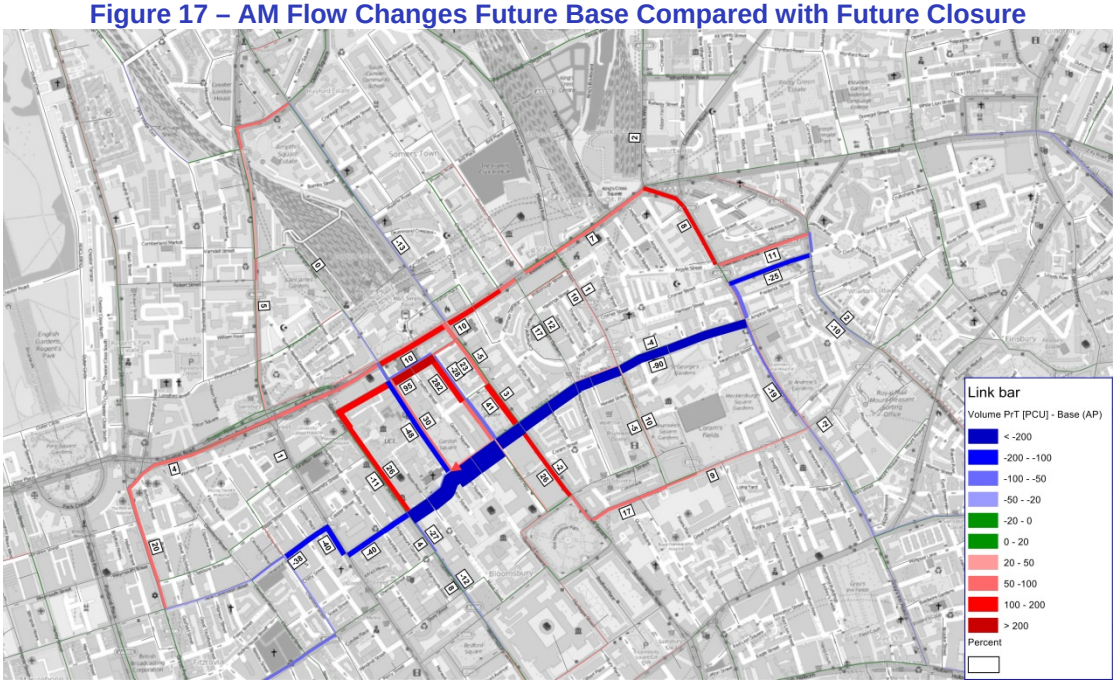


Figure 17 shows the impact of the closure when compared to the Future Base scenario; it presents similar patterns of movement when compared to the Base impacts but the

magnitude of some changes is not as pronounced. There is a reduced increase in throughput northbound on Tavistock Square compared to the Base, and marginally higher increases westbound on Euston Road. Throughput has also increased southbound on Great Portland Street; the reduced capacity southbound on Gower Street, as a result of WEP, could be accountable.

Figure 18 – PM Flow Changes Future Base Compared with Future Closure

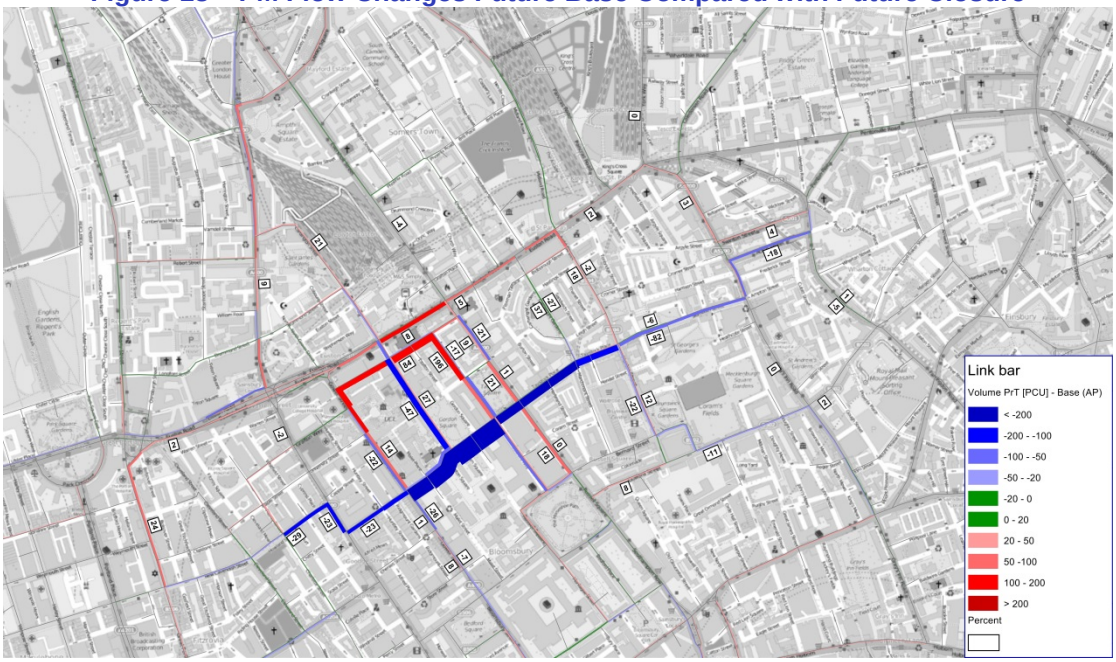


Figure 18 shows the reassignment in the PM Future Closure model. Again the patterns of movement are similar to the Base situation with slightly reduced magnitude. Vehicles continue to route northbound via Tavistock Square and Endsleigh Gardens, but the flows routing via Euston Road to travel southbound along Gower Street is reduced compared to the base. A higher proportional increase is show southbound along Great Portland Street as was shown in the AM Peak.

A flow bundle analysis has been undertaken to compare the reassignment of trips from the westbound closure route. The methodology is identical to that outlined in Section 4.2 above.

5.3. Reassignment Analysis

A flow bundle was carried out on the closure links in the Future Base models, the trips between Origins and Destinations highlighted from the flow bundle were then opened in the Closure model to identify where trips have redistributed.

Figure 19 – AM Future Base Flow Bundle Westbound

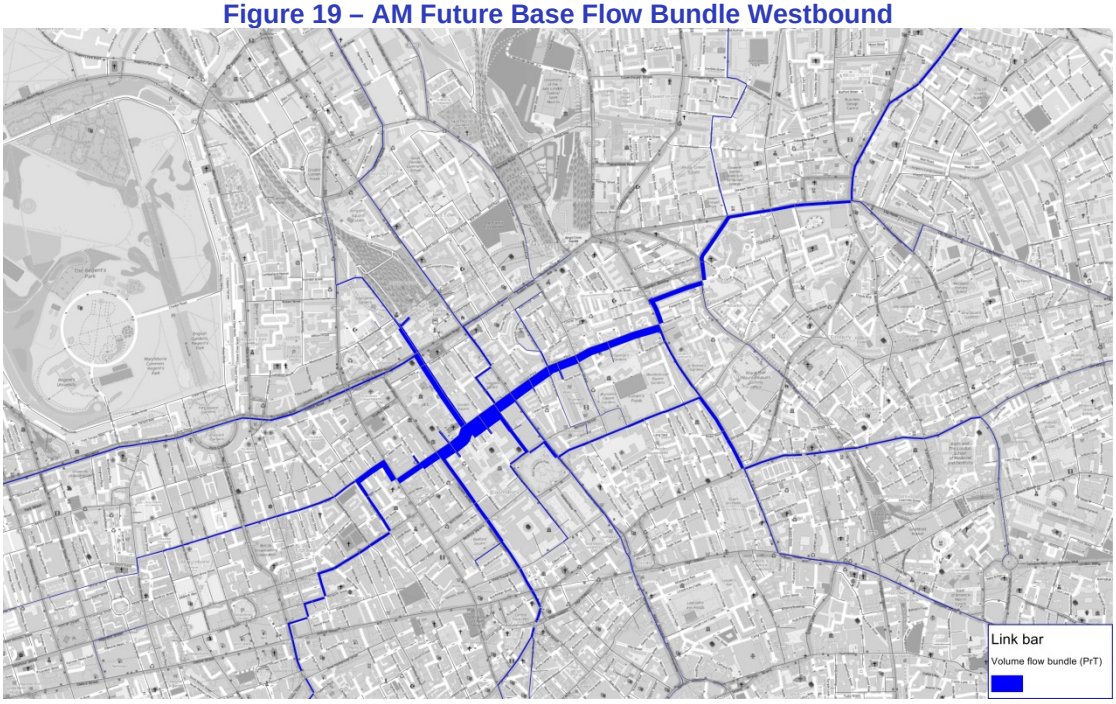


Figure 19 presents the AM Peak flow bundle from the Future Base model for all trips traversing any section of the westbound closure, it shows the origin and destination and the volume of trips, a thicker bar means more trips. Trip routings are similar to the base model, with origins north east of the inner ring road and Clerkenwell to the east. Destinations are predominantly out towards the west or south west. Route choice for trips using the closure links is not significantly influenced by the WEP proposals.

Figure 19 may not show all trips between the origins and destinations highlighted by the flow bundle, as some trips may utilise alternative routes between the same origin to destination pair.

Figure 20 – AM Future Base Flow Bundle All Origin and Destinations

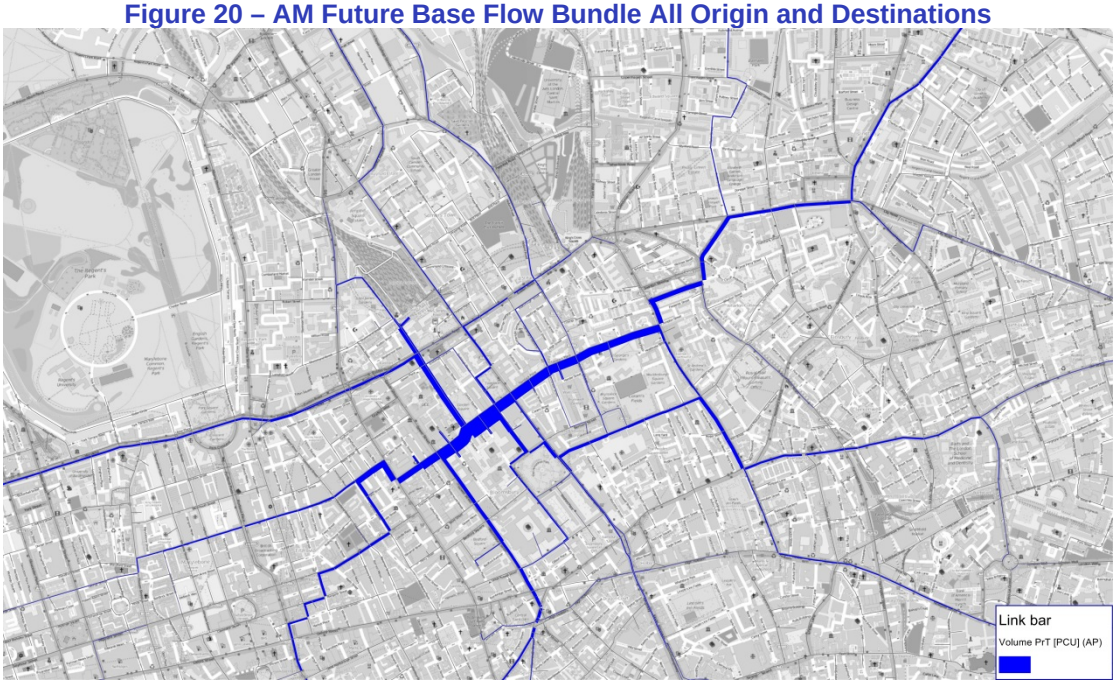


Figure 20 presents all trips between the origins and destinations highlighted in the flow bundle. It highlights that some trips route westbound along Euston Road and High Holborn.

To show where these trips have reassigned to following the road closures, the demand matrix outputted from the Future Base model can be opened and displayed in the Future Closure model, this will show the new routes trips use between the origin and destination pairs.

Figure 21 – AM Future Closure Flow Bundle Reassignment

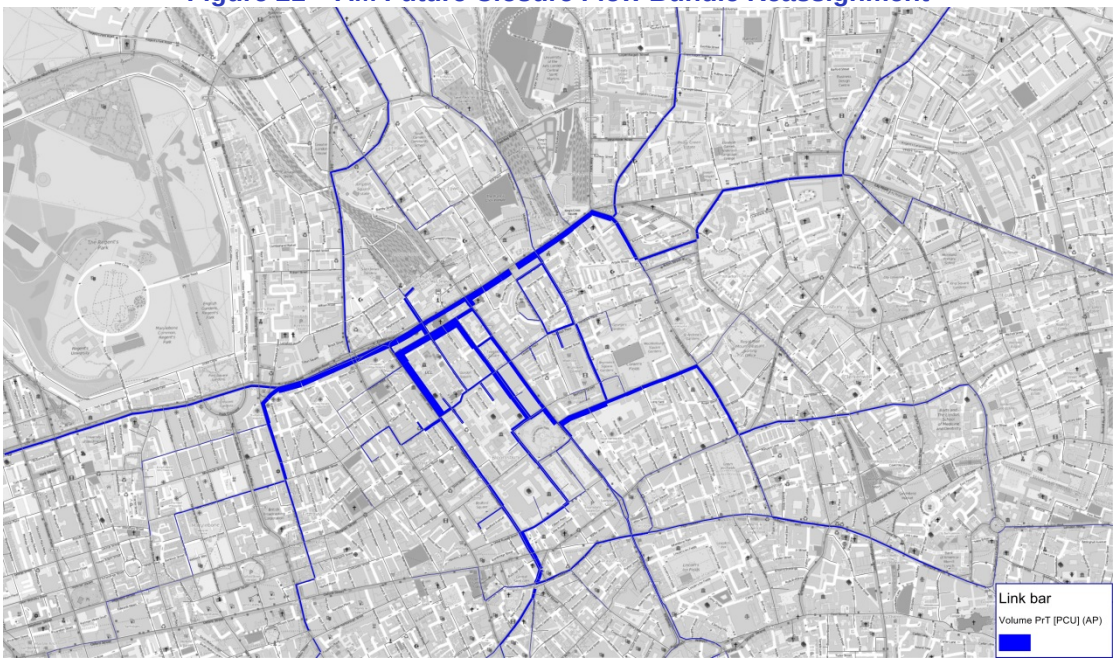


Figure 21 presents the AM peak flow reassignment. It highlights similar reassignment to the Base model, flows have predominantly reassigned to either Euston Road or Guilford Street westbound, with some local reassignment onto minor roads. Some trips have reassigned westbound on High Holborn turning north into Gower Street.

Figure 22 – PM Future Base Flow Bundle Westbound

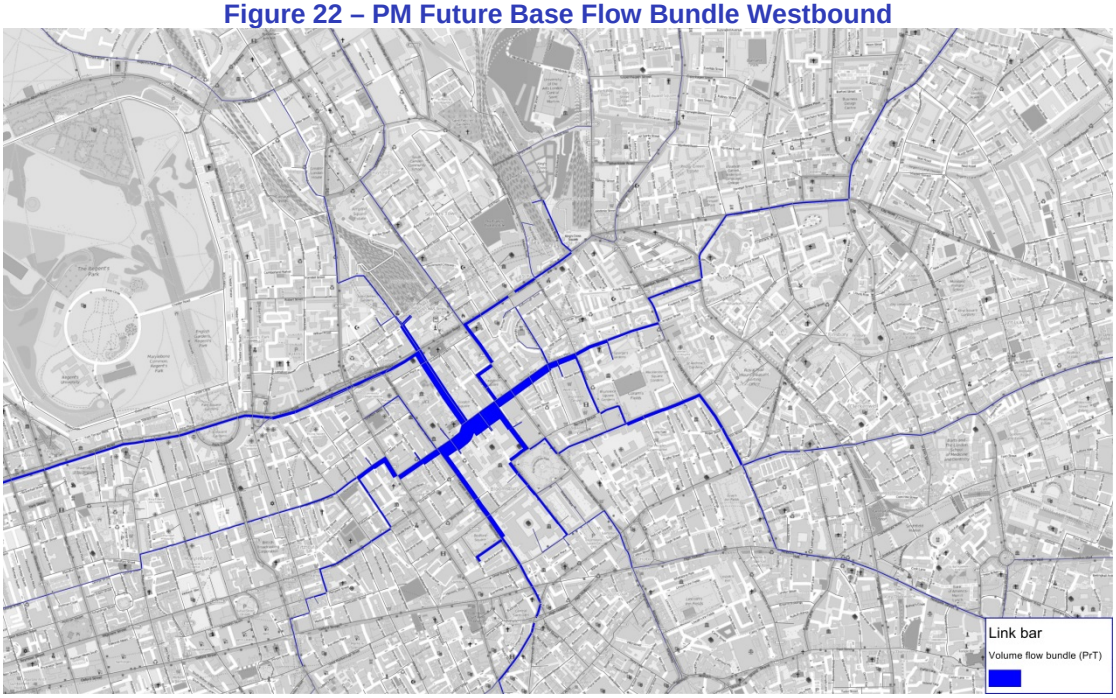


Figure 22 presents the PM peak route choice of trips which use the proposed closure links in the Future Base model. Similar to the AM Peak, origins are to the north and west of the model and destinations out to the west or central London. Not all trips between these origins and destinations may use the closure links; Figure 23 presents the alternative routes available.

Figure 23 – PM Future Base Flow Bundle All Origin and Destinations

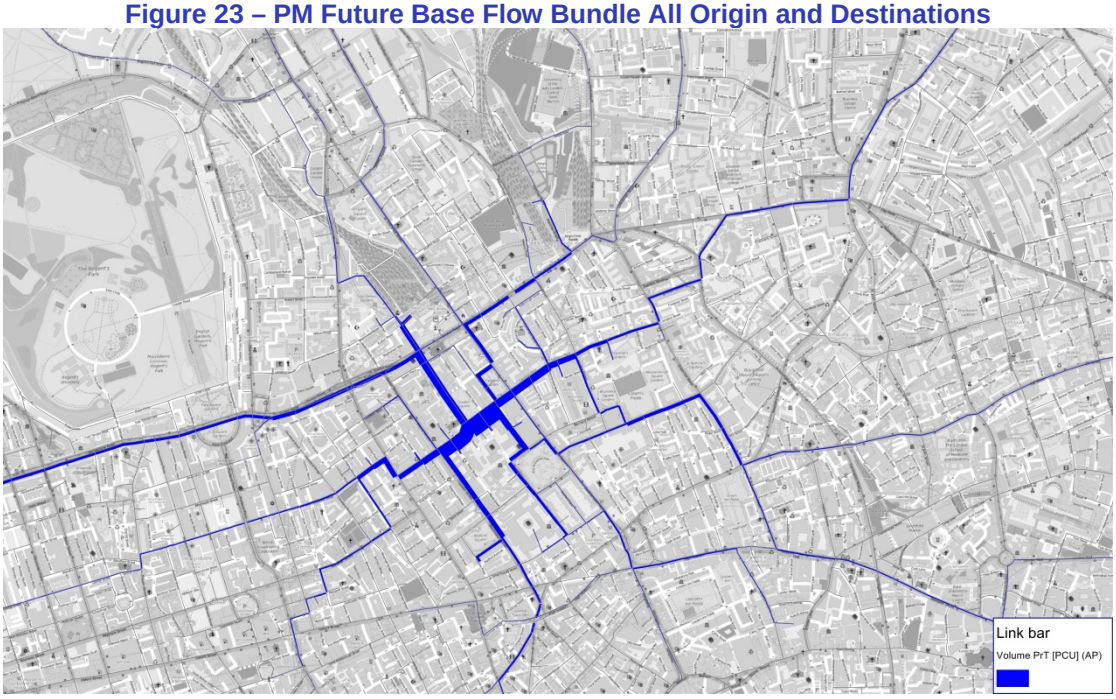


Figure 23 presents the complete route choice of trips between the origins and destinations selecting in the flow bundle. It highlights that there are alternative routes east to west along High Holborn and westbound along Euston Road. The majority of trips use the closure links. To understand the impact of the closures on the route choice, for all trips, the flow bundle matrix is opened in the Future Closure model.

Figure 24 – PM Future Closure Flow Bundle Reassignment

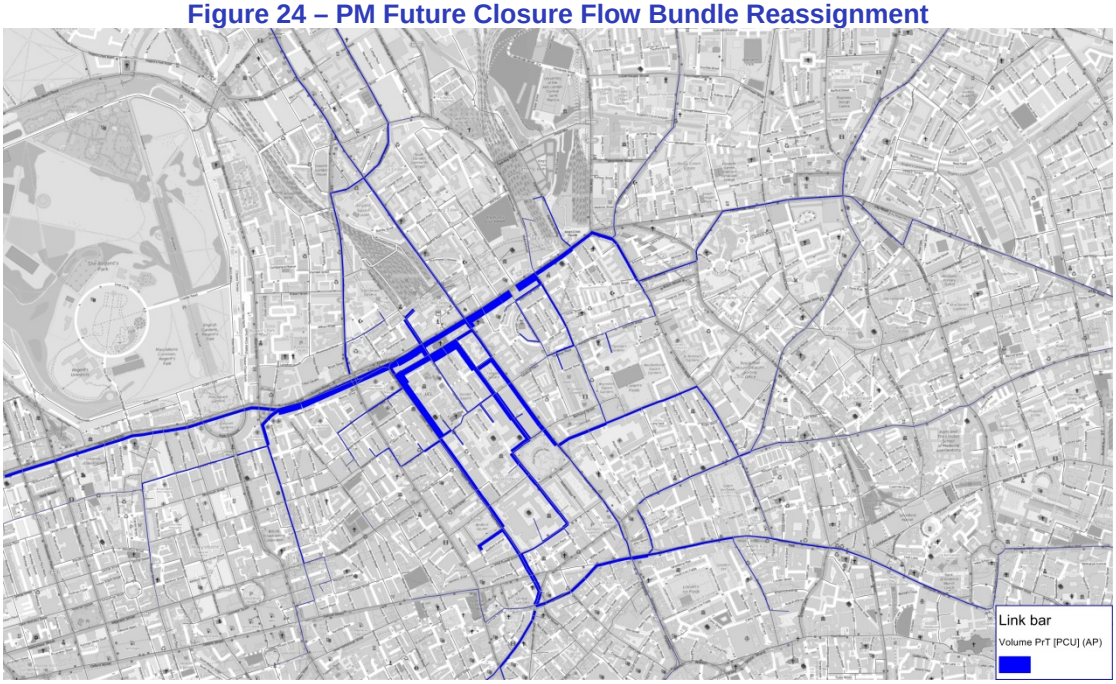


Figure 24 presents the routing of trips through the network following the closure. It shows that the majority of trips have reassigned to either Euston Road or High Holborn. Trips are also shown travelling northbound along Gower Street to access locations to the west of Tottenham Court Road. Trips also reroute via Tavistock Place and Gower Street, southbound, but in fewer numbers than the Base situation.

5.4. Congestion

The ONE Model can provide an indication of where delay may be affected by the proposed westbound closure. Figure 22 and Figure 23 present the junction delay statistics in the study area for the AM Peak. Junctions with at least one turn with a volume over capacity ratio (V/C) greater than 85% are shown as orange, and junctions with a V/C nearing 100% are shown as red. These congestion indicators are for illustration only. To properly assess congestion at junctions and links the area would require detailed micro-simulation modelling in TRANST/VISSIM.

Figure 22 – AM Future Base Model Junction Delay

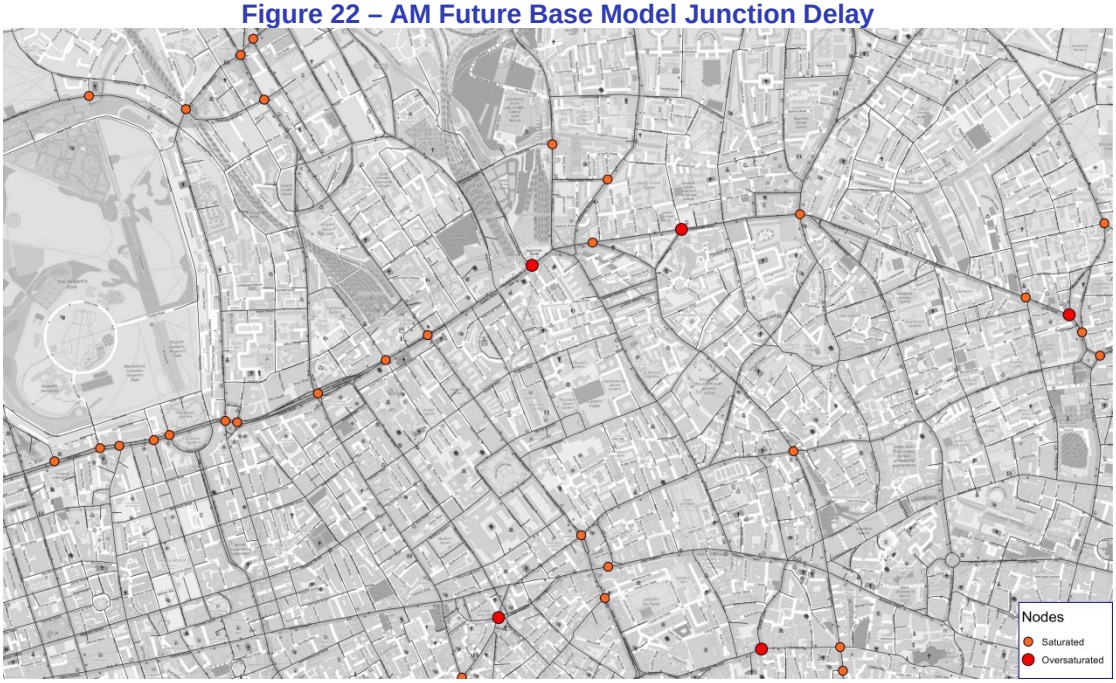


Figure 22 illustrates the junctions where a turn volume capacity ratio is greater than 85% in the AM Future Base model. Compared to the Base model it highlights a number of locations where congestion is predicted to increase, meaning throughput for a particular turn is approaching capacity. Locations include Euston Road and at the southern end of the WEP scheme.

Figure 23 – AM Future Closure Model Junction Delay

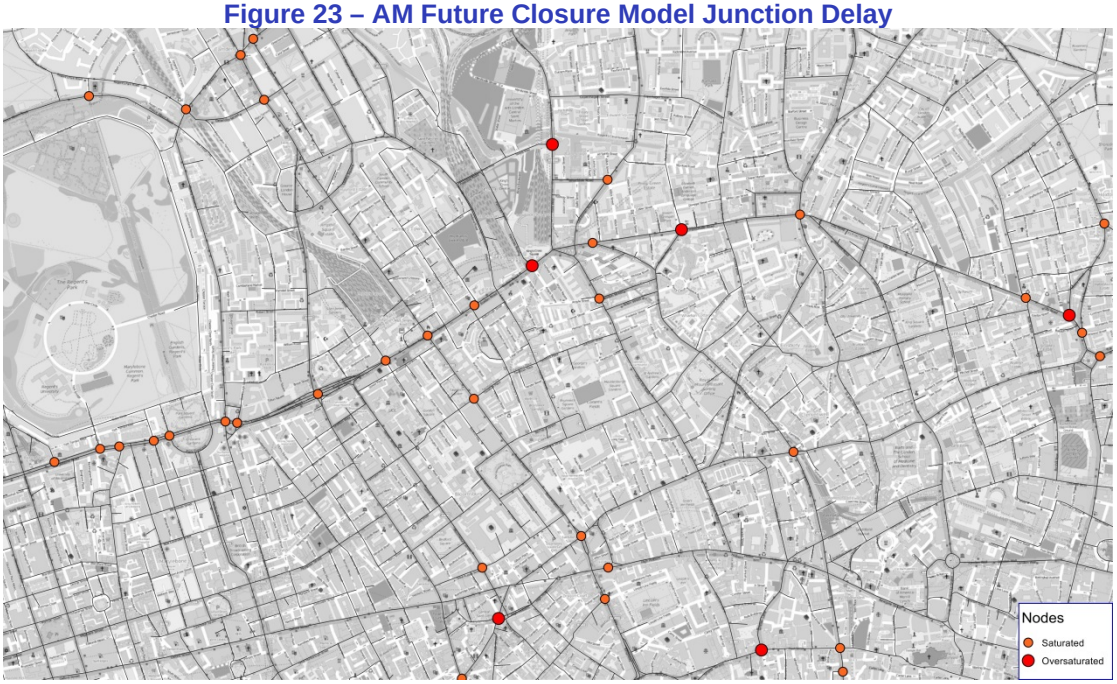


Figure 23 indicates the delay statistics for the AM Future Closure model. It highlights that junction congestion has increased in some locations as a results of increased throughput as vehicles find alternative routes westbound. Junctions where congestion is indicated to worsen are Gray's Inn Road / Swinton Street, Woburn Place / Tavistock Place, Euston Road / Ossulston Street. Some of these locations are along the alignment of the proposed closure, the modelling undertaken here did not account for the re-allocation of green time from closed arms to those that indicate higher flows, namely Woburn Place / Tavistock Place.

Figure 24 – PM Future Base Model Junction Delay

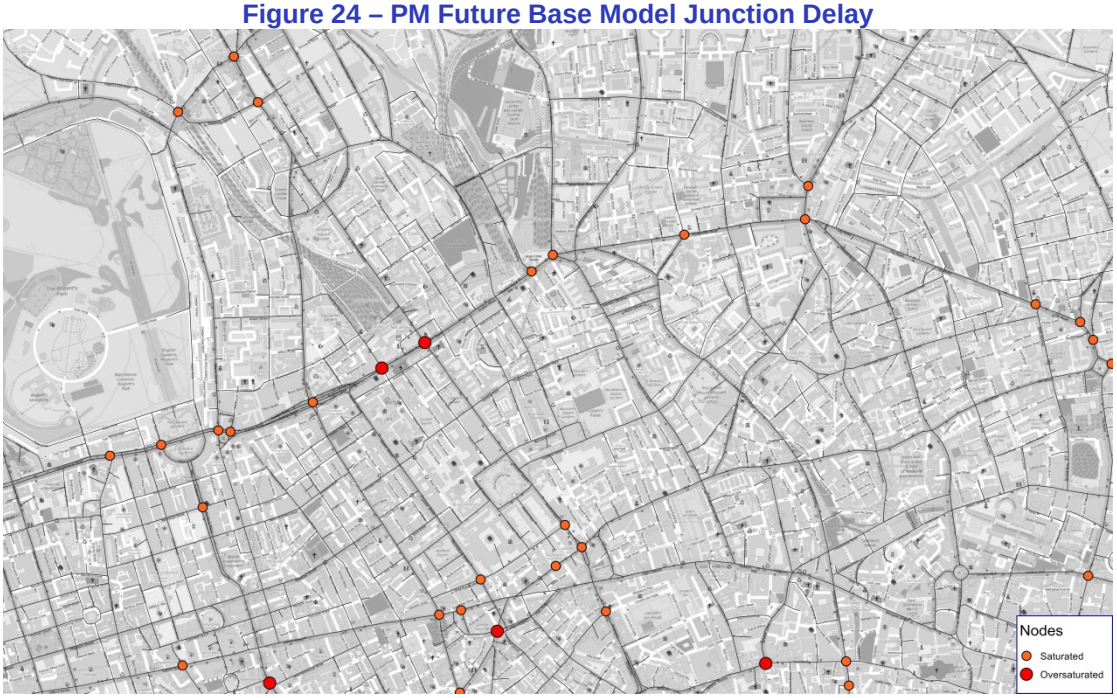


Figure 24 illustrates the junction delay information for the PM peak Future Model. It indicated existing congestion in the network along Euston Road and to the south of the WEP scheme and the southern section of Southampton Row.

Figure 25 – PM Future Closure Model Junction Delay

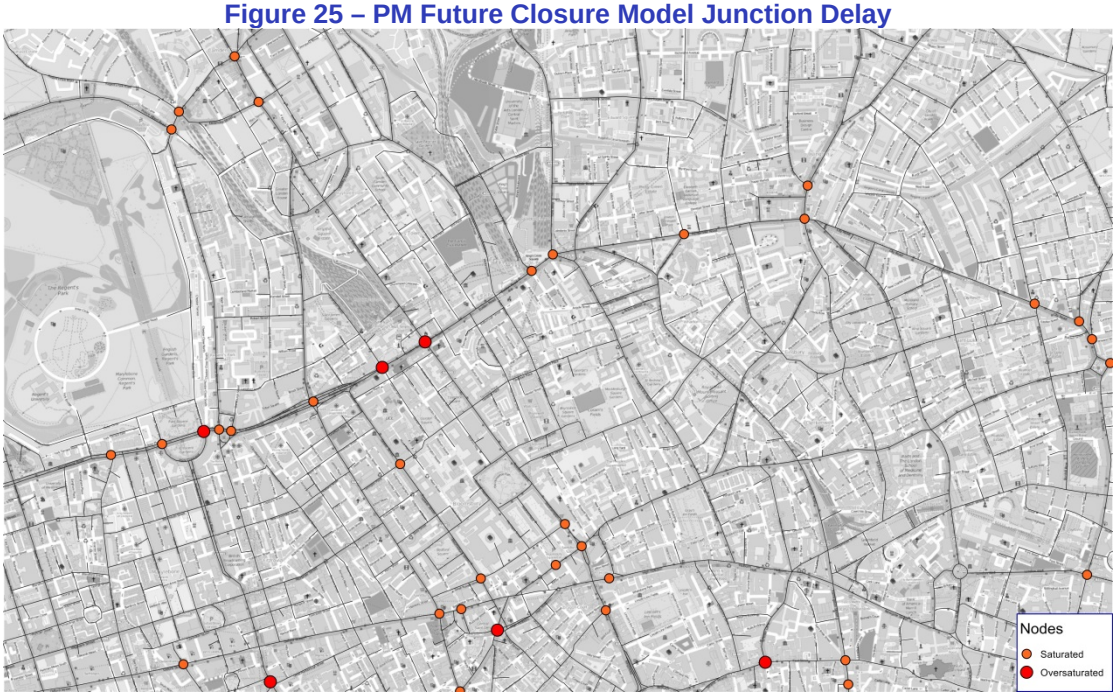


Figure 25 illustrates the junction delay information for the PM Future Closure model. It indicates that turn delays have not significantly changed in the area, the junction of Gower Street and Torrington Place is now approach capacity. This assessment did not make adjustments to green times at the effected junctions, therefore in reality this impact could be mitigated by providing Gower Street a higher proportion of green time.

6. Conclusions

The strategic assessment of westbound road closures between Judd Street and Gower Street has indicated flow reassignment to the Inner Ring Road. East to west reassignment is also showing to the south along High Holborn and Guilford Street. In the immediate vicinity of the closures traffic throughput decreases northbound along Gordon Street, reassigning to Tavistock Square northbound. In the southbound direction flows have increased along Gower Street.

The reassignment of trips is very similar when applying the closures to the Base network condition or the Future Base condition, including additional schemes. Junction delays are relatively static between the Base, Future Base and the Closure models.

The congestion assessment illustrates junctions where the ONE Model capacity is nearing saturation. If the suggested redistribution of traffic flow to Euston Road is sufficient to cause concern then further more detailed micro-simulation modelling should be undertaken in VISSIM.