3 Model Development - Networks

3.1 Highways

3.1.1 Model Version

The forecast year model reported in this document is part of an updated production version (v3.8) of TfL's London Highway Assignment Model (LoHAM). Using TfL's HamoC tool[9], a bespoke Kingston-centric version of the model has been produced for use in this study (KingHAM). The model supplied by TfL has a 2031 forecast year and represents the AM peak hour (08:00 – 09:00). This was developed by TfL from a 2012 base year version of KingHAM and considers the routeing of vehicles and the congestion on the core road network.

3.1.2 Model Network Updates and Assumptions

Network updates were required to adjust the TfL-supplied 2031 KingHAM network to a 2041 representative network, required for the forecasting scenarios. An update to definitions of generalised costs, representing updated 2041 values of time and distance for the individual user classes within the model, was supplied from a more recent 2041 HAM model[10]. TfL also supplied updated 2041 cycle demand for the assignment, and provided 2041 matrices to use in the forecasting.

Highway schemes completed since 2012 together with committed schemes[11] were then identified. These include the package of Go Cycle schemes, designed to encourage mode shift from car to more sustainable modes. These are listed in **Table 7**, and have been incorporated into the 2041 model.

Table 7: Summary of highway model changes

Scheme	2041
North Kingston Area Scheme	✓
Tolworth Broadway	✓
Surbiton Crescent Traffic Scheme	✓
Go Cycle: Station Plaza	✓
Go Cycle: Wheatfield Way	✓
Go Cycle: Portsmouth Road	✓
Go Cycle: Kingston to Surbiton	✓
Go Cycle: Surbiton to Tolworth	✓
Go Cycle: Kingston to New Malden	✓
Go Cycle: Kingston to Kingston Vale	✓

[9] HAMoC enables the creation of bespoke, local area models for LoHAM. The process reduces the model detail in non-essential areas to help manage model run times and provide a more proportionate model for studies within a specific local area.
[10] The Values of Time (PPM) and Values of Distance (PPK) were taken from the input files provided in TfL's North London Highway Assignment Model (NoLHAM) v3.8.
[11] 2012 is the original base year used to create the 2031 model. Therefore, schemes completed in the period 2012- present day, needed to be included in the model

In addition to these schemes, previous work completed by Arup as part of the KingHAM base year calibration and documented in the LMVR (issued to TfL on 7th July 2017) was included within the updated 2041 model.

All of the schemes identified above were subjected to a network review process to ensure that they were coded correctly based on the proposed specifications outlined in the supplied model scheme list.

3.1.3 Model Network Review

To review the new coding for the highway changes (**Table 7**), a series of checks were undertaken with Google Maps and Google Street View used as the main data sources to verify junction layouts (type, priorities, number of arms and lanes, turns), bus priority schemes, and link lengths associated with model changes.

A further review of the updates that were incorporated from the KingHAM base year calibration work was completed to ensure that these coding changes had been implemented correctly. Spot checks were completed at nodes updated as part of the calibration work to ensure the junction layouts had been correctly updated and that their geographical location (x, y coordinate)[12] were correct.

3.2 Public Transport

3.2.1 Model Version

The forecast year models reported in this document are part of TfL's Railplan public transport assignment model (v7.1), which is based in CUBE software. This was the latest version available at the time of this study.

3.2.2 Model Network Updates and Assumptions

Committed public transport schemes were contained within the networks supplied by TfL for the Railplan model. The schemes that were identified as having a potential strategic relevance to demand and network performance in and around Kingston borough are outlined in **Table 8**.

Table 8: Summary of supplied schemes in Railplan

Scheme	Included
South West London Line Enhanced Capacity	✓
Revised stock on South West providing 10-car on Main Line Suburban and Windsor Lines	✓
Thameslink KO2 – Victoria (South Central) services	✓
Crossrail 2 and associated NR changes	✓
4% frequency/capacity increased on London Buses	✓
Subsurface Partial Upgrade	✓
Subsurface Full Upgrade	✓

[12] 55 nodes with differing coordinates were identified both in the Kingston area and in the wider zones of the model. It was judged that for nodes within the Kingston area, the Arup-specified coordinates from the LMVR should be used to update the model, and for all other nodes, the TfL 2031 based coordinates should be retained. In total, the coordinates of 27 nodes were updated.

These schemes were reviewed to ensure that they were coded correctly based on the proposed specifications outlined in the model scheme list. The increases in frequency and capacity were analysed to ensure that assumptions were sensible.

In addition to these schemes, Kingston will be served by new rolling stock as part of the Waterloo and South West upgrade. The introduction of new Class 710 'Aventra' vehicles is set to replace the existing Class 455, Class 456 and Class 458 vehicles that currently operate on the network, and as well as having walk through carriages, they will provide a significant boost to standing capacity for peak suburban rail services, and improve crowding.

3.2.3 Model Network Review

As part of the model forecasting process, a review of the future year networks was undertaken. This included checking the relevant bus, rail and underground transit lines to ensure that routing, stopping patterns and coded frequencies were as expected. Transit line capacities (expressed as seated capacity per hour) and transit line frequencies (expressed as trains per hour) for each future year were also compared between each of the future year scenarios. This was a way of checking that any changes in frequencies or capacities on transit lines were sensible and would not invalidate the forecasting outputs.

Following this review, and accounting for all the changes made as part of the base year model validation, no additional changes were required to the network.

4 Model Outcomes/Results

4.1 Base year to 2041 Reference Case

This section compares the modelled base year to the 2041 reference case to analyse the forecast changes over a 30-year period. It is based on changes in population and employment growth forecast for the borough and the wider Greater London area, together with committed changes to the highway and public transport network.

4.1.1 Highways

Traffic Flows

Figure 5 shows morning peak hour (0800-0900) changes in modelled traffic volumes, where a red band represents a flow increase and a green bar a traffic decrease, with the width of the band proportional to the level of increase or decrease in traffic. Significant traffic growth is forecast on the strategic roads, primarily focused around the A3 westbound corridor between the junction with Coombe Lane, Tolworth junction, Hook junction and beyond (growth of between 800-1600 passenger car units or pcus[13]). Traffic flows also increase on the A3 eastbound between Tolworth and the A3 junction with Coombe Lane (400 and 800 pcus).

In general terms, the increases in traffic on the strategic road network, will result in additional congestion and consequential re-routeing of traffic onto local roads.

Minor flow reductions are forecast on other strategic routes including the A240 Surbiton Road and the A307 Richmond Road within Kingston town centre which are in the order of around 100 to 400 pcus. This decrease in flow is considered to be a consequence of increased highway demand as a result of road space reallocation resulting from the proposed Go Cycle schemes within Kingston town centre.

Other forecast flow changes include a change of between 400-800 pcus on certain routes including:

- A307 from Esher in the direction of Claremont Park and Cobham;
- A308 Upper Sunbury Road in the eastbound direction near Hampton railway station; and
- A3050 Hurst Road in the westbound direction from Hampton Court towards Walton-on-Thames.

[13] A Passenger Car Unit is a measure used to assess highway capacity for transport modelling. Different vehicles are assigned different values, according to the space they take up. A car has a value of 1; smaller vehicles will have lower values, and larger vehicles will have higher values.

Junction Delays

Figure 6 shows morning peak hour (0800-0900) changes in modelled delays at junctions across the network where a red circle represents a delay increase and a green circle a delay decrease, with the size of the circle proportional to the level of increase or decrease in delay.

Most of the forecast increase in junction delays within the Kingston borough are focused around the town centre and Hook junction on the A3. These areas also have the greatest concentration of employment and household growth in comparison to the base year. There are also significant delays forecast on strategic routes south of the A3 towards Ewell, Cheam and West Sutton.

In the town centre, delays are focused around the A307 junction with the A308 near Clarence Street with delays increasing by over 2 minutes when compared to base year levels. Delays are also forecast to increase by a similar magnitude at the A240 roundabout with the A307 south of the town centre.

At Hook junction, much of delay increases occur at entry arms to the roundabout from both the westbound (Hook Rise South) and the eastbound (Kingston bypass). There is also a considerable delay increase on the slip road from the A3 to Hook Rise South (westbound) and on the A243 near Gladstone Road.

South of the A3, junction delays are forecast to increase along several strategic routes including the A240, A2043 and A24. Delays on the A240 are forecast to increase by more than 2 minutes per vehicle (on average) at junctions with the B284 Ruxley Lane and Kingston Road near Stoneleigh Railway Station.

On the A2043, the junctions along the high street near Worcester Park are forecast to increase substantially with average delays per vehicle forecast to increase by over 2 minutes.

Network Stress

Figure 7 shows morning peak hour (0800-0900) changes in network stress, measured as the relationship between traffic flow and capacity (or volume over capacity – V/C) at junctions across the network. A red circle represents a V/C increase and a green circle a V/C decrease, with the size of the circle proportional to the level of increase or decrease in V/C.

Figure 5: Change in traffic flows - base year to 2041 reference case (AM peak)

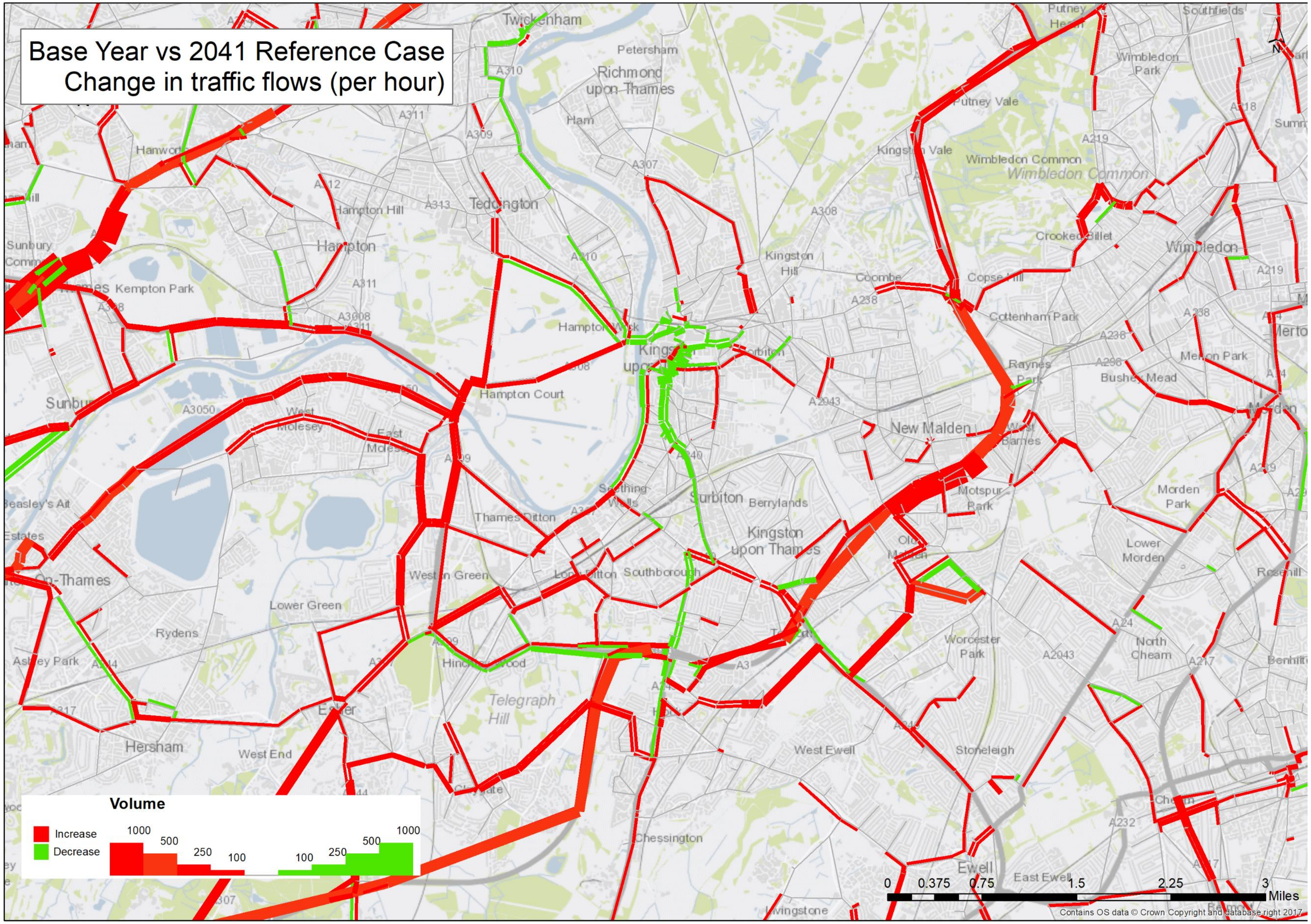


Figure 6: Change in junction delays - base year to 2041 reference case (AM peak)

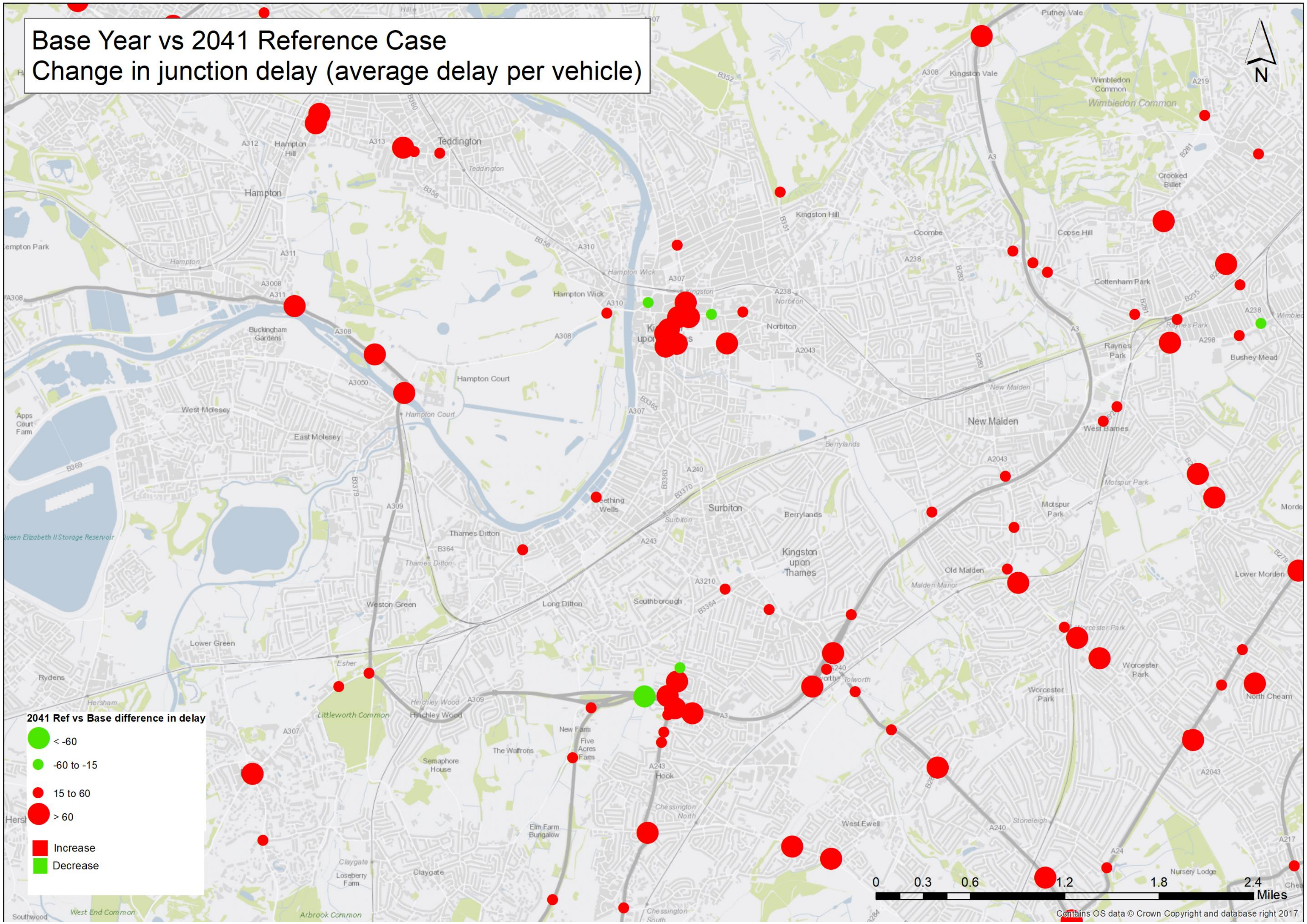
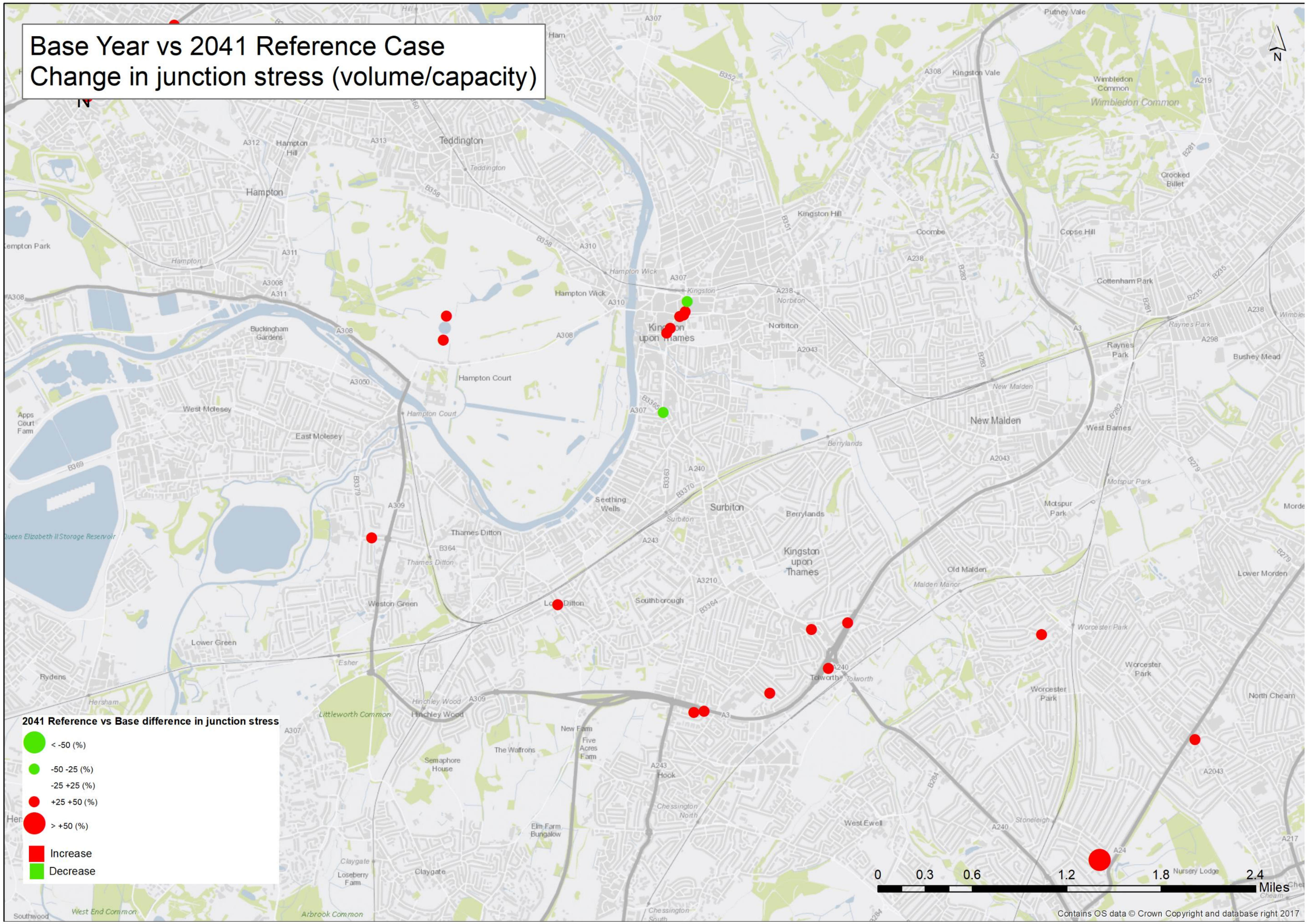


Figure 7: Change in junction stress - base year to 2041 reference case (AM peak)



4.1.2 Public Transport

Demand Flows (Rail)

Passenger flows on the South West Main Line (SWML) in the inbound direction are forecast to increase substantially between the base year and 2041 in the order of ~21,000 between Surbiton, Berrylands and New Malden and ~25,000 between New Malden, Raynes Park and Wimbledon. Flows are also forecast to increase substantially in the outbound direction in the order of ~12,000 although most of these trips are rail trips with destinations external to Kingston borough. On the Kingston loop line, flows are forecast to increase between ~1,500 and 2,000 through Kingston, Norbiton and New Malden. Flows also increased by a similar magnitude in the outbound direction.

Rail passengers on the branch to Epsom via Motspur Park are forecast to increase in the order of 3,500 to 4,000 in both directions between Wimbledon and Worcester Park.

The change in demand for rail between the 2011 base year and 2041 reference case for the morning peak period (0700-1000) is shown in **Figure 8**.

Demand Flows (Bus)

Bus flows are forecast to grow significantly on specific key corridors leading into Kingston town centre including:

- A308 (Kingston Hill) carrying routes 85 and K3;
- A307 (Richmond Road) carrying route 65; and
- A310 (Kingston Road) carrying routes 281 and 285.

Flow increases here are in the order of 500 to 1,000 passengers in the base year during the three-hour peak period, but are forecast to increase significantly (~1,000 to 2,000) within Kingston Town Centre, focused around the A307 and A308, which is partly due to the density of bus routes on this section of network.

The A240 (Surbiton Hill Road) which connects Kingston and Surbiton stations carries a high density of routes (65, 71, 281, 406, 418, 465, K2 and K3) and is also forecast to increase substantially. Flows increase between these two stations and the area around Chessington North station.

The change in demand for bus between the 2011 base year and 2041 reference case for the morning peak period (0700-1000) is shown in **Figure 9**.

Figure 8: Change in rail passenger volumes - base year 2041 reference case (AM peak period)

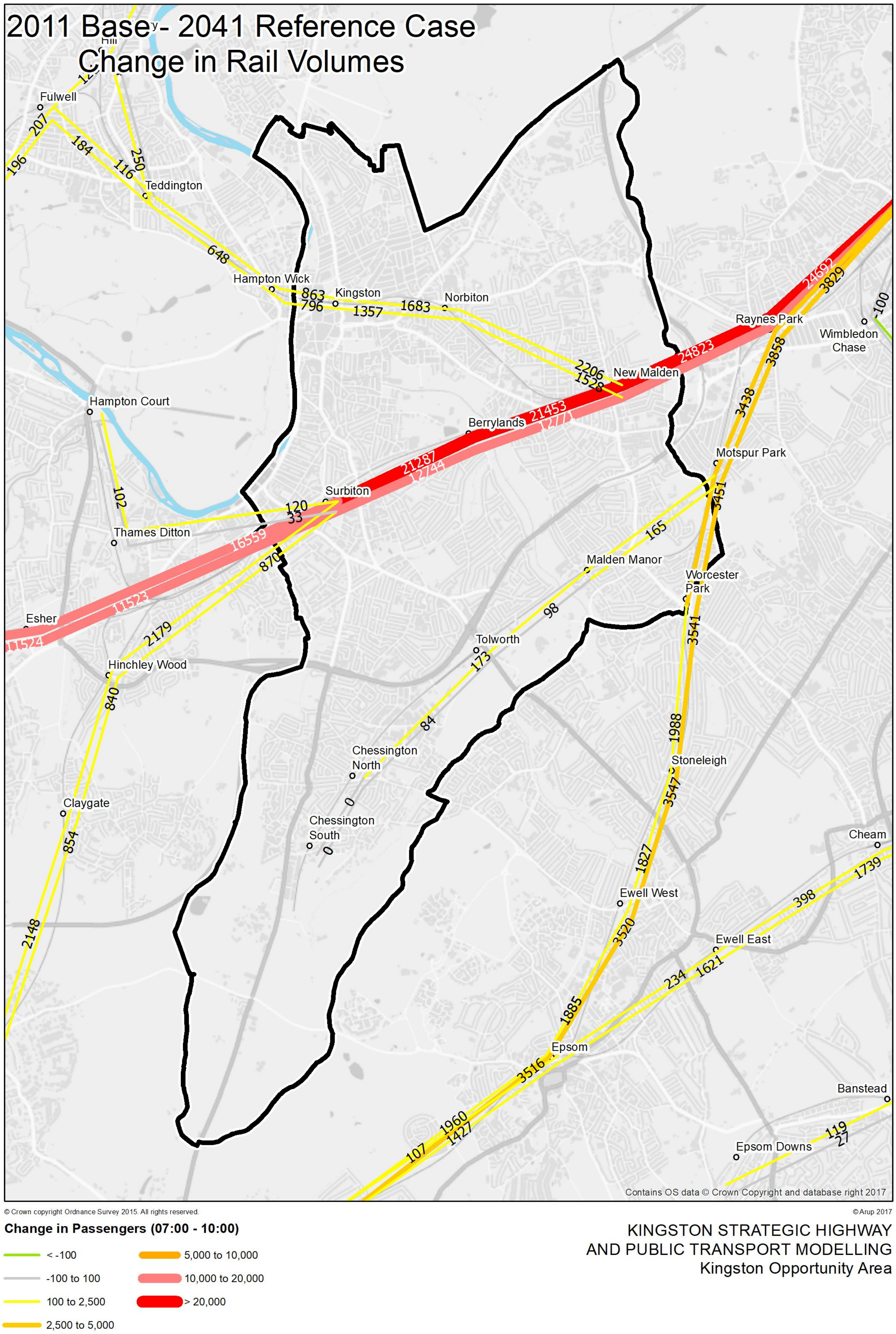
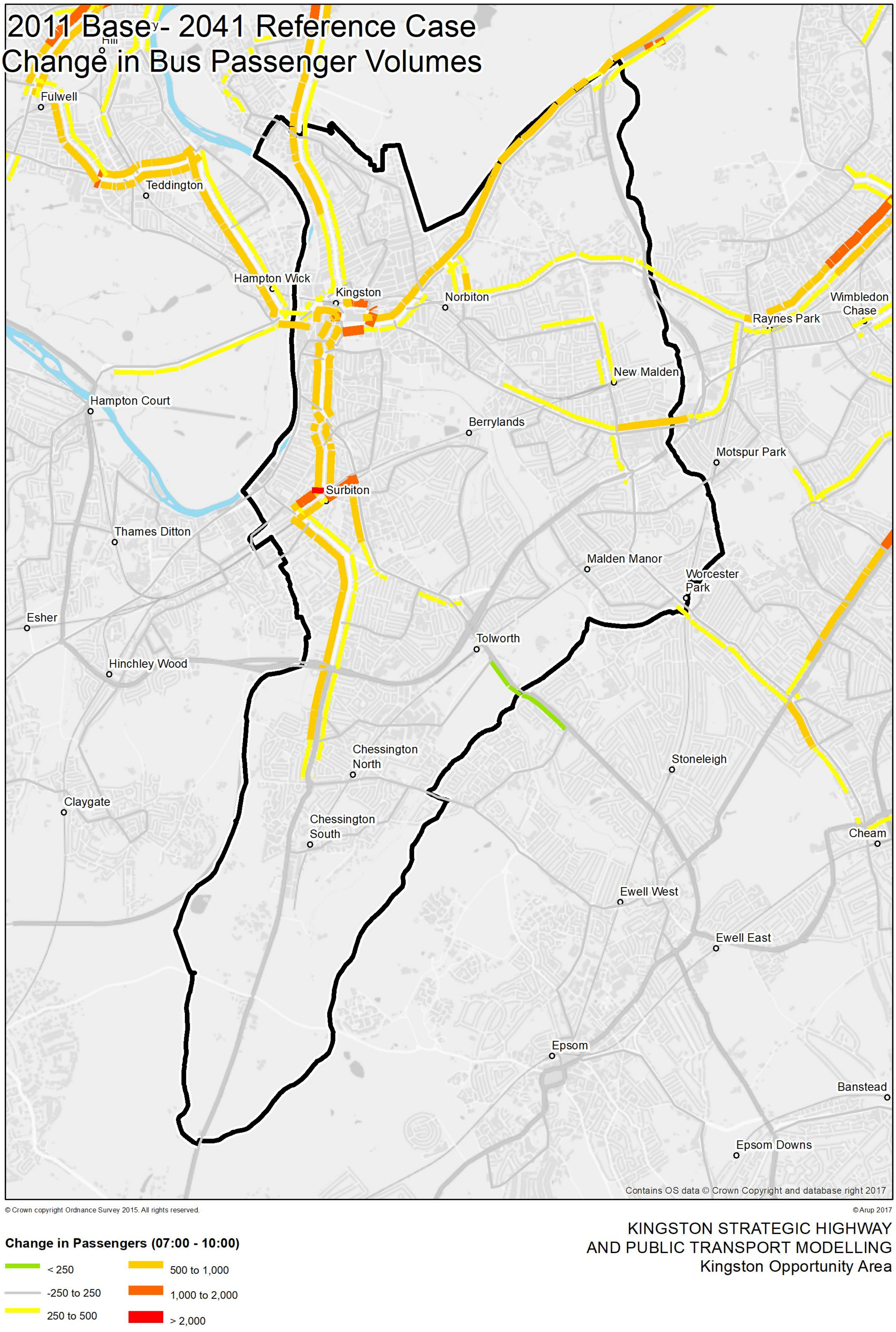


Figure 9: Change in bus passenger volumes - base year to 2041 reference case (AM peak period)



Station Entries and Exits

The changes in forecast employment and homes between 2011 and 2041 are likely to have an impact on station loading within the study area, particularly for:

- Station entries at Kingston - forecast to increase by 36% over the 30-year period from 2,330 to 3,160 while station exits at Kingston are forecast to increase by 41%;
- Norbiton entries - forecast to increase by 63% and exits decrease by 51%; and
- Surbiton entries - on the South West Main Line are forecast to increase dramatically by 50% representing a growth of ~4,000 passengers over the three-hour period.

The change in station entries and exits between the 2011 base year and the 2041 reference case scenario is set out in **Table 9** below. Only the busiest stations with significant volume changes have been included.

Table 9: Station entries and exits – base year to 2041 reference case (AM peak period)

Entries	2011	2041	Change (%)
Kingston	2,330	3,190	37
Norbiton	890	1,450	63%
Chessington North	1,190	1,370	15%
Surbiton	6,670	10,190	53%
Raynes Park	3,160	4,540	44%
Hampton Court	890	990	11%
Exits	**2011**	**2041**	**Change (%)**
Kingston	1,390	1,990	43%
Norbiton	390	590	51%
Surbiton	3,320	4,720	42%
Raynes Park	1,510	2,150	42%

Crowding

The level of crowding[14] on trains is defined as the number of people standing per square metre of available standing space (PPMS). TfL generally groups this into bands, starting at less than 1 PPMS (generally considered to be uncrowded) to more than 4 PPMS (maximal); at this level of crowding passengers will have difficulty boarding trains with knock on operational impacts due to increased train dwell time at stations. For this assessment, we have also included a more than 5 PPMS category which can be considered ‘crush’ loading. **Figure 10** and **Figure 11** represent what these two levels of crowding look like with respect to passengers onboard and standing at the platform[15]. 4 PPMS has very crowded standing room only conditions onboard the train and with a small number of people unable or choosing not to board.

[14] Crowding can be defined as <1 PPMS – some standing, 1-2 PPMS – busy, 2-3 PPMS – crowded, 3-4 PPMS – very crowded and >4 PPMS – maximal.
[15] These pictures are of LUL stock and are for illustrative purposes only, rail rolling stock will differ from this

7 PPMS has severely crowded conditions onboard the train with no additional space and a severe equivalent number of people on the platform unable to board the service.

Figure 10: Four PPMS crowding level

Figure 11: Seven PPMS crowding level

In the network around Kingston, the 2011 base year and the 2041 reference case, crowding on rail through Kingston and Norbiton stations changes less than 1 PPMS to 1-2 PPMS in 2041.

Crowding on the South West Main Line between destinations outside of the study area and Clapham Junction increases dramatically over the 30-year period from an average of 2-3 PPMS in 2011 to an average of 4-5 PPMS in 2041.

The branch from Epsom via Motspur Park is also overcrowded in the 2041 reference case scenario although there is a minimal change in crowding conditions over the 30-year period. Worcester Park to Raynes Park and Wimbledon has an average of 3-4 PPMS in both the base year scenario and the 2041 reference case. This suggests that whilst conditions are already crowded, they do not materially worsen over the 30-year period, which could be due to several factors, including:

- Small forecast increase in flows which has minimal impact on overall crowding;
- Capacity improvements to suburban services on the South West Network with new rolling stock providing more standing space during peak hours; and
- Passengers seeking alternative, less crowded routes into Central London.

The crowding conditions on the rail and underground network within the borough and surrounding area in the 2011 base year are shown in **Figure 12**. The crowding conditions in the 2041 reference case scenario are shown in **Figure 13**. They both represent morning peak hour conditions.

Figure 12: Crowding on rail - base year (AM peak)

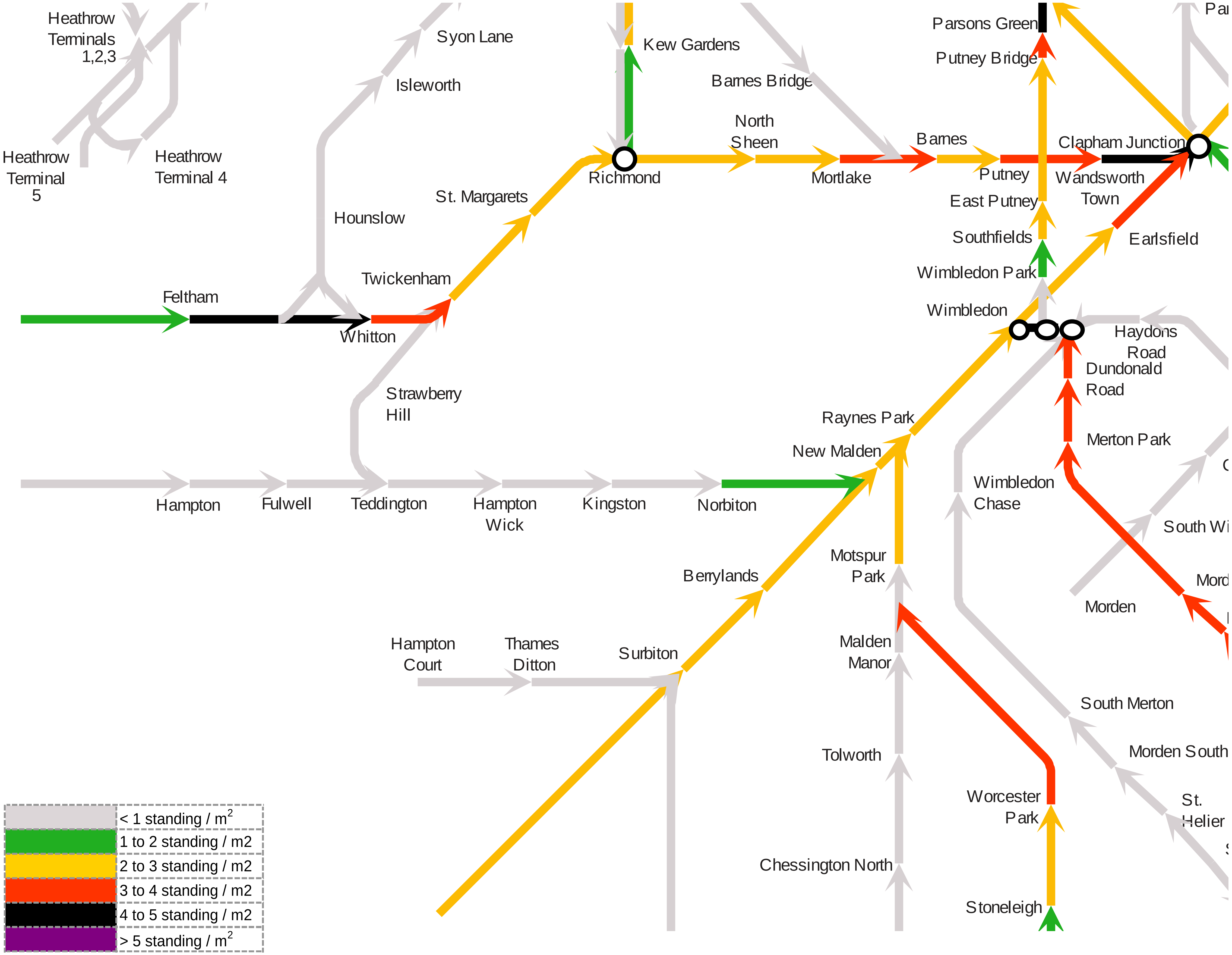
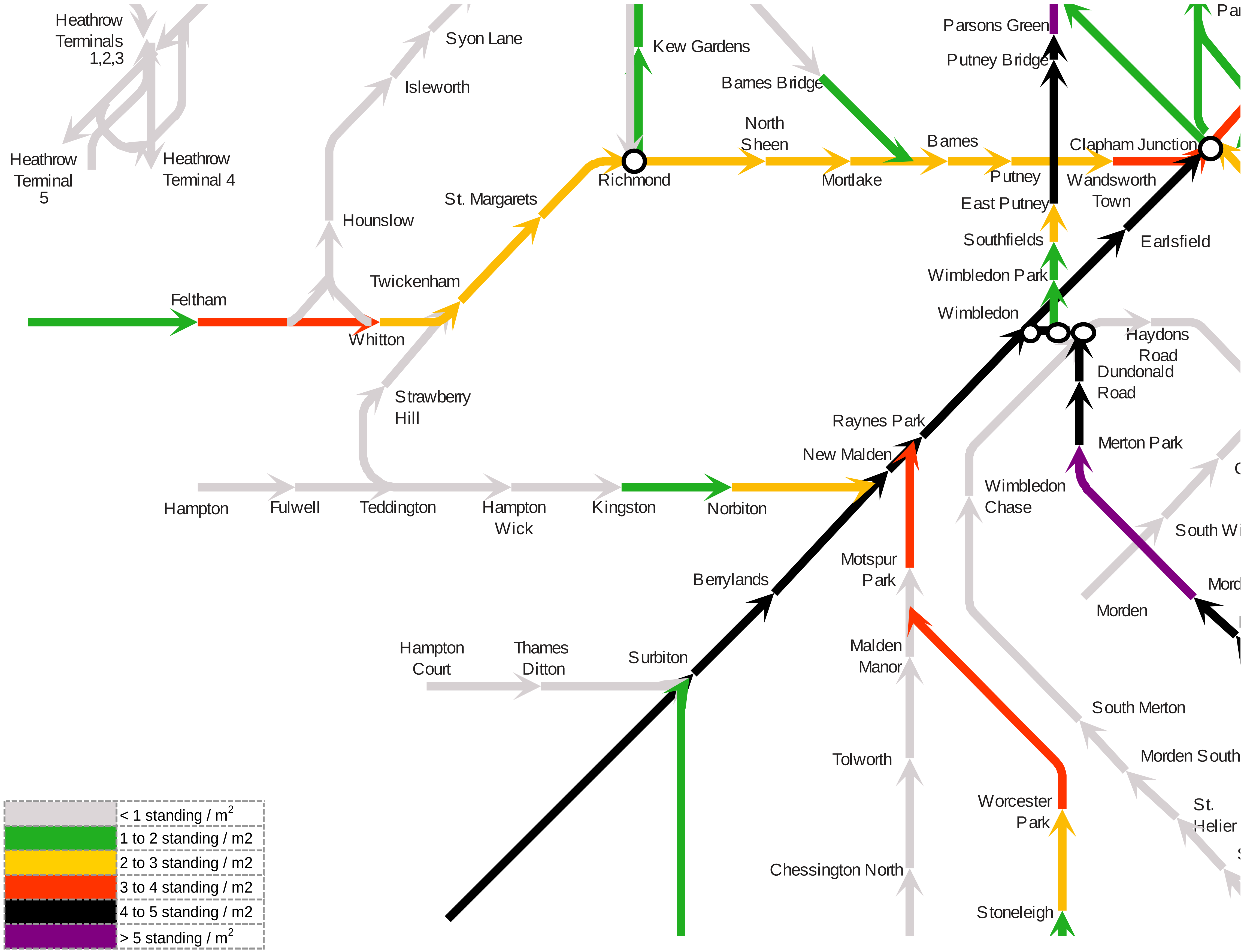


Figure 13: Crowding on rail - 2041 reference case (AM peak)



4.2 2041 Reference Case to 2041 Medium Growth

This section compares the 2041 reference case scenario with a 2041 scenario that assumes a medium level of growth in additional jobs and homes as part of the Kingston opportunity area.

4.2.1 Highways

Traffic Flows

Figure 14 shows morning peak hour (0800-0900) changes in forecast traffic volumes. The additional growth in homes and jobs associated with the medium growth scenario is forecast to have a marginal impact on traffic flows, with most of the substantial pressures on the network occurring due to growth between the base year and the 2041 reference case. There were no highway links found to have increase of flows greater than 100-200 pcus in this comparison.

Changes in flows due to the additional employment and household growth is predominantly focused around areas east of Kingston town centre in Norbiton and New Malden. The key increases include:

- A3 (eastbound) between Tolworth junction and the junction with the A308 in Kingston Vale;
- A240 Ewell Road southbound between the junction with Beaufort road and the A3 junction at Tolworth;
- A308 westbound towards Kingston town centre from the junction with the A3 at Kingston Vale; and
- A307 northbound towards Kingston town centre from the junction with the A243 near Surbiton station.

Traffic flows on areas of the highway network around New Malden are also forecast to increase, particularly along the B282 and Malden Road in both directions leading from the junctions with the A3.

Within Kingston town centre itself, an increase in traffic on the A2043 inbound towards the town centre is forecast, while other impacts occur within the vicinity of the Fairfield South and A307 junction near the recreation ground.

There are some minor decreases in flows on certain parts of the network (between 50 to 100 pcus); however, it is likely that the majority of these will simply be re-assignment within the highway model.

Junction Delays

Figure 15 shows morning peak hour (0800-0900) changes in modelled delays at junctions across the network, where a red circle represents a delay increase and a green circle a delay decrease, with the size of the circle proportional to the level of increase or decrease in delay.

Junction delay at certain strategic junctions are forecast to increase due to the additional growth, particularly within Kingston town centre and along the A3 within the vicinity of most of the additional homes and jobs.

Delays at the B282 and Malden Road junctions with the A3 are forecast to increase between 1 and 2 minutes due to additional trips in the New Malden area and increased traffic towards Kingston town centre. Other junctions with a similar level of change include the A243 junction with the A307 near Surbiton railway station, and the A309 junction with the B3379 and A3050 at Hampton Court railway station.

In Kingston town centre, the largest delay increases (> 2 minutes) include:

- Villiers Road and Fairfield South/Hawks Road junction (town centre east);
- A307 junction with Orchard Road/Fairfield South; and
- A307 junction with the A240 Penrhyn Road near Kingston College.

Other delay increases also occur on the inner ring road where the A307 and A308 meet near Clarence Street, although these are smaller (1 to 2 minutes).

There are minor increases in delay on the entry arms of the A3 Hook roundabout in both directions (45-seconds to 1 minute). There are no substantial changes in delays forecast for the A3 Tolworth junction.

Network Stress

Figure 16 shows morning peak hour (0800-0900) changes in network stress (or V/C) at junctions across the network. A red circle represents a V/C increase and a green circle a V/C decrease, with the size of the circle proportional to the level of increase or decrease in V/C.

The distribution of junctions with significant increases in junction saturation was found to be broadly similar to that of junction delays. The following junctions all experience an increase of 25-50%, and operate at between 85-100% capacity:

- A3 junction with South Lane;
- A3 junction with Coombe Lane; and
- Junction of Moor Lane/ Bridge Road, near Chessington North station.

Other smaller changes were focused around the B282 and Malden Road junction near Motspur Park connecting into both junctions on the A3. V/C ratios at the B282/Malden Road junction increased by 10-25% and operate at 70-85% in the 2041 medium OA scenario. Other junctions along the B282 and B283 are also forecast to see an increase in saturation because of capacity constraints.

As many of the junctions within Kingston town centre, Tolworth and Hook are already significantly over-saturated in the 2041 reference case scenario, the additional growth added as part of the medium OA assumption is forecast to have minimal impact on junction stress. This is likely because of the additional traffic avoiding these areas and instead seeking alternative, less-congested routes that are likely to have fewer junction delays.

Figure 14: Change in traffic flows - 2041 reference case to 2041 medium OA growth (AM peak)

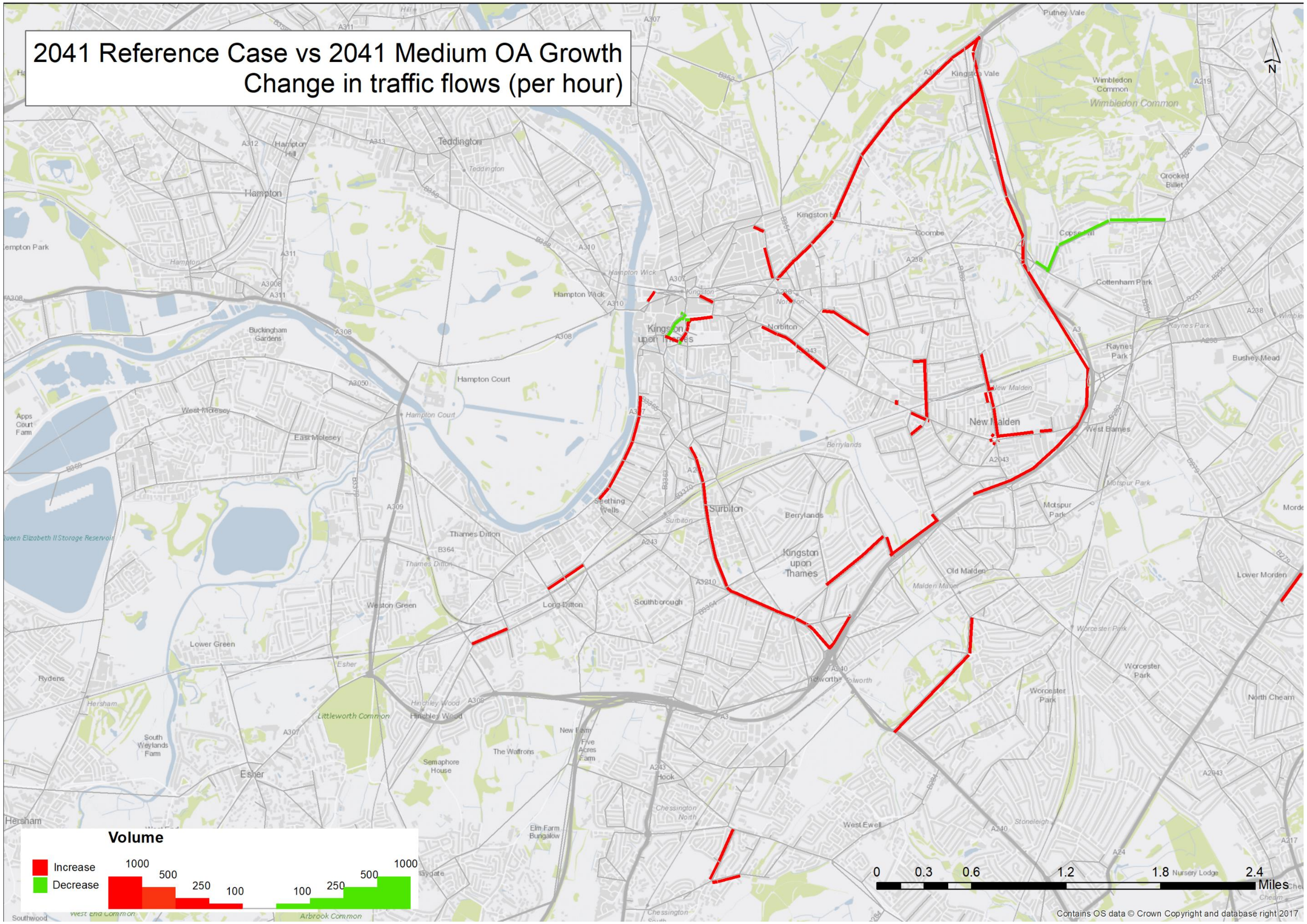


Figure 15: Change in junction delay - 2041 reference case to 2041 medium OA growth (AM peak)

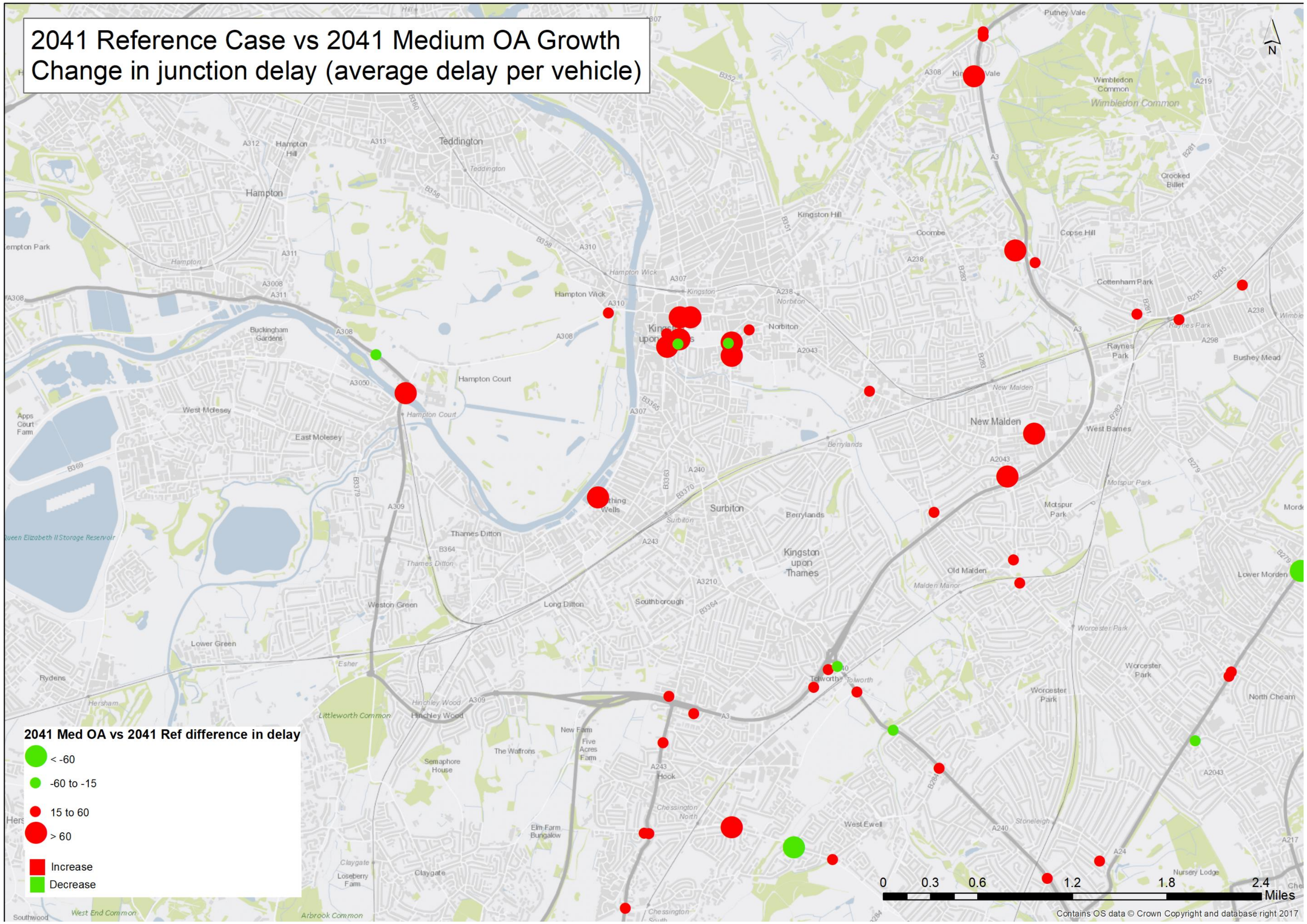
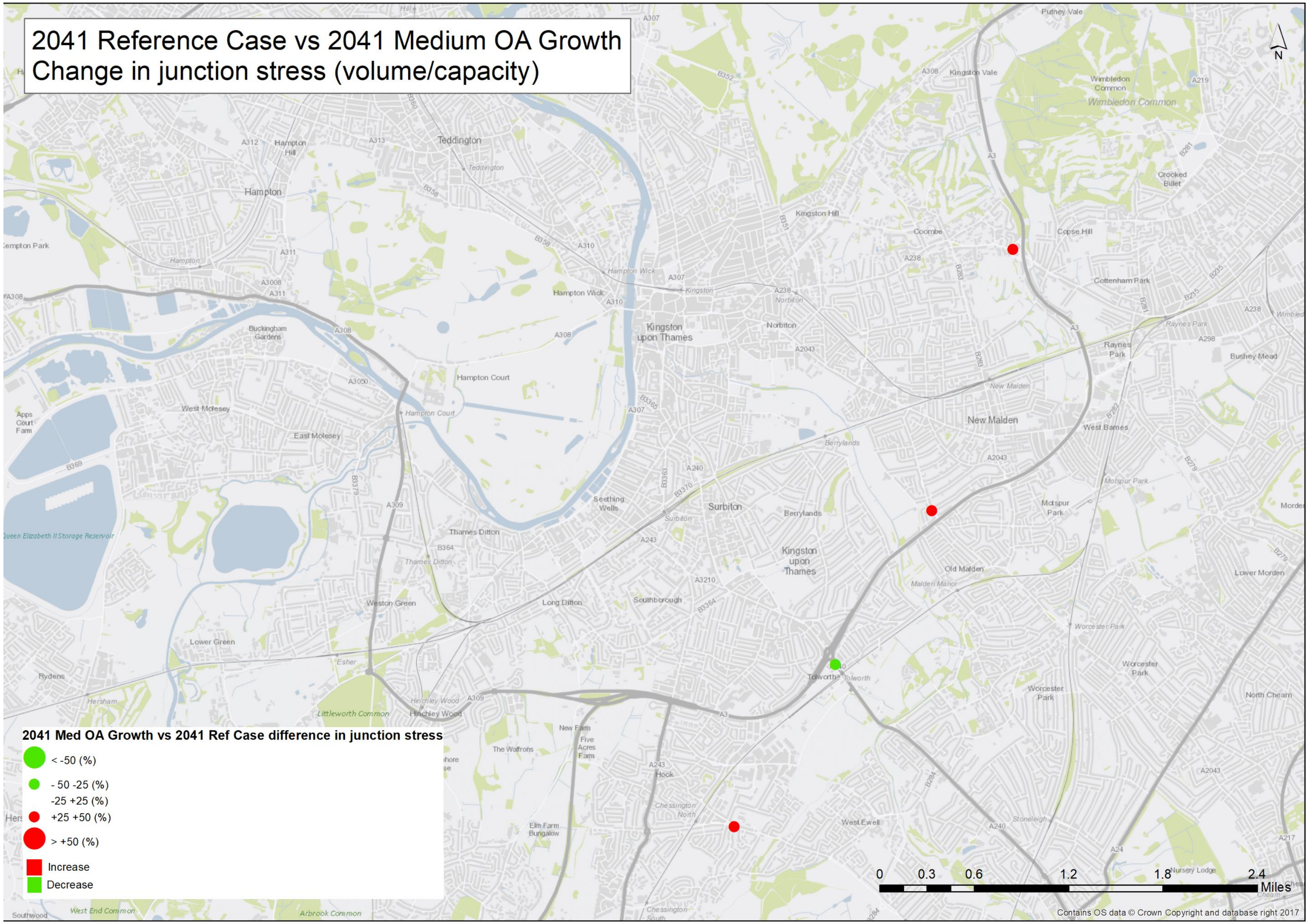


Figure 16: Change in junction stress - 2041 reference case to 2041 medium OA growth (AM peak)



4.2.2 Public Transport

Demand Flows (Rail)

The change in demand on rail between the 2041 reference case and the 2041 medium OA growth scenario is shown in **Figure 17**.

This indicates that there are relatively minor changes to network demand with much of the increases to rail flows in the opposite direction to the morning peak direction of flow. This is likely to be mostly driven by a forecast increase in local employment opportunities within the borough. Flows increase between Raynes Park and New Malden by ~1,500 and New Malden and Norbiton by ~1,000. Kingston to Norbiton has a flow increase of ~700. The change in demand beyond Kingston station is very low, suggesting that most of the demand increases are driven by travel to and from Kingston rather than through trips.

In the peak direction, flows are forecast to increase marginally by around 100 from Norbiton to New Malden but by over 1,000 from New Malden to Raynes Park and beyond.

Demand Flows (Bus)

The change in demand for bus between the 2041 reference case and the 2041 medium OA growth scenario is shown in **Figure 18**. Bus demand in the OA growth scenario is forecast to increase on similar routes to that of the 2011 base comparison, although the changes are significantly lower.

Bus passengers using routes along the A240 (Surbiton Hill Road) are forecast to increase by ~500 to 1,000 between Surbiton and Kingston stations. This is partly due to more rail passengers exiting at Surbiton station because of increased homes and jobs in the area. This corridor is an area of the network that could see further pressure in future years. Routes 65, 71, 281, 406, 418, K2 and K3 all operate along this stretch at varying frequencies.

In addition, bus passenger demand is forecast to increase on routes long the A308 (Kingston Hill) by around the same magnitude as Surbiton Hill Road, although the extent of this increase is confined to the stretch between the town centre and Kingston Hospital.

Bus passenger flows on A310 Kingston Road see minimal changes between the two scenarios, as does the A307 Richmond Road.

These patterns suggest that most of the bus demand growth within the borough is related to local trips into areas of the town centre and are focused less around connectivity to key rail stations.

Figure 17: Change in rail passenger volumes - 2041 reference case to 2041 medium OA growth (AM peak period)

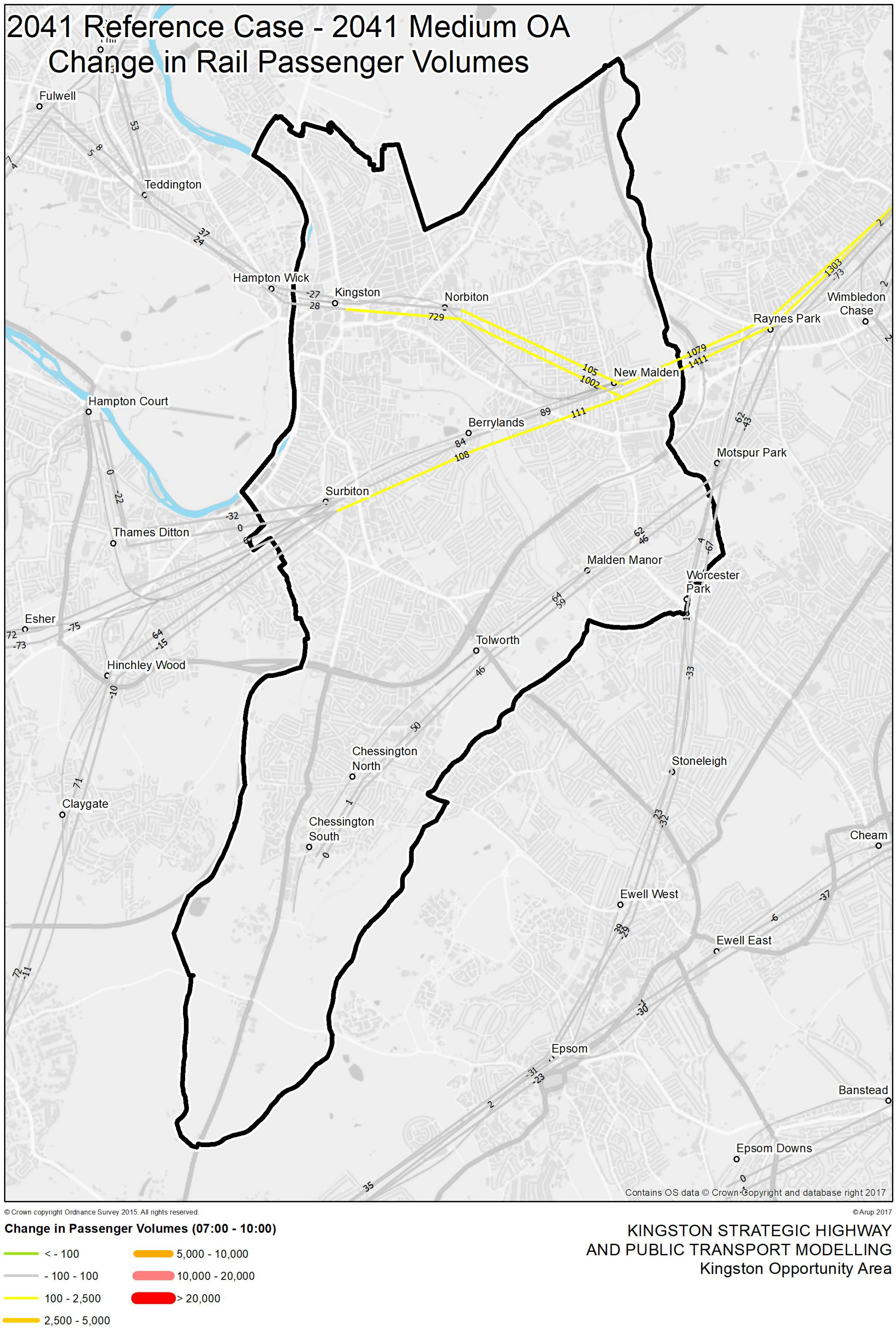
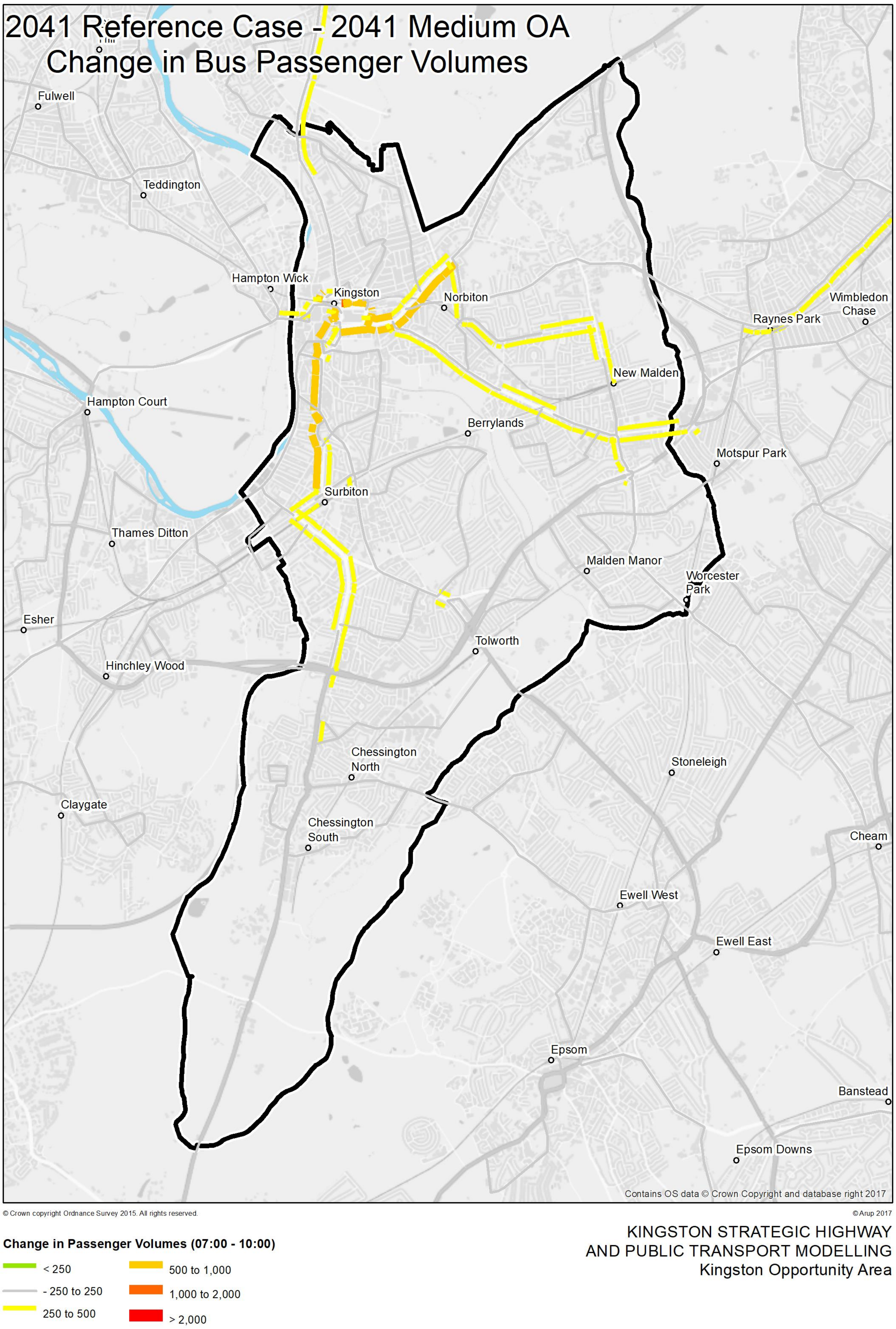


Figure 18: Change in bus passenger volumes - 2041 reference case to 2041 medium OA growth (AM peak period)



Station Entries and Exits

The increase in employment and households forecast in the medium OA growth scenario is forecast to have a marginal effect on the entries and exits at rail stations within the borough and surrounding area. Highlight changes from the 2041 reference case are:

- Increase in entries at Kingston of 3% and Norbiton of 11%; and
- Increase in exits at Kingston of 38% and Norbiton of 54%.

The change in station entries and exits between the 2041 reference case scenario and the 2041 Medium OA growth scenario is included in **Table 10** below. Stations with no significant volumes or change have been omitted.

Table 10: Station entries and exits - 2041 reference case to 2041 medium OA growth (AM peak period)

Entries	2041 Ref	2041 Med	Change (%)
Kingston	3,190	3,270	3%
Norbiton	1,450	1,610	11%
Chessington North	1,370	1,410	3%
Surbiton	10,190	10,410	2%
Hampton Court	990	960	-3%
Exits	**2041 Ref**	**2041 Med**	**Change (%)**
Kingston	1,990	2,750	38%
Norbiton	590	910	54%
Surbiton	4,720	5,160	9%

Crowding

Despite the changes in station entries and exits at key stations within the borough, the additional demand on the network between the 2041 reference case and medium OA growth scenario is not forecast to exacerbate crowding conditions. The crowding plots show no material change in the PPMS levels between these scenarios although it should be noted that saturation levels are likely to have changed marginally within the crowding bands shown. The results highlight that most of the network constraints and over-saturation of rail links arise due to the passenger growth forecast between the 2011 base year and 2041 reference case.

4.3 2041 Medium Growth to 2041 Medium Growth with Crossrail 2

This section highlights the changes in transport conditions between the medium OA scenario with and without the proposed Crossrail 2 scheme. Crossrail 2 will connect South West London to North East London via new tunnels constructed under Central London through Chelsea, Victoria, Euston and Dalston. Around Kingston and the south west, Crossrail 2 will follow existing rail alignments with an all-station 'metro-style' stopping pattern. Further information on the proposed Crossrail 2 scheme is included in section 1.4.

4.3.1 Highways

Traffic Flows

Figure 19 shows morning peak hour (0800-0900) changes in modelled traffic volumes between the 2041 medium growth scenario with and without Crossrail 2. The addition of Crossrail 2 is forecast to have a minimal impact on overall traffic flows.

Reductions of around 50-100 pcus are forecast on the A3 inbound towards Central London from the Tolworth junction onwards. This could result from a number of highway trips being replaced by public transport due to the attractiveness of the 'new' frequent and direct Crossrail services.

There is also a forecast decrease in flows on the A307 between the junction with the Kingston bypass and Surbiton station. This decrease in flow can, in part, be explained by a decrease in traffic between Hinchley Wood and Surbiton stations wanting to travel to Surbiton and Kingston town centres, and instead, opting to use Crossrail 2 to complete a portion or all their journey.

There are some increases in highway flows forecast (100-200pcus), but these are mainly on short stretches of network on strategic routes that feed into Crossrail 2 stations. Increased highway flows on Coombe Lane West, for example, could result from individuals connecting into Raynes Park, which will have an increased peak frequency into Central London with Crossrail 2. Similarly, increased flows around Surbiton and Chessington North are likely to be because of an increased pull from the new Crossrail services.

Junction Delays

Figure 20 shows morning peak hour (0800-0900) changes in modelled delays at junctions across the network, where a red circle represents a delay increase and a green circle a delay decrease, with the size of the circle proportional to the level of increase or decrease in delay.

Due to the relatively low change in highway flows, junction delay changes are forecast to be minimal between the Crossrail 2 scenarios. An increase of flow of 30 seconds to 1 minute is forecast within Kingston Town centre around the A307 junction with Orchard Road, which can be linked to the increase in homes and jobs in the area.

Network Stress

Figure 21 shows morning peak hour (0800-0900) changes in network stress (or V/C) at junctions across the network. A red circle represents a V/C increase and a green circle a V/C decrease, with the size of the circle proportional to the level of increase or decrease in V/C.

The distribution of junctions with significant increases in junction saturation was found to be broadly similar to that of junction delays. Key locations that experience junction saturation increasing by 25-50%, and operating at between 85-100% capacity include:

- A3 junction with South Lane;
- A3 junction with Coombe Lane; and
- The junction of Moor Lane and Bridge Road near Chessington North railway station.

Other smaller changes were focused around the B282 and Malden Road junction near Motspur Park connecting into both junctions on the A3. The B282/Malden Road junction increased by 10-25% between the scenarios to operate at 70-85% in the 2041 medium OA scenario. Other junctions along the B282 and B283 also see an increase in saturation due to capacity constraints.

As many of the junctions within Kingston town centre, Tolworth and Hook are already significantly over-saturated in the 2041 reference case scenario, the additional growth added as part of the medium OA assumption with Crossrail 2 is shown to have minimal impact on junction stress. This is likely to be because of the additional traffic avoiding these areas and instead seeking alternative, less-congested routes that are likely to have fewer junction delays.

Figure 19: Change in highway traffic flows – 2041 Medium OA with and without CR2 (AM peak)

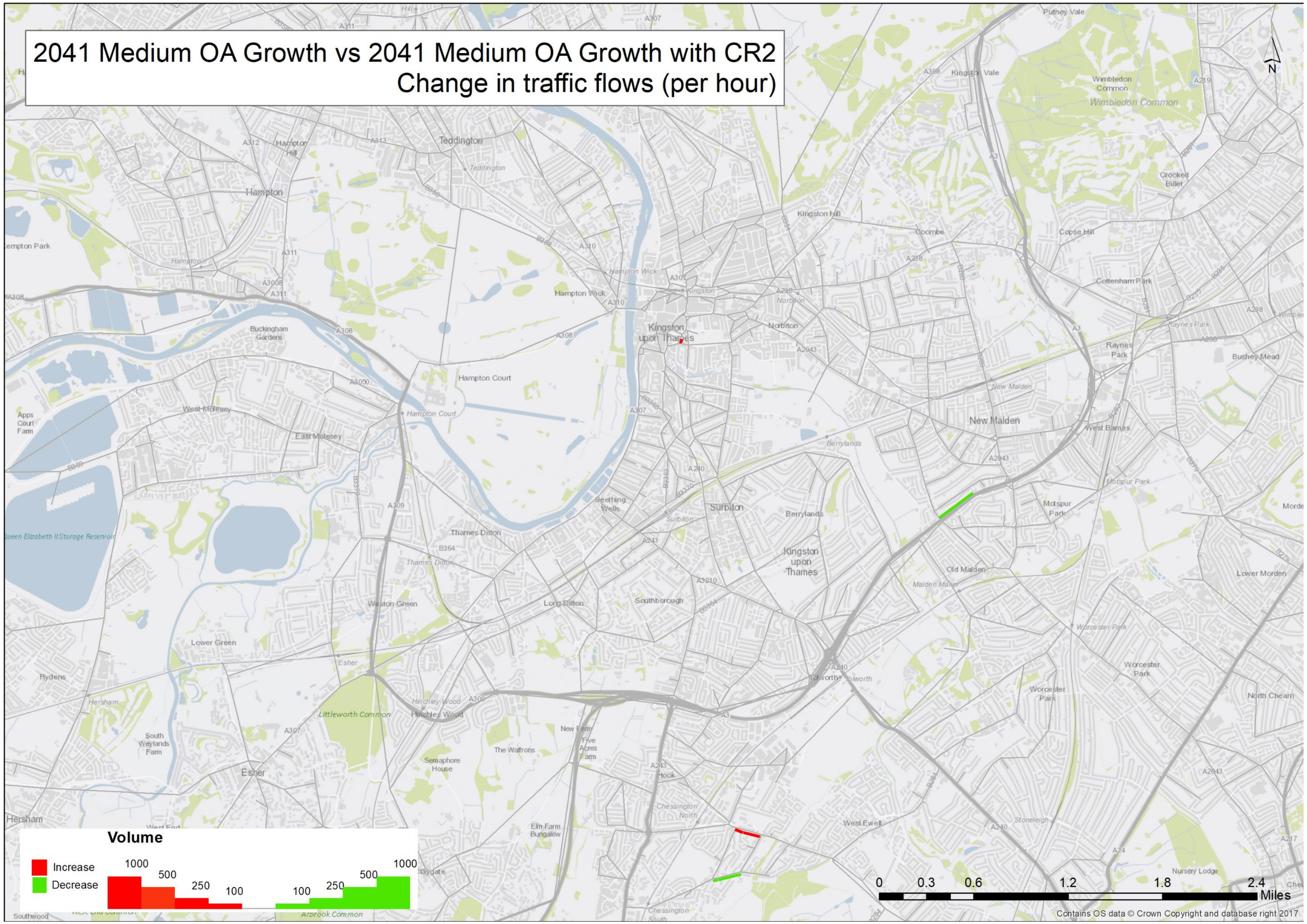


Figure 20: Change in highway junction delay – 2041 Medium OA with and without CR2 (AM peak)

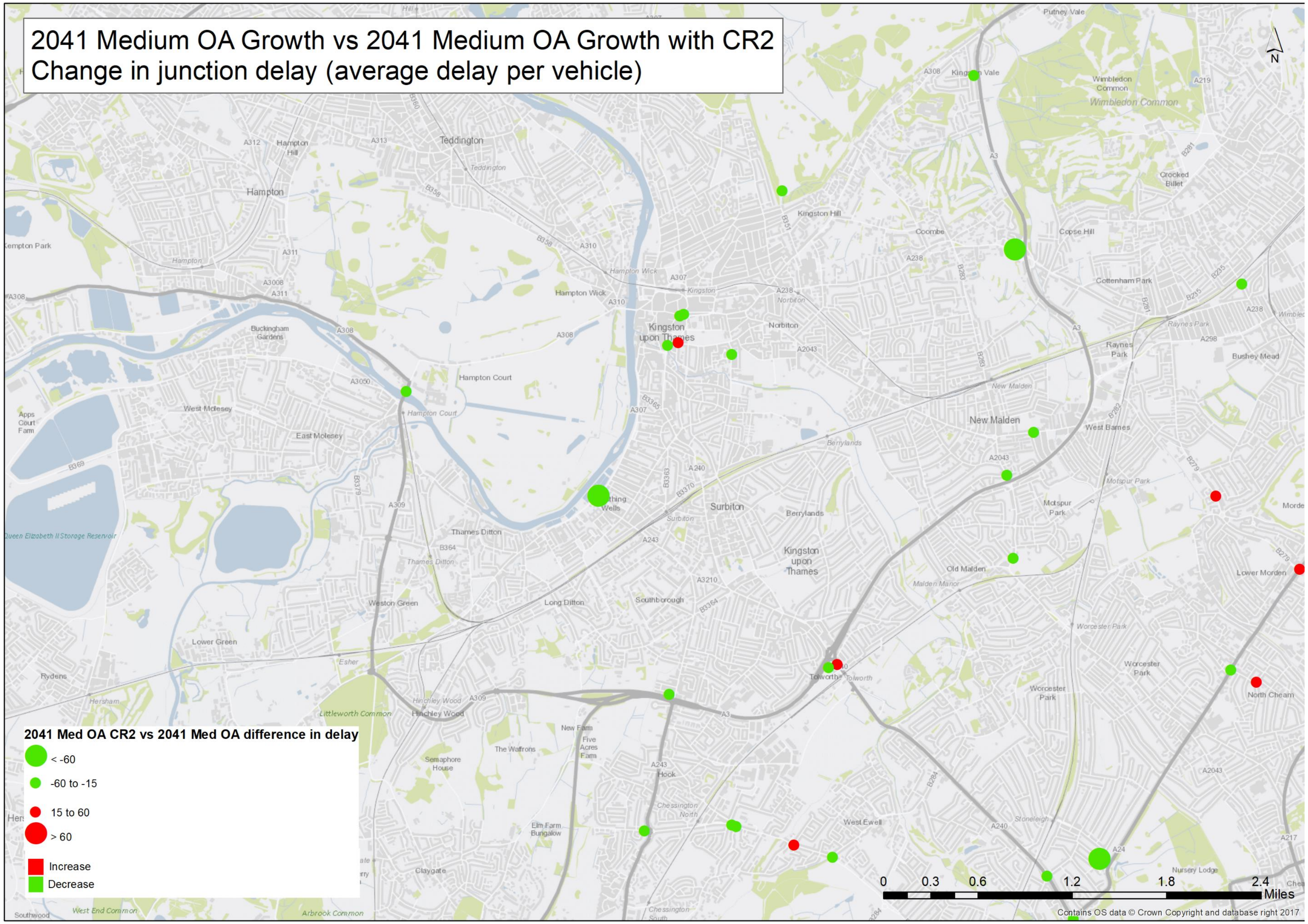


Figure 21: Change in highway junction stress - 2041 Medium OA with and without CR2 (AM peak)

4.3.2 Public Transport

Demand Flows (Rail)

The addition of Crossrail 2 from 2041 is forecast to have a substantial impact on rail passenger demand on the network. This is due to significant increase in rail service frequency and capacity that the new metro-style services could deliver.

Inbound flows towards central London from Kingston via Norbiton increase by ~8,000, and by more than ~15,000 between New Malden and Wimbledon where the branches from Chessington, Epsom and Hampton Court merge.

Although demand increases are generally higher inbound, the outbound direction towards the Kingston borough also increases substantially. Flows from New Malden to Norbiton increase by ~ 7,000 and Norbiton to Kingston by 6,000.

On the Chessington branch, which historically is not a busy rail route, flows increase by ~1,600 in the outbound direction and by ~3,000 on the inbound direction (from Tolworth onwards).

The model forecasts the flows on the Epsom branch of Crossrail 2 to decrease in the order of ~2,000 flows compared to the without scenario. This is likely to be due to a consolidation of services based around a reduction in national rail services between Epsom and London Waterloo (via Ewell West). Crossrail 2 is a popular service for trips originating in Epsom and is forecast to make up a large proportion of total station demand. However, the increase is not large enough to offset the decrease in through-flows created by the removal of certain services.

Through services, operating through Epsom towards London Victoria (via Ewell West) have been assumed to grow from a 6tph frequency to an 8tph frequency with Crossrail 2 in place. Furthermore, the interchange penalty associated with changing from these services to Crossrail 2 at Epsom is considered too great to out-weigh the benefits of faster and more direct journey times.

The change in demand for rail between the 2041 medium OA without Crossrail 2 scenario and 2041 medium OA with Crossrail 2 scenario is shown in **Figure 22**.

Demand Flows (Bus)

The introduction of Crossrail 2 services to serve destinations in Kingston results in a relatively widespread decrease in bus routes across the borough.

Demand decreases are forecast primarily on bus route segments that link existing rail stations that are set to be served by the proposed Crossrail 2 route including:

- Decrease in north-south demand between Tolworth and Chessington and Kingston (via Surbiton). This primarily affects routes 65, 71 and K1.
- Decrease in east-west demand between Hampton Court and Kingston (routes 111, 216 and 411) and Norbiton, Raynes Park and Wimbledon on the route 57.

However, there are forecast increases in demand on specific bus route segments that connect into Crossrail 2 stations from areas that currently have poorer levels of accessibility to rail or have marginally less competitive service provision. These examples include:

- St Mary's University connecting into Hampton Wick station rather than Teddington station. This would impact upon routes 281 and 285.
- Kingston station to Kingston Academy (in both directions) has a significant increase in bus demand as this area is not served by rail. This is likely to impact upon demand and crowding levels of the route 65.
- Morden Park town centre to Raynes Park (northbound) also has an increase in bus demand forecast. Motspur Park station is a short distance from this area, but it is likely that the high service frequency and lower wait times at Raynes Park is more attractive to trips originating from this area. This forecast increase would impact on bus route 72.

The increase in service frequencies and reduction in journey times makes Crossrail 2 services considerably more attractive, meaning it is now considerably less attractive to travel via bus to rail stations that offer more frequent service levels such as Surbiton.

On the other hand, the increased accessibility to/from Kingston borough brought about by the Crossrail 2 scheme, coupled with the forecast increase in employment means that certain corridors in the borough are likely to see an increase in demand for bus services. This is particularly relevant for areas that have limited connection to rail services including areas around Kingston Academy and A307 Richmond Road and St Mary's University, A310 Kingston Road. In addition, areas that have good accessibility to a rail station are forecast to use bus for short trips to a station that has a significantly improved service level. This is evident in the increase in bus demand forecast between Morden Park and Raynes Park on the Grand Drive (B279).

These forecast changes make the case that certain bus routes may need to be revised to better service Crossrail 2 from certain areas, while service provision on other routes could be reduced with minimal impact to passengers. Resources from routes that are seeing a significant switch to direct use of rail due to Crossrail 2 could be transferred to amend existing routes or create new routes to serve growth areas or areas with limited rail accessibility.

The change in demand for bus between the 2041 medium OA without Crossrail 2 scenario and 2041 medium OA with Crossrail 2 scenario is shown in **Figure 23**.

Figure 22: Change in rail passenger volumes - 2041 Medium OA with and without CR2 (AM peak period)

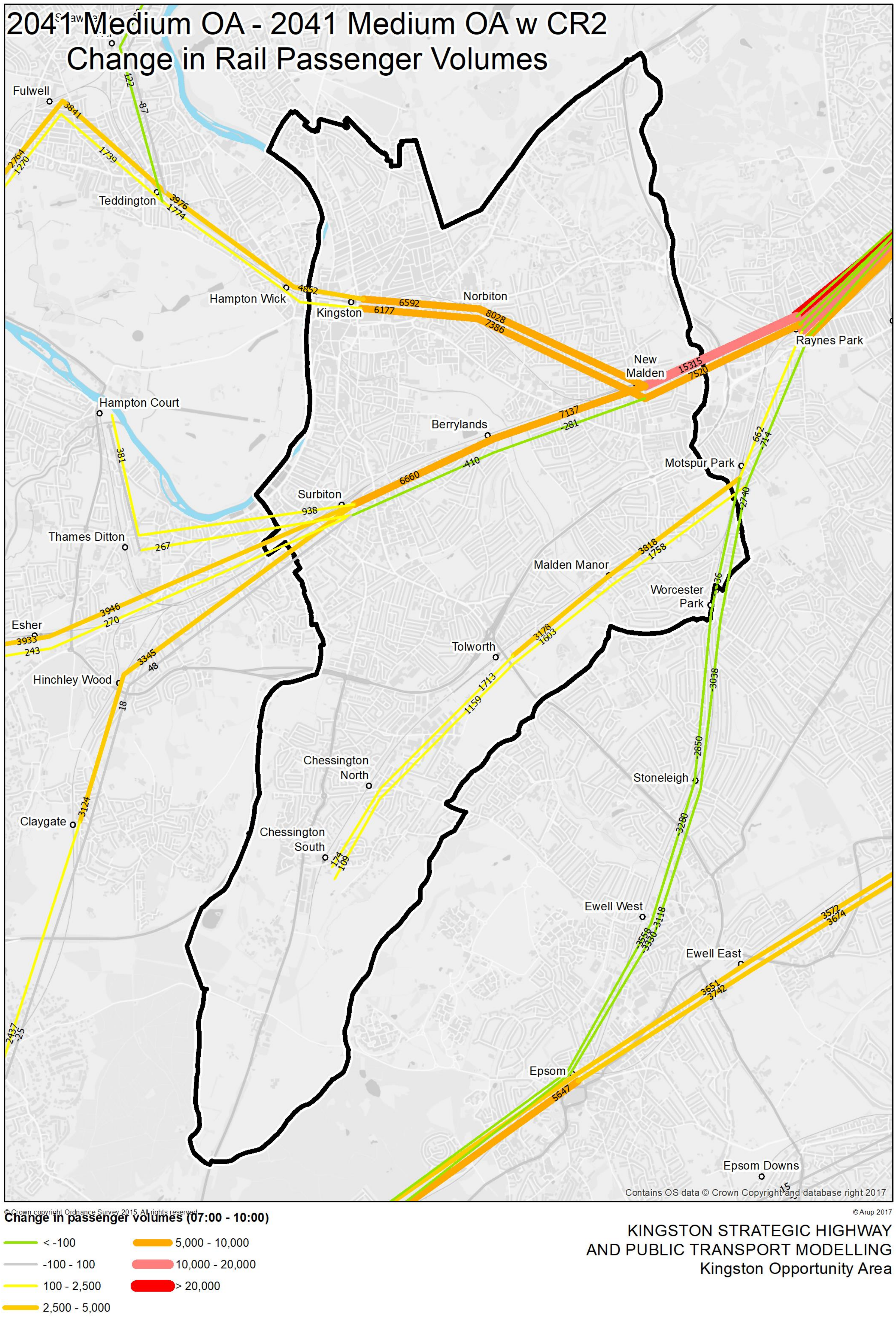
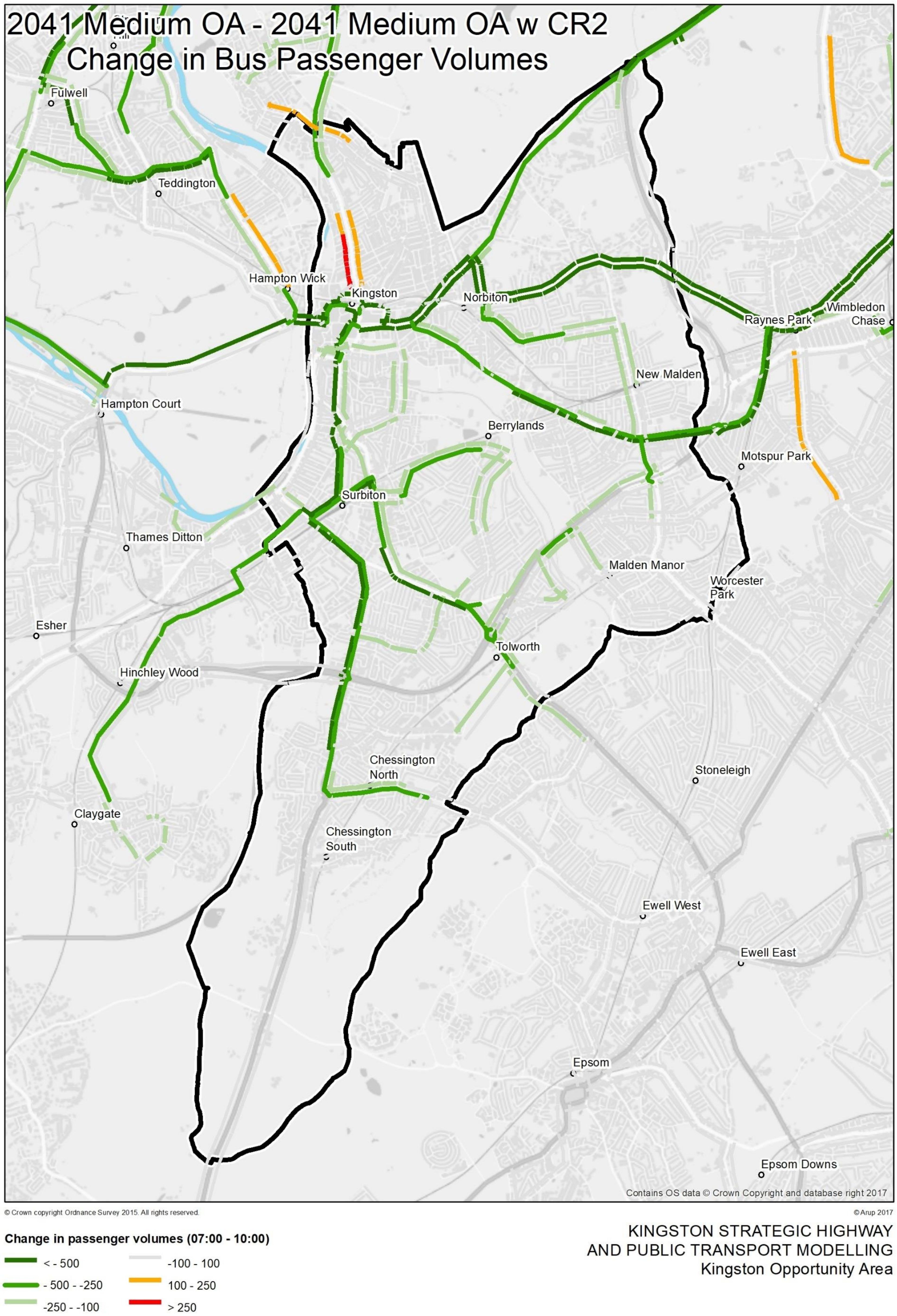


Figure 23: Change in bus passenger volumes – 2041 Medium OA with and without CR2 (AM peak period)



Station Entries and Exits

The addition of Crossrail 2 and the associated capacity from the new services is forecast to result in significant increases in passenger volumes entering and exiting stations. Some of the key changes include:

- At Kingston, increase in station entries of 70% and exits of 155% compared to the without Crossrail 2 scenario;
- Norbiton exits increase by 108% – increased employment opportunities are now facilitated with better access by Crossrail 2; and
- Surbiton entries fall by 17% and exits fall by 23%, which could be due to:
    - Attractiveness of Crossrail 2, feeding demand directly into the network from their origins, rather than via another mode (i.e. bus) to a more frequent/direct service – particularly relevant in the 2011 scenario where suburban services into and out of London Waterloo may have had limited frequencies and available capacities;
    - In the Crossrail 2 scenario, a large proportion of services leaving Surbiton are moderately crowded, meaning it is more attractive for individuals to access the Crossrail 2 route at an earlier station; and
    - Greater demand using Crossrail 2 to reach their destination even with respect to intra-borough trips. This increases the number of exits at key locations where demand and employment is forecast.

The change in station entries and exits in the Medium OA growth scenario with and without the Crossrail 2 scheme is included in **Table 11**. Stations with no significant volumes or change have been omitted.

Table 11: Station entries and exits – 2041 Medium OA growth with and without CR2 (AM peak period)

Entries	2041 Med OA	2041 Med OA CR2	Change (%)
Kingston	3,270	5,570	70%
Norbiton	1,610	3,350	108%
Chessington North	1,410	2,950	109%
Surbiton	10,410	8,660	-17%
Berrylands	390	940	141%
Raynes Park	4,560	6,480	42%
Hampton Court	960	1,350	41%
Hampton	1,120	2,750	146%
Fulwell	60	1,110	1,750%
Exits	**2041 Med OA**	**2041 Med OA CR2**	**Change (%)**
Kingston	2,750	7,010	155%
Norbiton	910	2,420	166%
Chessington North	250	1,300	420%
Surbiton	5,160	3,980	-23%
Raynes Park	2,150	3,270	52%
Hampton	280	790	221%
Fulwell	70	770	1000%

Crowding

Crossrail 2 is forecast to have a significant impact on alleviating crowding on the network in and around Kingston. In the 2041 without Crossrail 2 scenario, crowding on the South West Main Line through Surbiton, Berrylands, New Malden and Raynes Park has 4-5 PPMS, with Crossrail 2 included, this is reduced to 2-3 PPMS.

This is likely to be due to the additional Crossrail 2 “metro” serves joining from Shepperton, Chessington and Epsom, creating a significant increase in overall capacity between Surbiton, Wimbledon and beyond. The new Crossrail 2 vehicles are likely to be significant designed to reduce overcrowding with more available floorspace for standing.

This figure also assumes that no other changes are made to national rail services operating from destinations within Sussex, which are likely to make a large contribution to the remaining crowding across all services.

On the Epsom branch via Worcester Park and Raynes Park, crowding reduces from 3-4 PPMS without Crossrail 2, to just 1-2 PPMS with Crossrail 2. However, it should be noted that flows on this stretch are forecast to decrease by ~3,000 with the scheme in place. This could be due to increased demand on national rail services through Ewell East, where passengers are forecast to change to Crossrail 2 and the Northern Line at Balham/Tooting Broadway, rather than at Epsom.

The crowding plot showing rail and underground connections within the Kingston Borough and the wider South West London area is included in **Figure 24**.

Figure 24: Crowding on rail - 2041 Medium OA with and without CR2 (AM peak)