Bath Clean Air Plan

Bath and North East Somerset Council

Queen Square Traffic Management Scheme

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1. Introduction

Poor air quality is the largest known environmental risk to public health in the UK[1]. Investing in cleaner air and doing more to tackle air pollution are priorities for the EU and UK governments, as well as for Bath and North East Somerset Council (B&NES). B&NES has monitored and endeavoured to address air quality in Bath, and wider B&NES, since 2002. Despite this, Bath has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until 2025 without intervention.

In 2017 the government published a UK Air Quality Plan for Nitrogen Dioxide[2] setting out how compliance with the EU Limit Value for annual mean NO_2 will be reached across the UK in the shortest possible time. Due to forecast air quality exceedances, B&NES, along with 27 other Local Authorities, was directed by Minister Therese Coffey (Defra) and Minister Jesse Norman (DfT) in 2017 to produce a Clean Air Plan (CAP). The Plan must set out how B&NES will achieve sufficient air quality improvements in the shortest possible time. In line with Government guidance B&NES is working towards implementation of a Clean Air Zone (CAZ), including both charging and non-charging measures, in order to achieve sufficient improvement in air quality and public health.

Jacobs has been commissioned by B&NES to produce an Outline Business Case (OBC) and Full Business Case (FBC) for the delivery of the CAP; a package of measures which will bring about compliance with the Limit Value for annual mean NO_2 in the shortest time possible in Bath. The OBC assessed the shortlist of options set out in the Strategic Outline Case[3], and proposed a preferred option including details of delivery. The FBC develops the preferred option set out in the OBC, detailing the commercial, financial and management requirements to implement and operate the scheme. The OBC and FBC form a bid to central government for funding to implement the CAP.

This report was originally prepared in March 2019 in response to a question raised during the formal public consultation about the effect of potential traffic management measures on the Outline Business Case (OBC) for the CAZ. This is because the latest modelling (GBATH) showed that a Class C CAZ excluding cars failed only because of a continued predicted exceedance (2021) in the following location:

- A4 Gay Street, between George Street and Queen Square.

The report examines whether 'targeted' traffic management measures could be introduced in conjunction with a CAZ to address this air quality 'hot-spot', so making a Class C CAZ possible. It draws on parallel work undertaken looking at the diversionary and air quality impacts of delivering a series of traffic management schemes in the City Centre as part of the 'Public Realm and Movement Strategy' (PRMS). One such scheme considered then was possible changes to Queen Square to improve the public realm and reduce the level of traffic in this location. Any such reduction in traffic here would clearly reduce traffic using the critical section of Gay Street to the north. As such, ancillary implementation with a CAZ has the potential to make a Class C scheme viable.

Where the Class C CAZ with the proposed Queen Square traffic management scheme was taken forward as the preferred option, this report was updated in November 2019 to reflect the current detailed design proposals and operational details for the scheme.

[1] Public Health England (2014) Estimating local mortality burdens associated with particular air pollution. https://www.gov.uk/government/publications/estimating-local-mortality-burdens-associated-with-particulate-air-pollution
[2] https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017
[3] Bath and North East Somerset Council Clean Air Plan: Strategic Outline Case, March 2018 (http://www.bathnes.gov.uk/sites/default/files/siteimages/Environment/Pollution/strategic_outline_case_bath_28.03.2018_with_annexes.pdf)

2. Public Realm and Movement Strategy - Past TM Scheme Testing

2.1 Schemes Examined

The Place Making Plan (PMP), the Public Realm and Movement Strategy (PRMS) and the 'Getting around Bath' Transport Strategy (GaBTS) all identify the need to reduce the intrusion of vehicles, particularly into the historic core of the city. As such, examining potential traffic management changes to achieve this has been a continuing and separate theme of work to the Bath CAZ. The PRMS identifies aspirational access restrictions and bus gates in the City Centre that would start to rebalance access and movements. It is intended that a Traffic Management Plan (TMP) will support the delivery of these changes in reducing the intrusion of vehicles into the historic core and, in addition, act as the road map, identifying what measures can be implemented and in what sequence. As noted, this is a strategy aspiration irrespective of the CAZ.

An initial assessment of the proposed schemes to identify those requiring bespoke highway modelling and air quality assessment was detailed in a Technical Note prepared by CH2M and submitted on the 21st July 2017. The list of PRMS schemes considered is set out below:

- **Scheme 1**: Access restriction Milsom Street (10:00 hrs to 18:00 hrs);
- **Scheme 2**: Access restriction Cheap Street (10:00 hrs to 18:00 hrs;
- **Scheme 3**: Access restriction York Street (10:00 hrs to 18:00 hrs);
- **Scheme 4**: Access restriction Kingsmead Square (10:00 hrs to 23:00 hrs);
- **Scheme 5**: Access restriction Queen Square (east and south sides - closed to through traffic); and
- **Scheme 6**: Westgate Buildings - Introduction of a bus gate at the junction with James Street West (10:00 hrs to 18:00 hrs)

In addition to these, aspirations for the following additional traffic management measures were also tested:

- **Scheme 7**: The introduction of a bus gate entrance to Orange Grove (10:00 hrs to 18:00 hrs) - ie all access north of the Pierrepoint Street junction with Terrace Walk (Entry) restricted to buses and taxis only, thereby extending coverage of the existing bus gated area at Pulteney Bridge and High Street; and
- **Scheme 8**: Restricted access in Gay Street between The Circus and George Street (to consider impact of a (i) southbound one way; (ii)northbound one way).

Of these, the Queen Square scheme (Scheme 5) involving access restriction to Queen Square (eastern and southern sides - closed to through traffic) was considered to have the biggest potential for creating adverse operating impacts and diversionary routing, and hence a need for bespoke modelling using the 2013 'base' S-Paramics model for the 7:00-10:00 am and 3:00-7:00 pm periods.

Scoping work also noted that that the level of impact would depend on the specific layout of the junctions on the north side of Queen Square with two-way working on the north and west side, and that, prior to any modelling with S-Paramics, a preliminary design layout of the two junctions would need to be developed. As such, a further Technical Note presented the results of design work and modelling work examining the potential for a range of scheme options for Queen Square.

2.2 Queen Square: Options

2.2.1 General

This section of the report describes the options considered for Queen Square. Referenced drawings are included in **Appendix A**. All the schemes developed during this previous work would restrict the flow of traffic using the critical section of Gay Street to a greater or less degree, so all have associated re-routing or diversionary impacts. The options tested were as follows:

- Option 1 - Partial Closure with Shuttle Working;
- Option 2 - Partial Closure with Changes to Square;
- Option 3A - Public Realm Improvements (Variant A); and
- Option 3B - Public Realm Improvements (Variant B).

2.2.2 Option 1

Option 1 sought to deliver the aspiration to close the eastern and southern sides of Queen Square to 'through' traffic without an adverse impact on the existing built environment and streetscape. This is shown in Drawing **674726.BB.27.09-02** in Appendix A and **Figure 2.1** below, the aim being to deliver a scheme that could be accommodated within the existing carriageway 'foot-print'.

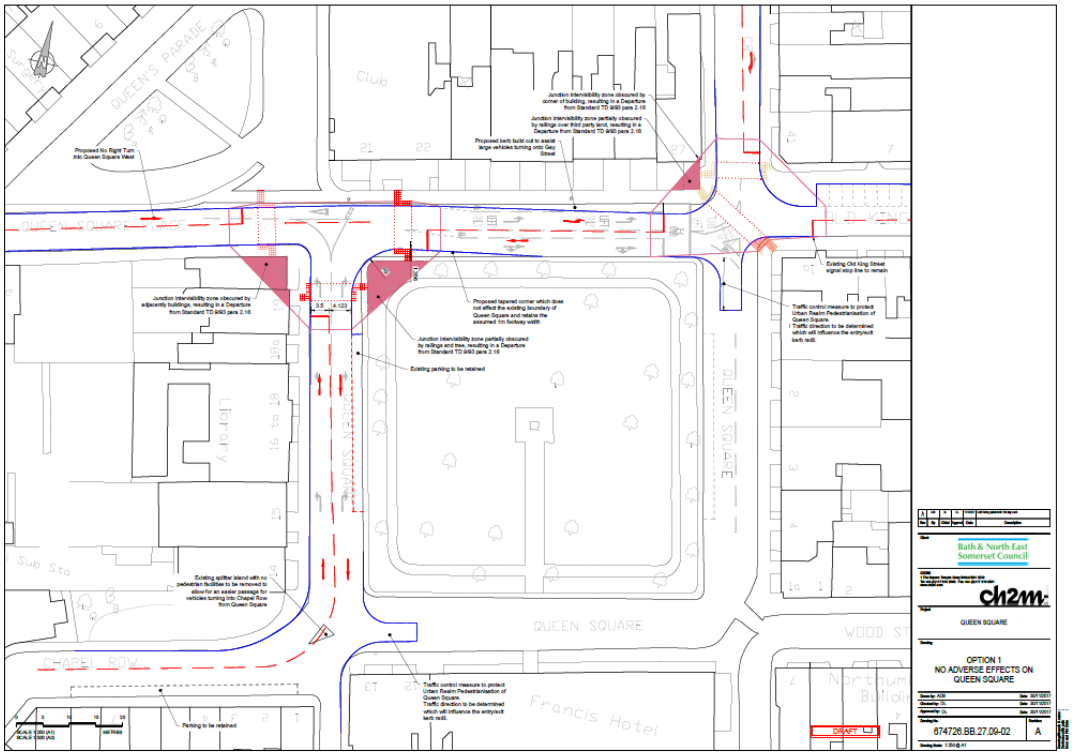

Figure 2.1: Queen Square - Option 1

With this layout, the control at the Gay Street junction would need to change with the closure of the eastern and southern sides of Queen Square. A large vehicle now proceeding south on Gay Street would now be required to execute a right turn, so demanding a wider swept path envelope. As such, another large vehicle turning left into Gay Street would have to maintain a waiting position much further back. If the driver were to advance further forward, for example to get a better view, then one vehicle would mutually obstruct passage of the other. This was considered to represent a significant operating risk. As such, concurrently running the left turn from Queen Square at the same time as the Gay Street approach, as happens now in the method of control, was not considered feasible. Another issue would be accommodating the movement from Queen Square to Old King Street with only a single eastbound approach lane on the north side. These drivers would be required to wait for 'gaps' in the opposing Gay Street traffic to access Old King Street but, as an 'ahead' movement through a green signal, this could easily be confused into assuming a 'right of way' over vehicles in Gay Street. There were thus considered to be significant safety concerns with concurrent signalled operation of the approaches from The Square and Gay Street. Furthermore, even if this need for 'opposed' operation was accepted, any vehicles waiting on the corner to access Old King Street would impede all following traffic making the left turn, potentially for a significant part of the green period.

It was thus considered that the issues could only be resolved safely by running the Queen Square eastbound left/ahead and Gay Street southbound approaches in separate signal stages, so effectively 'shuttle working' the A4 at this tight right-hand corner in the route. As noted in the Figure above, the scheme would also require the signalling of the Queen Square Place junction at the north-west corner of the Square. This would be needed to accommodate the heavy northbound right turn movement from the A367 Chapel Row, which would otherwise be forced to yield to traffic in both directions on the A4.

2.2.3 Option 2

Option 2 sought to maintain concurrent running of the A4 in each direction at the Gay Street junction. This layout allowed mutual passage of two large vehicles without conflict, although it did not remove the potential impedance issue with opposed turning from Queen Square into Old King Street. This movement would therefore need to be prohibited to prevent vehicles waiting to proceed ahead into Old King Street from blocking the dominant A4 eastbound traffic flow.

Critically, this option showed that attempting to facilitate the mutual passage of two large vehicles within this layout would result in a large adverse effect on the built environment and public realm of the Square (NE corner). As such, this option was not taken any further.

2.2.4 Options 3A and 3B

These schemes sought to reduce the potentially damaging impact to traffic flows of needing to 'shuttle work' the A4 at the Queen Square/Gay Street junction. As such, both retained the 'gyratory', but sought to reduce the carriageway width within the 'Square' to increase the footway area, improve/add crossings and enhance the public realm. It was accepted that this would fall short of the 'ideal' desired PRMS outcome, but it was necessary to examine what could be achieved without throttling and reducing the capacity for traffic movement through the 'Square' to the same degree as Option 1. **Figure 2.2** and **Figure 2.3** below show the Option 3A and Option 3B variants considered and tested. Drawings are included in Appendix A.

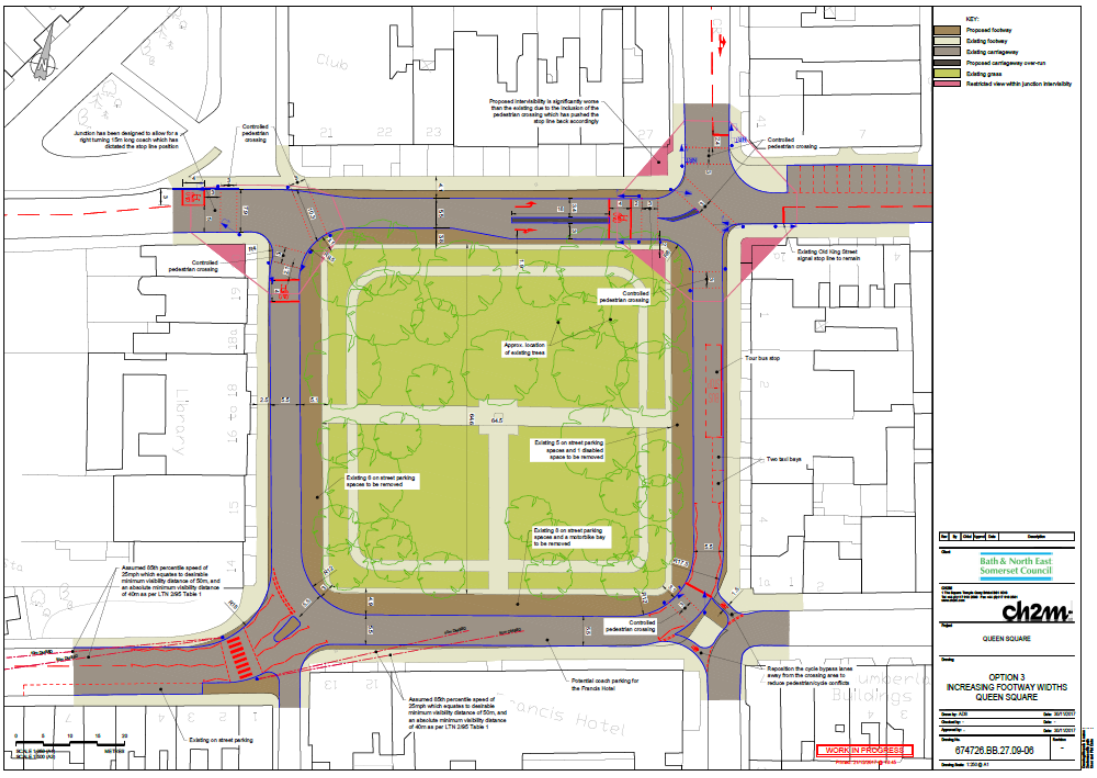

Figure 2.2: Queen Square - Option 3A

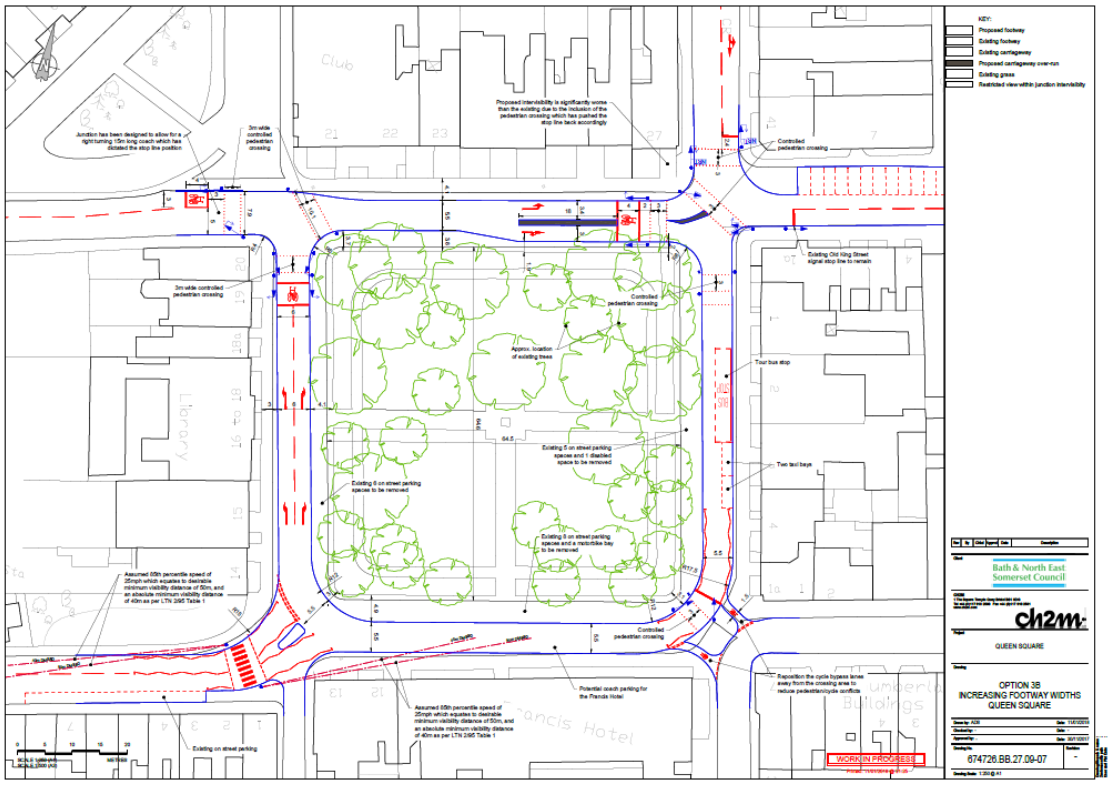

Figure 2.3: Queen Square - Option 3B

With both variants, the widening of the footway around Queen Square would result in the loss of five on-street parking spaces and one disabled space on the eastern side, eight on-street parking spaces and one motorbike bay on the southern side, and six on-street parking spaces on the western side of the Square. However, this layout would enable the bus stop and two taxi bays on the eastern side of the Square to be retained. The residual width of the carriageway on the southern side would also enable potential coach drop off/pick-up outside the Francis Hotel.

The key difference is the level of footway widening and carriageway reduction considered on the western side of the Square. This is reduced to a single wide lane with Option 3A, although two lanes are retained with Option 3B. In either case, the 'free' left turn from Queen Square to Queen Square Place (Charlotte Street) is lost.

2.3 Assessed Operating Impacts - S-Paramics

2.3.1 Traffic Flow Changes

As noted earlier, all the schemes have potential to reduce the volume of traffic using the section of Gay Street between Queen Square and George Street. In the case of Option 1, this is due to a significant reduction or 'throttling' of the achievable capacity through the Queen Square/Gay Street junction. **Tables 2.1** shows the expected diversionary changes with all options in the weekday AM peak period (7:00-10:00 am) using the 'base' S-Paramics model (2013). The predicted changes for the PM peak period (3:00-7:00 pm) are similarly shown in **Table 2.2**.

The quoted figures are given for selected roads where the impacts are highest and are based on 'actual' flows passed by the network or changes to these.

Table 2.1: Modelled traffic Volume Changes (two-way), Morning Peak Period (7:00-10:00 am)

Location	BASE Flow	OP1 Change	OP3A Change	OP3B Change
1. A4 Gay Street: Queen Square to George Street	3,565	-671	-334	-210
2. Gay Street: George Street to The Circus	318	-29	-57	-46
3. A4 George Street: Milsom Street to Lansdown Road	3,441	-420	-139	-89
4. Milsom Street	582	-100	-47	-14
5. A3039 Walcot Street	659	+136	+66	+37
6. Bennett Street	312	+68	+3	+37
7. Brock Street	384	+131	+29	+38
8. Brunswick Place	1,210	+104	+72	-27
9. Julian Road: Marlborough Buildings to Crescent Lane	2,462	+241	+144	+41
10. Guinea Lane	1,285	+183	+83	+40
11. A4 London Road: Walcot Street to Cleveland Place (Walcot Parade	4.036	-46	-10	-
12. A367 Chapel Row	1,929	-465	-268	-200
13. Monmouth Place	723	+185	+128	+128
14. A4 Upper Bristol Road: Marlborough Lane to Nile Street	3,491	-53	-69	-21
15. Bathwick Street	4,741	+112	-25	-40
16. A36: Sydney Place to Bathwick Roundabout	3,705	+117	+8	+4

Table 2.2: Modelled traffic Volume Changes (two-way), Evening Peak Period (3:00-7:00 pm)

Location	BASE Flow	OP1 Change	OP3A Change	OP3B Change
1. A4 Gay Street: Queen Square to George Street	5,133	-994	-258	-153
2. Gay Street: George Street to The Circus	443	-108	-75	-80
3. A4 George Street: Milsom Street to Lansdown Road	4,826	-731	-95	-40
4. Milsom Street	506	-112	-79	-43
5. A3039 Walcot Street	1,537	+99	+11	+10
6. Bennett Street	425	-76	-57	-51
7. Brock Street	479	-15	-51	-56
8. Brunswick Place	1,711	+422	+212	+123
9. Julian Road: Marlborough Buildings to Crescent Lane	3,403	+683	+218	+127
10. Guinea Lane	1,526	+231	+179	+138
11. A4 London Road: Walcot Street to Cleveland Place (Walcot Parade	5,426	-62	+130	+66
12. A367 Chapel Row	3,263	-760	-323	-233

Location	BASE Flow	OP1 Change	OP3A Change	OP3B Change
13. Monmouth Place	851	+178	+164	+173
14. A4 Upper Bristol Road: Marlborough Lane to Nile Street	3,951	-34	-76	+14
15. Bathwick Street	5,925	+128	+12	+15
16. A36: Sydney Place to Bathwick Roundabout	4,919	+225	+50	+44

Not unexpectedly the results show that Option 1, if implemented, has the greatest potential for diversionary impact due to the level of capacity reduction enforced by effective 'shuttle working' of the A4 approaches at the Queen Square/Gay Street junction. Whilst there are potential impacts affecting a large part of the City Centre, the 'key' area affected in both the AM and PM peak periods are streets to the immediate north of Queen Square. This includes the Julian Road/Brunswick Place and the Brock Street/The Circus/Bennett Street routes, both of which offer convenient 'bypass' opportunity to Queen Square. It should be noted that Royal Avenue is not included within the S-Paramics model, but eastbound routing using this road and Queen's Parade Place is also a highly probable outcome. Options 3A and 3B also introduce diversionary impacts into this same 'sensitive' area, albeit at a reduced level.

2.3.2 Queue Lengths

Figure 2.4 and **Figure 2.5** compare the mean AM peak hour (8:00-9:00 am) and PM peak hour (5:00-6:00 pm) queue lengths (in metres) on the three main approaches to Queen Square. Note that the Queen Square Place/Charlotte Street approach includes the 'internal' northern part of Queen Square in the Do-Nothing (so measured from the stop-line with Gay Street). However, this is measured back from the proposed stop-line position on the eastbound Queen Square Place approach in the scheme options.

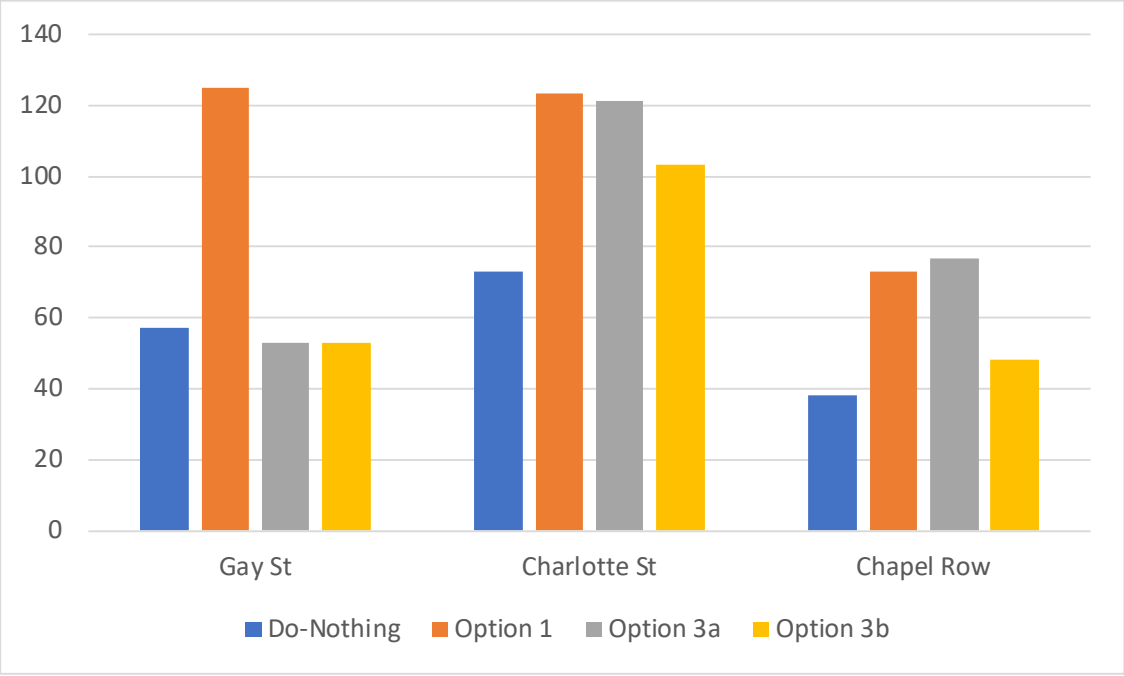

Figure 2.4: Queen Square Arms, Mean Queue Length Comparison, AM Peak Hour (8:00-9:00 am)

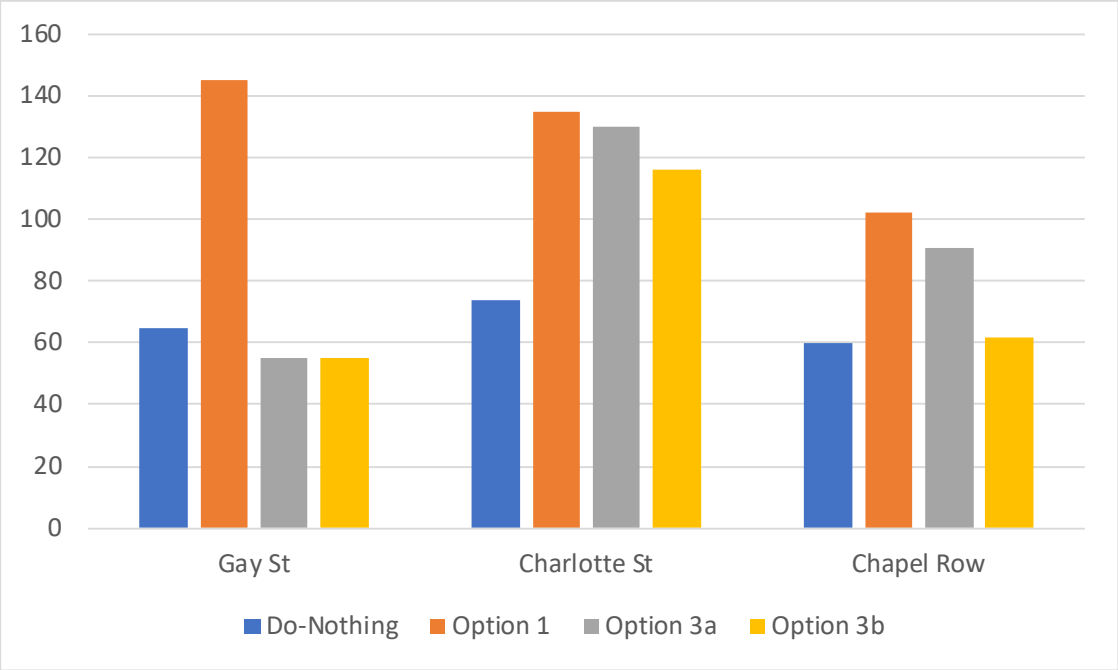

Figure 2.5: Queen Square Arms, Mean Queue Length Comparison, PM Peak Hour (5:00-6:00 pm)

From the CAZ perspective the results for the Gay Street approach are the most interesting. These show that, for Option 1, the typical queuing level in the southbound direction towards the Queen Square signals will be greatly increased in both peak hours, so leading to a greater and more regular incidence of stopped and idling traffic in the location where the air quality exceedance with a CAZ C is still shown to persist. So, whilst Option 1 will serve to reduce traffic in this part of Gay Street, the congestion is still likely to increase because of the significant capacity reduction through Queen Square. In contrast, the implementation of either Option 3A or Option 3B is shown to make the southbound queuing on Gay Street towards the signals no worse. However, the volume decreases through this part of Gay Street are also much less than Option 1. Analysis of the directional split shows that most of the reduction is associated with northbound traffic, namely from the A367 Chapel Row. This is the result of congestion on the west side of the 'Square' which encourages northbound re-routing diversion away from Gay Street to Monmouth Place, Upper Bristol Road, Marlborough Lane and Julian Road.

2.4 Application to a CAZ Class C

2.4.1 Preamble

As set out at the start of this note, the query raised is whether ancillary 'targeted' traffic management measures could be introduced in conjunction with a CAZ to address the outstanding air quality 'hot-spots', so making a Class C CAZ possible. The subsequent technical evidence based on past PRMS design work and modelling has thus sought to ascertain whether an acceptable scheme for Queen Square could be implemented which could reasonably achieve this in the time available.

2.4.2 Option 1

Whilst Option 1 is clearly shown to reduce traffic volumes through the critical part of Gay Street between Queen Square and George Street, the detailed micro-simulation modelling shows that it would increase southbound queuing and congestion here in both weekday peak periods. This option also has some significant re-routing impacts affecting 'sensitive' roads to the north so, to go with a CAZ C on the basis that Option 1 would be implemented would be predicated on the view that these diversionary impacts would be acceptable. In discussion with B&NES Traffic Management on the concept of linking a scheme based on Option 1 with a CAZ Class C as a 'package' the following view was expressed:

"The diversionary impact onto other roads would not be acceptable due to the congestion this will cause. In addition to this, properties on the east side (of Queen Square) have no alternative loading facilities and those on the south side rely on the road for deliveries too. We'd need Secretary of State approval to close the roads if we were to restrict access for greater than 8 hours a day to properties that have no other vehicle access. If we were to receive an objection to the effect of the closures on loading that couldn't be overcome, a public inquiry would have to be held too. These issues present a considerable risk as to whether the closure could go ahead, in other words the decision could be outside of the Council's hands. As such, we wouldn't want the air quality mitigation to be dependent on this".

The 'deliverability' point with Option 1 is a 'key' one, as any decision to down-grade the proposed class of the CAZ from a Class D to Class C would have to be on the basis that supporting and identified traffic management measures were guaranteed as deliverable. There can be no such guarantee with Option 1 due to its impact on loading and spatial impact.

2.4.3 Options 3A and 3B

The Option 3A and 3B schemes as developed in the past PRMS work have a lower level of diversionary impact but, as a result, the predicted traffic flow reductions through the critical part of Gay Street are also much more modest. It is worth noting that Variant 3B was developed to address local potential problems with 'excess' queuing on the west side of the 'Square', leading in turn to 'wrap-around' queuing affecting the south and east sides of the 'Square' as well. As such, from an operating perspective, it is more likely that Variant 3B would be taken forward than Variant 3A. The flow changes predicted with Variant 3B for Gay Street (Location 1 in Tables 4.1 and 4.2) show that:

- In the weekday 7:00-10:00 am period the predicted traffic reduction (two-way) in Gay Street is expected to be 210 vehicles, which compares with a 'base' flow of 3,565 vehicles (two-way) over the same period. This equates to a modest (-5.8%) change over this period; and
- In the weekday 3:00-7:00 pm period the predicted traffic reduction (two-way) in Gay Street is expected to be 153 vehicles, which compares with a 'base' flow of 5,133 vehicles (two-way) over the same period. This equates to an even lower change (-2.9%) change over this period.

The S-Paramics modelling did not include consideration of the inter-peak period from 10:00 am to 3:00 pm. However, hourly flows in this part of the day through Queen Street are generally lower so, with capacity sufficient, there is little to suppose that the introduction of an Option 3B scheme would reduce flow levels in Gay Street over this period very much, if at all.

To actively manage the traffic using Gay Street, particularly in the northbound direction, there will therefore be a necessity to use non-optimal traffic signal timings to restrain entry traffic to Queen Square from both the A367 Chapel Row and A4 Charlotte Street approaches. This need for 'gating' or restraint requires a variation to the Option 3B scheme to allow this to work effectively as an integral part of a CAZ Class C to address a risk of continued air quality non-compliance in Gay Street.

3. CAZ Scheme Modifications

3.1 Scheme Descriptions

A variation to the Option 3B scheme made necessary by the CAZ is shown on Drawing **674726.BB.27.09-09** in **Appendix B** and **Figure 3.1** below (Option 3C). This adds signal control at the A367 Chapel Row junction to allow traffic on this approach to be restrained as necessary 'at entry' to Queen Square. With Option 3B this would only have been achievable at the Charlotte Street junction, so creating a risk of 'excess' queuing on the west side of Queen Square. This could in turn block access to the left turn lane, so impeding traffic making the movement from Gay Street to Charlotte Street. In short, 'gating' when applied should not result in excess queuing in any part of Queen Square itself.

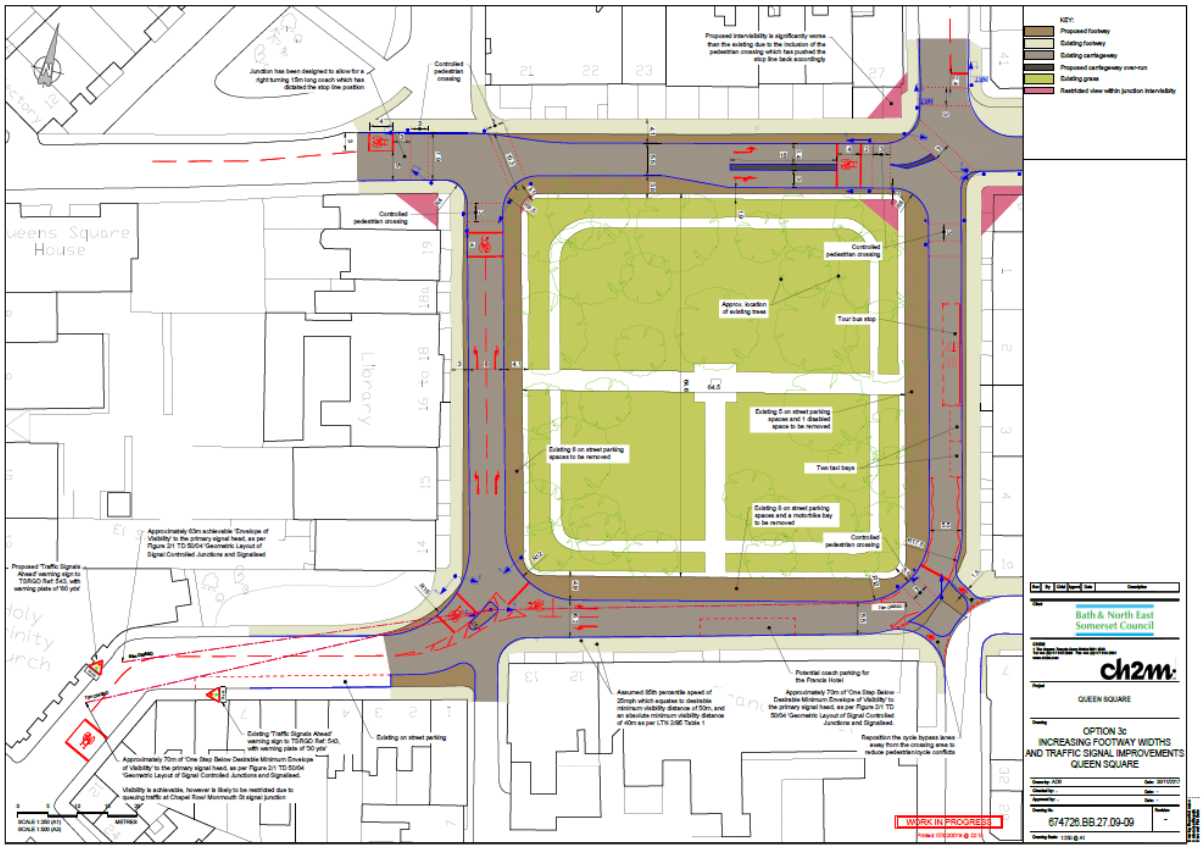

Figure 3.1: Queen Square - Option 3C

The minimum scheme change needed to Queen Square to enable enhanced traffic management control or/restraint is shown on Drawing **674726.BB.27.09-10** (Option 3D) and **Figure 3.2** below. This confines changes to the additional signal control needed in the NW and SW corners of Queen Square and removes the enhancements to footways around the central space which would rely on removal of existing on-street parking on three sides. The reason for developing Option 3D is to demonstrate that the enhanced traffic management needed to achieve the required air quality outcomes with a Class C CAZ in this area is not dependent on the wholesale removal of parking. This would otherwise make scheme delivery dependent on changes to existing TRO's, which could attract a level of opposition.

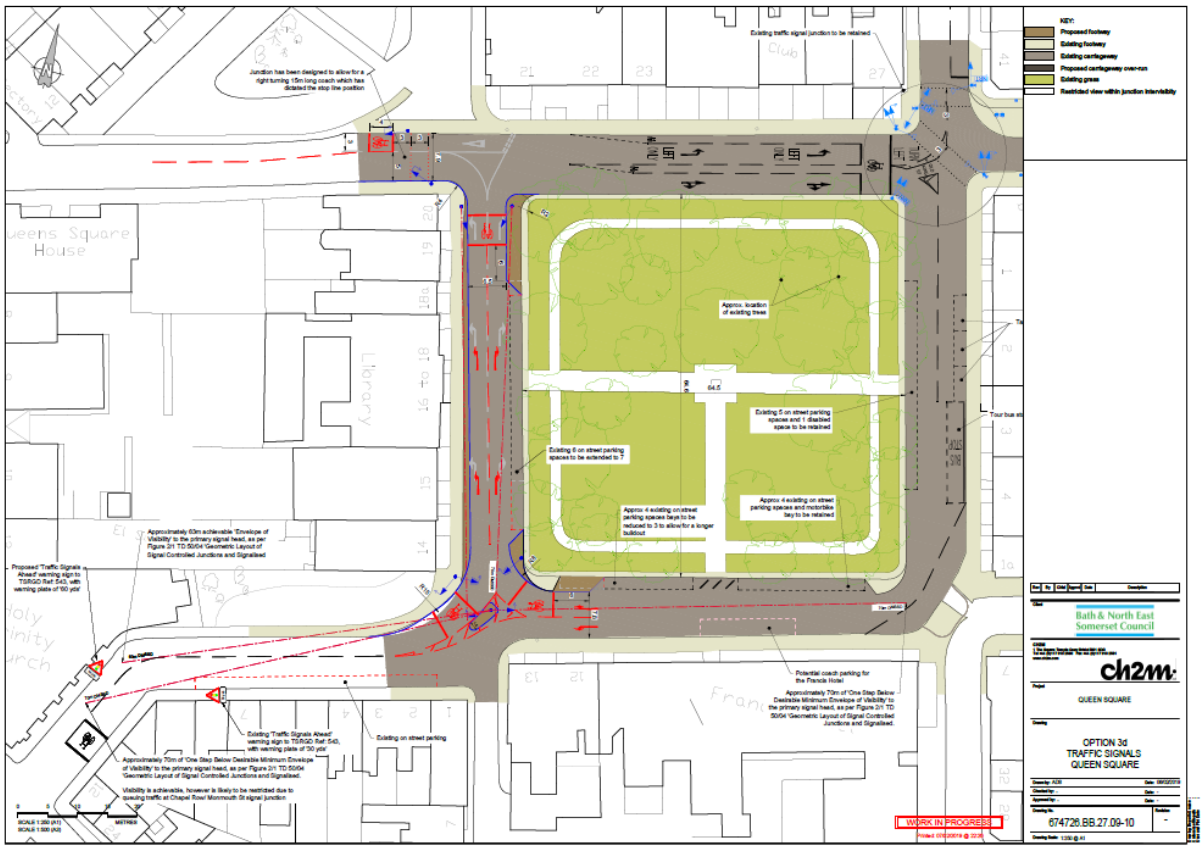

Figure 3.2: Queen Square - Option 3D

3.2 Scheme Modelling and Outcomes: Class C CAZ with TM

As with earlier work examining the PRMS options, a traffic signal optimisation model (LinSIG) was first used to ascertain the signal timings necessary to achieve the necessary level of traffic flow restraint in Gay Street. This used 2021 traffic flows from the AM peak, mean-inter-peak and PM peak hours from the GBATH Class C CAZ scenario (no TM). Comparison of flows in Gay Street with a Class C CAZ and a Class D CAZ showed that 'Annual Average Daily Traffic' (AADT) flows with the latter were only around 4% lower. However, it was accepted that a larger reduction in flow would need to be achieved to additionally account for the higher residual proportion of non-compliant vehicle fleet using Gay Street with just a Class C CAZ in place.

Table 3.1 below shows the 2021 air quality modelling results with the CAZ Class C (with TM) at critical locations, comparing these with other scenarios including the compliant CAZ Class D scenario (£9 charge) put forward for public consultation in the OBC issued in October 2018. All results take account of refinements made to the emission modelling to account for road gradient effects. It is clear from these results that suitable restraint applied to traffic using Gay Street could, in conjunction with a CAZ Class C, achieve the required air quality compliance in Bath by 2021. With the applied traffic signal-timings the NOx emission level in this specific location is shown to be reduced from 42.0 to 36.9. So, in practice, there would be scope to re-instate some of the vehicle capacity taken out in the LinSIG/GBATH testing. Notwithstanding this, the 'key' message emerging is that applying targeted traffic management at Queen Square would make a compliant CAZ Class C scheme possible, with previous results showing that it would not be possible to achieve otherwise.

Table 3.1: Air Quality Modelling Results: Comparison

Location	2017 Base	2021 Base	2021 CAZ C £9.00	2021 CAZ C £9.00 with TM	2021 CAZ D £7.50	2021 CAZ D £9.00
Gay Street	**60.1**	**50.9**	**42.0**	36.9	**40.8**	40.4
London Road (West of Cleveland Place)	**70.2**	**57.6**	38.5	38.2	36.7	36.4
London Road (East of Cleveland Place)	**61.9**	**52.2**	39.6	39.5	37.1	36.9
London Road (near A4)	**64.4**	**50.8**	31.4	31.3	31.0	30.9
Wells Road	**69.1**	**57.5**	31.0	30.9	30.2	29.9
Wellsway	**58.6**	**47.8**	25.1	25.1	24.5	24.5
Upper Bristol Road	**75.4**	**61.9**	36.4	36.3	35.6	35.5
Chapel Row	**53.7**	**45.7**	38.3	35.4	37.1	36.8
Lansdown Road	**62.4**	**51.9**	38.0	37.9	36.1	35.9
Broad Street	**58.1**	**49.8**	35.2	35.0	34.7	34.6
Lower Bristol Road	**51.0**	**44.5**	36.7	36.7	34.4	34.2
Maximum Value	**75.4**	**61.9**	**42.0**	39.5	**40.8**	40.4

Note: Yellow shading indicates scenarios achieving full air quality compliance

The GBATH modelling was also examined to understand the specific diversionary impacts of providing 'active' vehicle restraint through Queen Square to achieve the desired air quality outcome with a CAZ Class C. Earlier in this note the findings from earlier S-Paramics testing of the PRMS options (1, 3A and 3B) were described. Whilst accepting that volume change results presented in Tables 2.1 and 2.2 relate to the wider weekday 7:00-10:00 and 3:00-7:00 pm periods, they do provide an indication as to where GBATH diversionary increases might be expected to occur.

The flow difference plots extracted from GBATH comparing the CAZ Class C (with TM) against the 2021 'base-line' are included in **Appendix C**. Not unexpectedly, these show similarities in the likely pattern of diversionary impact in all modelled hours as follows:

- A 'managed' reduction in traffic using the critical section of Gay Street between George Street and Queen Square. The reduction benefits also affect The Circus and Bennett Street, which is presently used by some drivers to route between the A4 Gay Street and Lansdown Road, so avoiding delays at the George Street/Lansdown Road/Broad Street traffic signals;
- A potential increase in traffic routing via Royal Avenue/Queen's Parade Place in both directions, but predominantly westbound towards Marlborough Lane. This is primarily the result of an increased risk of southbound drivers on Gay Street turning right into Queen's Parade Place to avoid additional delays in routing through Queen Square. Whilst the aim would be to co-ordinate signals to reduce delays in Queen Square itself, drivers on the Gay Street approach could potentially be stopped at three points in executing the movement to Charlotte Street;
- An increased use of Monmouth Place as northbound drivers on Charles Street turn left at the Monmouth Street junction to avoid queuing on Chapel Row. The modelling suggests that some drivers may then elect to turn right at the junction with the A4 Charlotte Street back towards Queen Square, but this will in practice depend on driver perception as to the causation factor in Queen Square causing congestion. As such, a greater proportion of the traffic diverting to Monmouth Place may choose to reroute via Marlborough Lane than suggested by the GATH model. However, this would result in a greater reduction in northbound traffic using Gay Street than considered in the air quality modelling, which is already shown to reduce the NOx

level here to 36.9. As such, the level of 'gating' or restraint could be eased back by changing signal timings to reinstate some of the vehicle capacity taken out through applied 'flow management'; and

- Some increased risk of additional traffic using Marlborough Buildings, and thereafter either Julian Road/Morford Street or Cavendish Road/Sion Road as a route back to Lansdown Road.

To the east of Queen Square there is some re-routing predicted via Bathwick Street and the A4/Cleveland Bridge junction but, given congestion levels here throughout the day, this is low. During the morning peak period there is an opportunity for diversionary north-south re-routing via Northgate Street when the bus gate is not operational (10:00 am to 6:00 pm). However, the GBATH modelling does not suggest any increased flow impact here.

As with the previous S-Paramics modelling done with the PRMS options, the GBATH modelling shows that diversionary increases resulting from 'restraint' applied in Queen Square will impact on roads to the north and west. Limiting this impact will therefore depend on achieving the right level of restraint to achieve the air quality objective in Gay Street, but not over-playing the 'forced' reduction in flow achievable with either the Option 3C or 3D schemes.

3.3 Refinement of Scheme - Option 3E detailed design and site investigation works

Scheme option 3D underwent development and modelling which showed suitability for introducing vehicle restraint in conjunction with a CAZ Class C. This proposal has been further developed for the Full Business Case following several engineer site visits and assessments in conjunction with consultation between staff officers and a number of stakeholder groups.

Council officers procured a topographical survey and have carried out several site visits to assess existing drainage levels as well as checking the proposed layout can be safely accommodated given existing physical infrastructure and below ground utility services. Design staff have aimed to ensure the new scheme is 'buildable' with the need for expensive and time-consuming utility service diversions mitigated.

The latest scheme option 3E is shown in Appendix D.

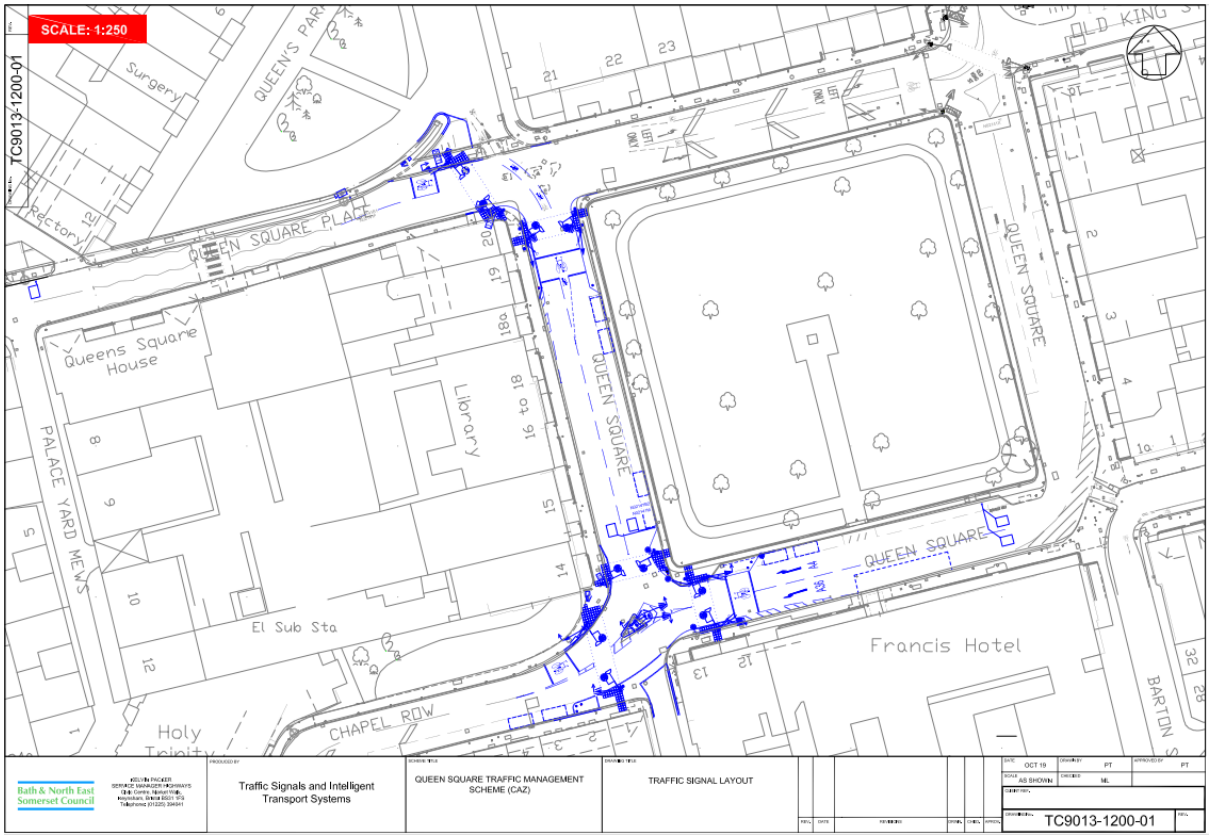

Figure 3.3: Queen Square - Option 3E

The scheme has evolved from its original proposed layout to this latest iteration following a B&NES Council inter-departmental Scheme Assessment Meeting (SAM). These meetings assess every proposed highway infrastructure scheme to ensure proposals meet national design standards as well as any local standards which may be applied. This includes things such as particular layouts or materials to be used. Officers representing several departments came together to make comments and recommendations, of which several got taken forward as part of the design process. Engineer site visits and consultation with other stakeholder groups such as public transport and cycle users have also taken place and therefore new feedback has been incorporated into the design. Road Safety Audit (RSA) and Walking, Cycling and Horse-Riding Assessment and Review (WCHAR) procedures have also been followed, impacting the design process.

In essence the junction layouts previously modelled at both junctions with option 3D remain the same, therefore the proposed 70 second cycle time remains in place as a baseline throughout the peak periods. However, there have been some changes since option 3D layout and these are explained below.

At the Charlotte Street junction the eastern build out around the square has been reduced in width by approximately 1m. The traffic lanes have also been very slightly reduced in width to allow the introduction of a central cycle lane, which facilitates cyclists moving from Queen Square to Queen's Parade in a clear and obvious road position rather than adopting either lane, which could have previously been the case. The build outs proposed at either footway approaching the signals from the square have both been reduced in length only marginally on the eastern side to precisely 'tie in' with existing 'No Parking' restrictions. The western footway has had a significant narrow length of proposed footway removed. This construction for the entire length of the approach would have proved difficult and expensive due to utility services, without adding sufficient benefit to justify the expense of diverting utilities and amending drainage. The footways are currently of insufficient width here.

The pedestrian crossing originally proposed has been realigned to allow for utility services and issues with drainage to a property on the corner of the square. A second signal crossing has also been incorporated to improve pedestrian access and utilise time when vehicles could otherwise be held at a red signal in both directions.

Pedestrian countdown timers on both crossings will be included along with low level cycle aspects to give cyclists on the road visibility to signals in their optimum position. These would also give cyclists a few seconds 'early start' to depart the stop line before any traffic proceeds, improving safety and attractiveness of using the route.

A maintenance parking bay will be constructed on Queen's Parade adjacent to the new traffic signal controller. This would involve relocating an existing parking space a few metres to the end of a row of echelon parking where sufficient space is available. This will provide a more attractive environment and remove any confusion over current parking in this location.

At the Chapel Row junction, the central traffic island has been reduced in size facilitating an easier manoeuvre into Princes Street. A raised uncontrolled area has been proposed across Princes Street at its junction with Chapel Row improving access for pedestrian users. The junction stop lines have been moved to accommodate the introduction of 3 new signal controlled pedestrian crossings, one across each arm. Again, these will utilise time when cars would be held at red if demanded and provide improved access for pedestrians. Pedestrian countdown timers and low-level cycle aspects would also be provided at the signals for pedestrians and cyclists respectively.

A further parking space will be lost outside property no. 2 on Chapel Row with the changes made compared with the original 3D layout option but will be reallocated elsewhere around Queen Square.

Additional CCTV provision will also be included. This will enable Council staff to have visibility over both junctions enabling the immediate effects of implementing certain levels of traffic management restriction to be known. This data will be used in conjunction with other data streams.

4. Conclusions

4.1 Overview

This report has described the development of traffic management measures in the Queen Square area to address a predicted air quality exceedance issue in the part of Gay Street between the 'Square' and George Street. Whilst modelling shows that compliance here could just be achieved with a CAZ Class D and no ancillary traffic management, this is not the case with a CAZ Class C. As such the work has focused on a scheme to control traffic flows using this part of Gay Street, and its potential impact on air quality emission levels here if implemented as part of a 'package' with a CAZ Class C.

The likely effectiveness and delivery of earlier schemes examined as part of PRMS work were first considered (Options 1, 3A and 3B). Option 1 was quickly rejected because of the assessed severity of its highway operating impact, the allied risk of significant diversion and servicing issues, along with concerns about deliverability. Option 3B was carried forward at this stage, although it was adapted to create two potential variants (Options 3C and 3D) more suited to additionally fulfil a 'gating' or restraint objective on the A367 Chapel Row and A4 Charlotte Street approaches (as required).

Subsequent air quality modelling results reveal that suitable restraint applied to traffic using Gay Street could, in conjunction with a CAZ Class C, achieve the required air quality compliance in Bath by 2021. With the applied traffic signal-timings the NOx emission level in this specific location is shown to be reduced from 42.0 to 36.9. So, in practice, there could be scope to re-instate some of the vehicle capacity taken out in the model testing. Notwithstanding this, the 'key' message emerging is that applying targeted traffic management at Queen Square would make a compliant CAZ Class C scheme possible, with previous results showing that it would not be possible to achieve otherwise.

Not unexpectedly, detailed examination of the GBATH model outputs show that 'restraining' capacity through Queen Square and so Gay Street as required will create diversionary routing increases on other surrounding roads. These include Royal Avenue, Queen's Parade Place, Monmouth Place and Marlborough Lane, and to a lesser extent Marlborough Buildings, Julian Road and Cavendish Road. So, as with the previous S-Paramics modelling done with the PRMS options, the GBATH modelling shows that diversionary increases resulting from 'restraint' applied in Queen Square will impact on roads to the north and west. Limiting this impact will therefore depend on achieving the right level of restraint to achieve the air quality objective in Gay Street, but not over-playing the 'forced' reduction in flow achievable with either the Option 3C or 3D schemes.

The Council will embark upon the use of several datasets in terms of air quality, traffic volume, traffic speed, congestion level and queue length - all provided in 'real time or near 'real time' - to manage Gay Street and its environs. Data from a new dedicated air quality monitor on Gay Street which will be introduced and, along with the new traffic signal loops, will be connected to the Council's existing Urban Traffic Management and Control (UTMC) system. New CCTV images will also become available. This system will provide Council staff with sufficient information to either restrict traffic flow into the square should air quality levels be declining or allow more traffic through if air quality is good. This decision would be based upon up to date and in several cases live data. This will be an iterative process needing to also account for diversionary effects, but ultimately once confidence is raised in the accuracy and reliance of data, the establishment of automatic 'strategies' within the UTMC system can be initiated. This would allow the UTMC system to automatically determine the most appropriate timings to provide given the immediate traffic levels and requirement for air quality to be maintained below 40 µg/m³.

Appendix A. PRMS Scheme Drawings - Queen Square (Options 1, 3A and 3B)

Junction has been designed to allow for a right turning 15m long coach which has dictated the stop line position

3m wide controlled pedestrian crossing

Proposed intervisibility is significantly worse than the existing due to the inclusion of the pedestrian crossing which has pushed the stop line back accordingly

Controlled pedestrian crossing

Existing Old King Street signal stop line to remain

3m wide controlled pedestrian crossing

Controlled pedestrian crossing

Approx. location of existing trees

Tour bus stop

Existing 5 on street parking spaces and 1 disabled space to be removed

Two taxi bays

Existing 6 on street parking spaces to be removed

Existing 8 on street parking spaces and a motorbike bay to be removed

Assumed 85th percentile speed of 25mph which equates to desirable minimum visibility distance of 50m, and an absolute minimum visibility distance of 40m as per LTN 2/95 Table 1

Controlled pedestrian crossing

Reposition the cycle bypass lanes away from the crossing area to reduce pedestrian/cycle conflicts

Potential coach parking for the Francis Hotel

Assumed 85th percentile speed of 25mph which equates to desirable minimum visibility distance of 50m, and an absolute minimum visibility distance of 40m as per LTN 2/95 Table 1

Existing on street parking

40m DMSSD

50m DMSSD

0 5 10 15 20

SCALE 1:250 (A1)
SCALE 1:500 (A3)
METRES

WORK IN PROGRESS

Printed: 11/01/2018 @ 21:25

KEY:

- Proposed footway
- Existing footway
- Existing carriageway
- Proposed carriageway over-run
- Existing grass
- Restricted view within junction intervisibity

Rev	By	Chkd	Apprvd	Date	Description

Client

Bath & North East Somerset Council

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Tel +44 (0)117 910 2580 Fax +44 (0)117 910 2581
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Project

QUEEN SQUARE

Drawing

OPTION 3B
INCREASING FOOTWAY WIDTHS
QUEEN SQUARE

Drawn by: ADS	Date:	11/01/2018
Checked by: -	Date:	-
Approved by: -	Date:	30/11/2017

Drawing No.	Revision
674726.BB.27.09-07	-

Drawing Scale: 1:250 @ A1

Drawing file path & name:
Xreference file path
User and Plot Date

Appendix B. Developed Options for Class C CAZ - Queen Square (Options 3C and 3D)

Junction has been designed to allow for a right turning 15m long coach which has dictated the stop line position

Controlled pedestrian crossing

Proposed intervisibility is significantly worse than the existing due to the inclusion of the pedestrian crossing which has pushed the stop line back accordingly

Controlled pedestrian crossing

Controlled pedestrian crossing

Approx. location of existing trees

Tour bus stop

Existing 5 on street parking spaces and 1 disabled space to be removed

Existing 6 on street parking spaces to be removed

Two taxi bays

Existing 8 on street parking spaces and a motorbike bay to be removed

Controlled pedestrian crossing

Approximately 63m achievable 'Envelope of Visibility' to the primary signal head, as per Figure 2/1 TD 50/04 'Geometric Layout of Signal Controlled Junctions and Signalised

Proposed 'Traffic Signals Ahead' warning sign to TSRGD Ref: 543, with warning plate of '60 yds'

63m DMSSD

70m DMSSD

70m DMSSD

Existing 'Traffic Signals Ahead' warning sign to TSRGD Ref: 543, with warning plate of '30 yds'

Approximately 70m of 'One Step Below Desirable Minimum Envelope of Visibility' to the primary signal head, as per Figure 2/1 TD 50/04 'Geometric Layout of Signal Controlled Junctions and Signalised.

Visibility is achievable, however is likely to be restricted due to queuing traffic at Chapel Row/ Monmouth St signal junction

Existing on street parking

Assumed 85th percentile speed of 25mph which equates to desirable minimum visibility distance of 50m, and an absolute minimum visibility distance of 40m as per LTN 2/95 Table 1

Potential coach parking for the Francis Hotel

Approximately 70m of 'One Step Below Desirable Minimum Envelope of Visibility' to the primary signal head, as per Figure 2/1 TD 50/04 'Geometric Layout of Signal Controlled Junctions and Signalised.

Reposition the cycle bypass lanes away from the crossing area to reduce pedestrian/cycle conflicts

0 5 10 15 20

SCALE 1:250 (A1)
SCALE 1:500 (A3)

METRES

WORK IN PROGRESS

Printed: 07/02/2019 @ 22:15

KEY:

- Proposed footway
- Existing footway
- Existing carriageway
- Proposed carriageway over-run
- Existing grass
- Restricted view within junction intervisibity

Rev	By	Chkd	Apprvd	Date	Description

Client

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1 The Square Temple Quay Bristol BS1 6DG
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www.ch2m.com

Project

QUEEN SQUARE

Drawing

OPTION 3c
INCREASING FOOTWAY WIDTHS AND TRAFFIC SIGNAL IMPROVEMENTS
QUEEN SQUARE

Drawn by: ADS	Date: 30/11/2017		
Checked by: -	Date: -		
Approved by: -	Date: -		
Drawing No. 674726.BB.27.09-09		Revision -	

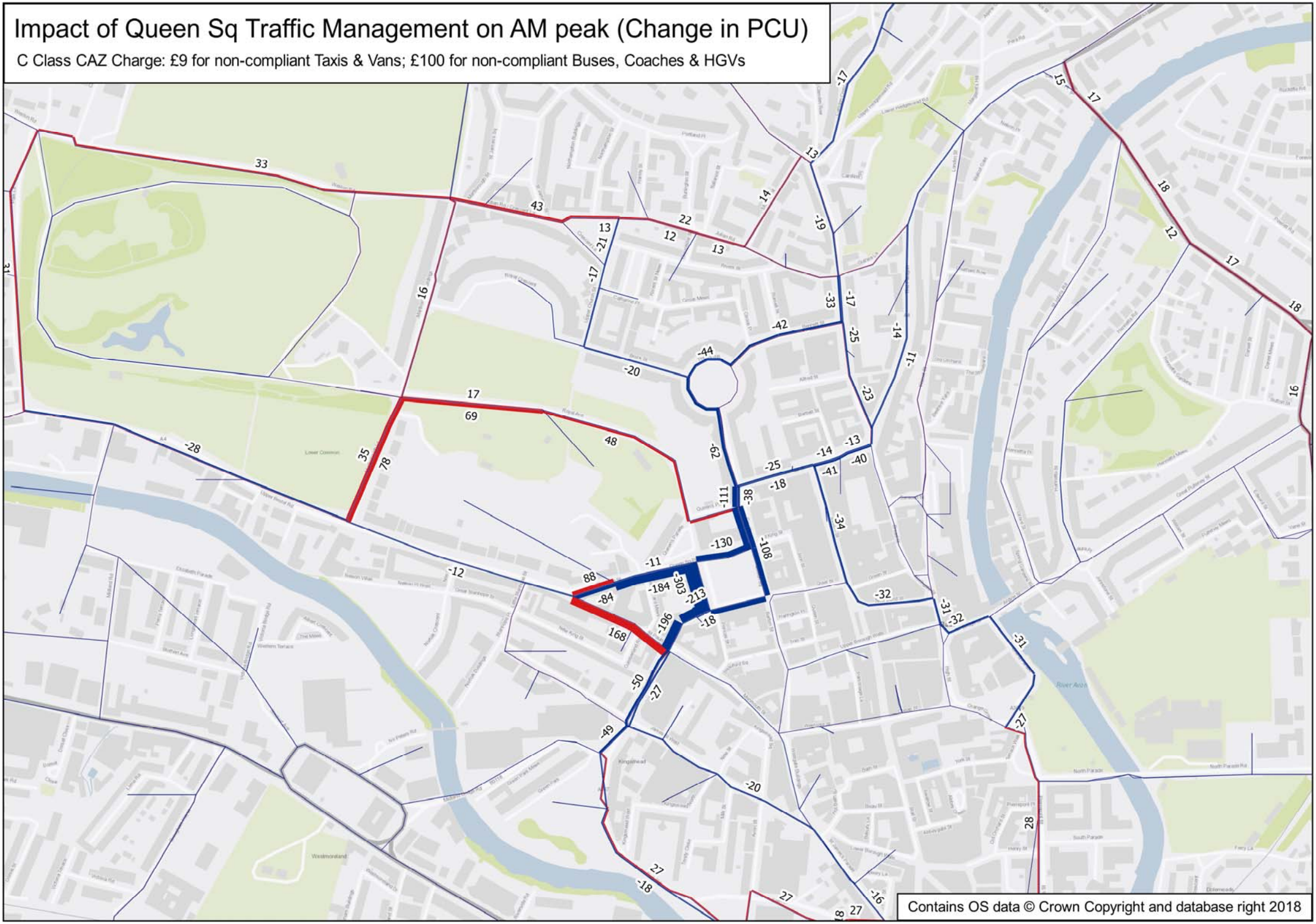
Drawing Scale: 1:250 @ A1

Drawing file path & name :
Xrefference file path
User and Plot Date

Appendix C. GBATH Flow Difference Plots: CAZ Class (with TM) against 2021 'Base-line'

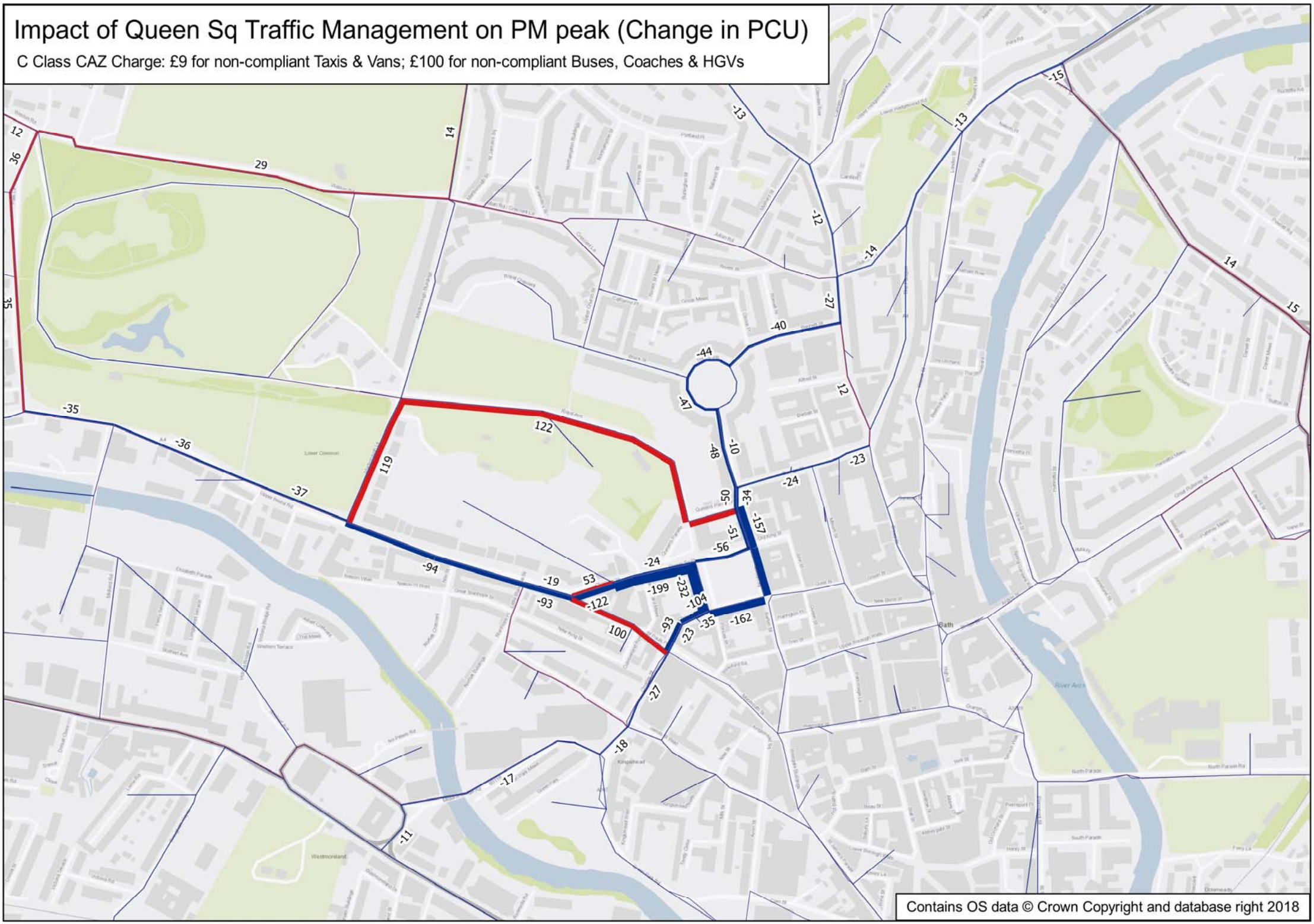
Impact of Queen Sq Traffic Management on AM peak (Change in PCU)

C Class CAZ Charge: £9 for non-compliant Taxis & Vans; £100 for non-compliant Buses, Coaches & HGVs



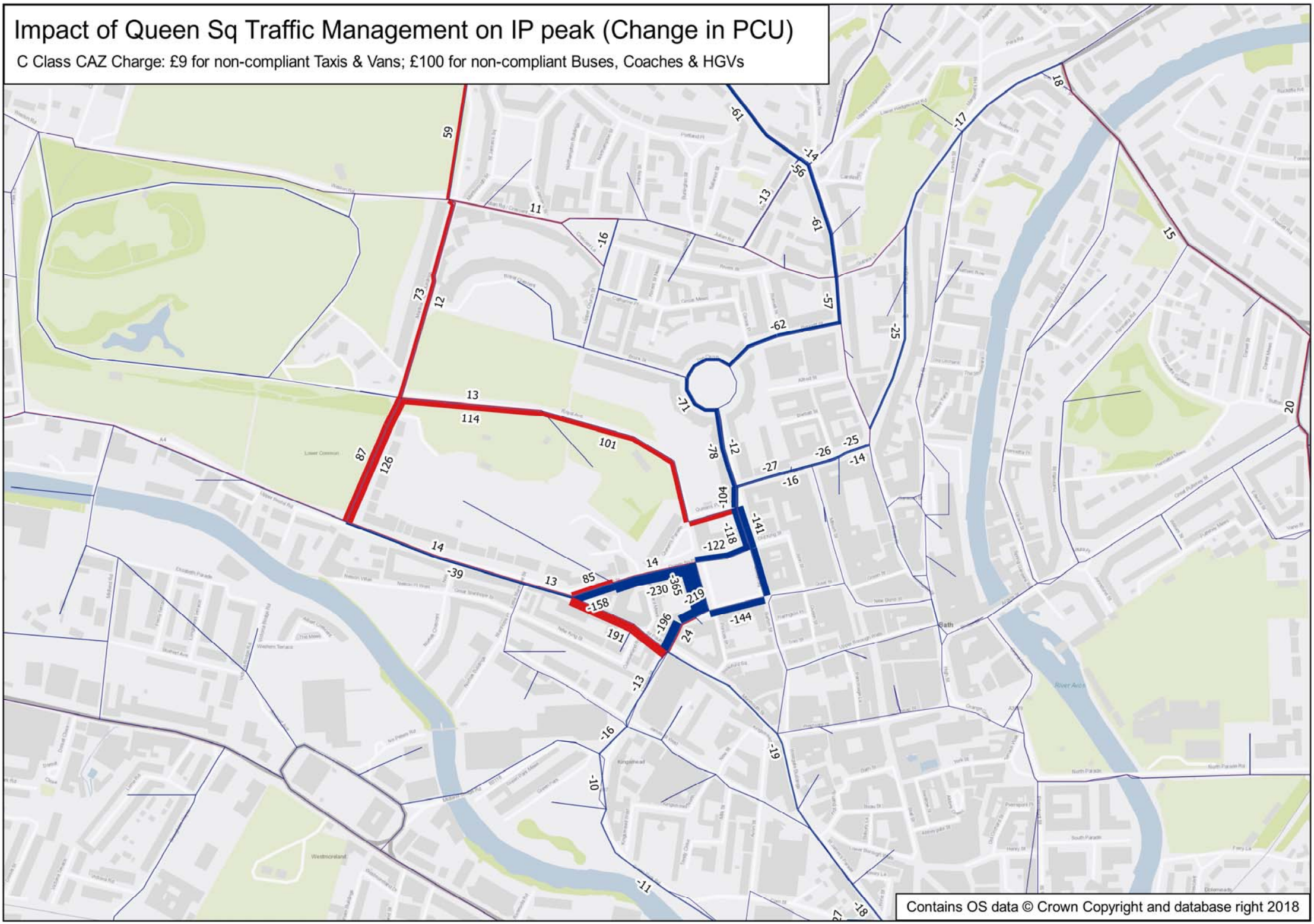
Impact of Queen Sq Traffic Management on PM peak (Change in PCU)

C Class CAZ Charge: £9 for non-compliant Taxis & Vans; £100 for non-compliant Buses, Coaches & HGVs



Impact of Queen Sq Traffic Management on IP peak (Change in PCU)

C Class CAZ Charge: £9 for non-compliant Taxis & Vans; £100 for non-compliant Buses, Coaches & HGVs



Appendix D. Developed Layout for Class C CAZ – Queen Square (Option 3E)

REV.

DRAWING No. TC9013-1200-01

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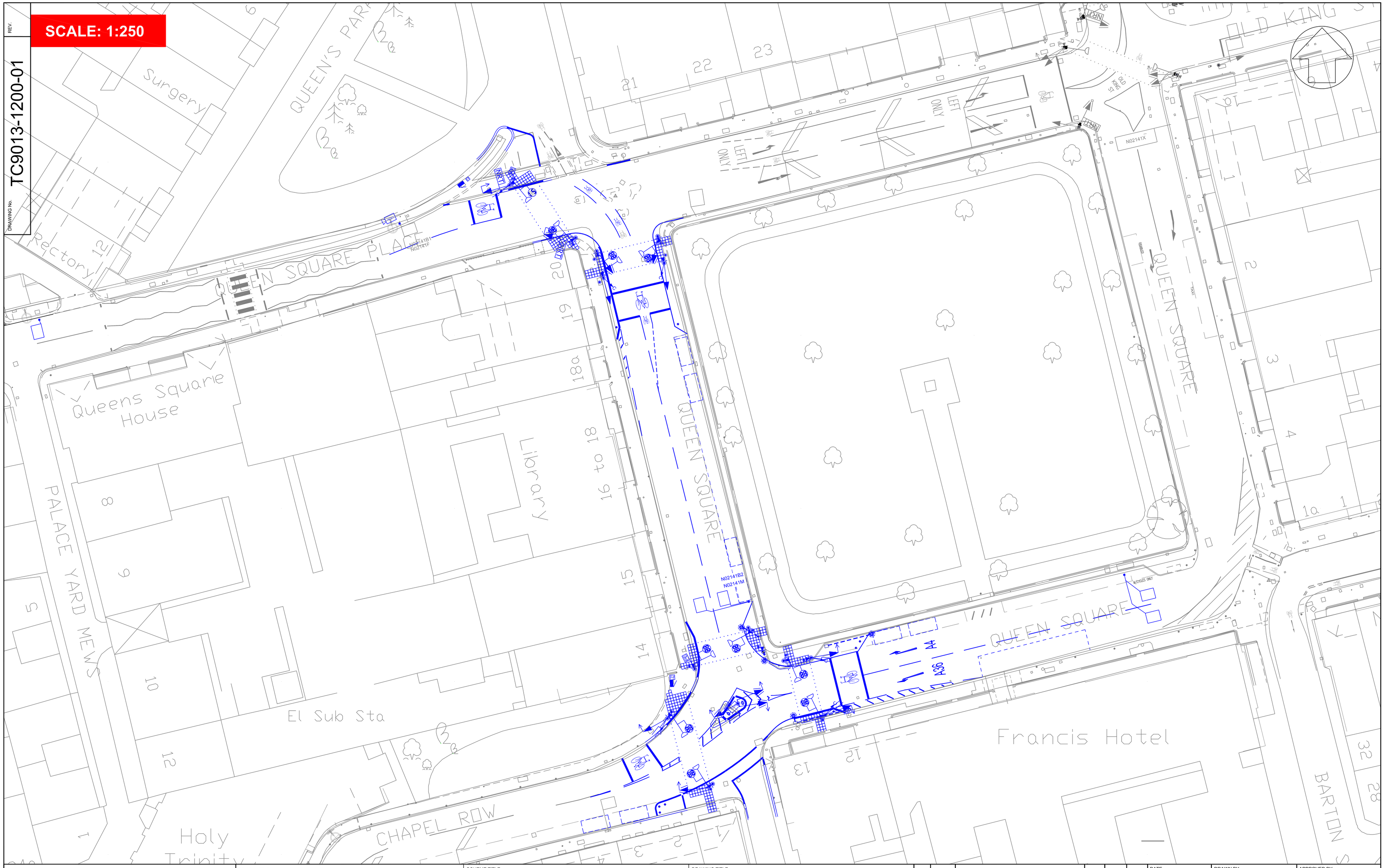

Bath & North East Somerset Council	KELVIN PACKER SERVICE MANAGER HIGHWAYS Civic Centre, Market Walk, Keynsham, Bristol BS31 1FS Telephone: (01225) 394041	PRODUCED BY Traffic Signals and Intelligent Transport Systems	SCHEME TITLE QUEEN SQUARE TRAFFIC MANAGEMENT SCHEME (CAZ)	DRAWING TITLE TRAFFIC SIGNAL LAYOUT	REV.	DATE	REVISIONS	DRWN. / CHKD. / APROV.

DATE OCT 19	DRAWN BY PT	APPROVED BY PT
SCALE AS SHOWN	CHECKED ML	
CLIENT REF.		
DRAWING No. TC9013-1200-01		REV.