Technical Note

ARUP

63 St Thomas Street
Bristol BS1 6JZ
United Kingdom
www.arup.com

t +44 117 976 5432
f +44 117 976 5433

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1 Introduction

Arup has been commissioned by Bristol City Council to provide advice relating to the feasibility of proposals to realign road infrastructure and unlock land for development at Western Harbour. The purpose of the study is to formally assess the feasibility of the opportunity from a multidisciplinary perspective, with a particular focus on transport.

Arup issued a Feasibility Report on 9th October 2018. The report considered ten different options for the rationalisation of road infrastructure within the study area. The report found that two of the options demonstrated sufficient feasibility to be considered in more detail – Option 8 and Option 10.

Following the issue of the Feasibility report, further work has been undertaken which examines Option 8 and Option 10 in more detail. The purpose of this re-examination is to identify ways in which detailed junction layouts could be enhanced in order to improve operations, and reduce land-take and construction costs.

This technical note summarises the further assessment work, focussing on traffic modelling and highways layout. It comprises the following sections:

- Section 2 discusses alternative junction arrangements for Option 8;
- Section 3 conceptualises and tests an alternative alignment of Option 10 ('The Hybrid');

The technical note is then concluded in Section 4, with outline highways drawings included as an appendix:

- Appendix A – Option 8 Rev A
- Appendix B – Option 8B
- Appendix C – Option 8C
- Appendix D – Option 8D
- Appendix E – Option 10 Rev A

2 Variants of Option 8

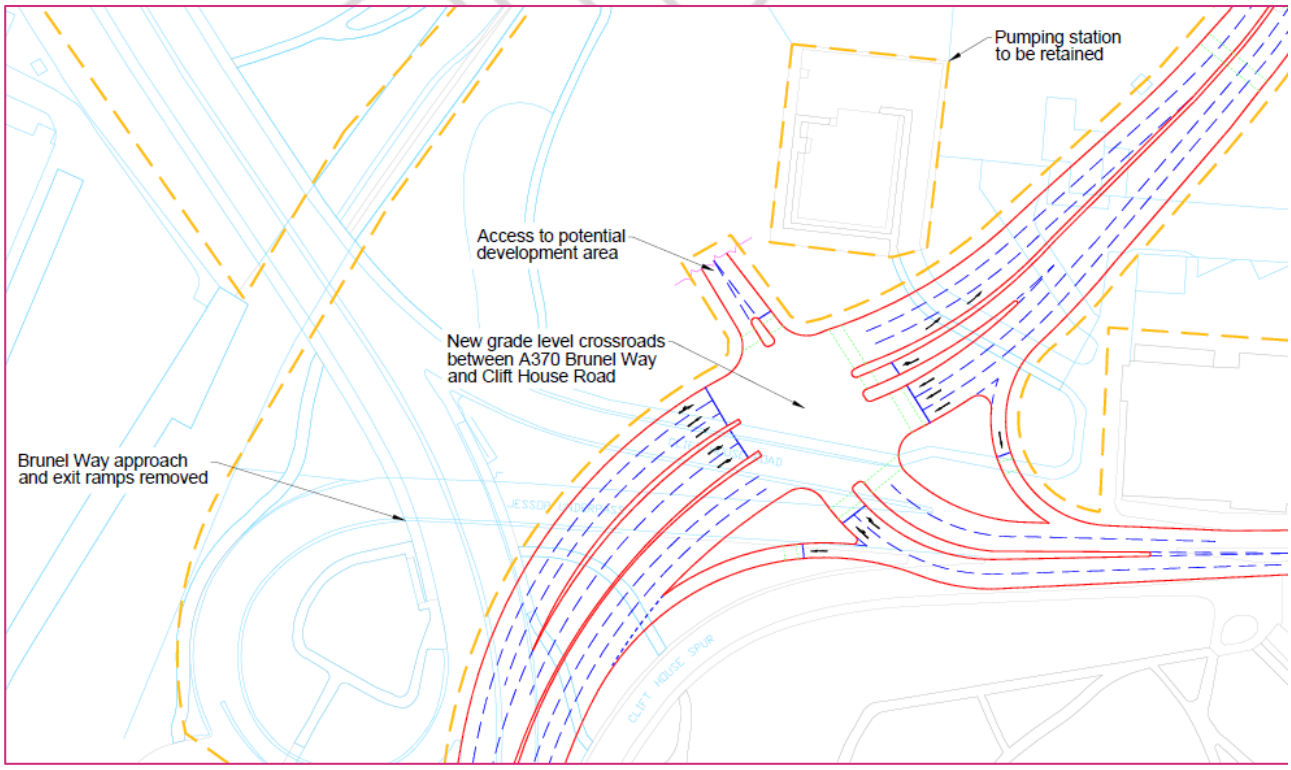
The Feasibility Report found that the alignment of Option 8 was feasible in traffic engineering terms and that it realises favourable outcomes in terms of most transport and non-transport parameters – such as queue lengths, delays and the relationship of demand and capacity. However, it is considered that variants of the option should be explored in order to refine the design and identify a stronger solution, particularly with regards to the below objectives:

- Alternative junction arrangements should be explored at the Clift House Road junction and the Cumberland Road / Metrobus junction, in order to reduce their footprint while maintaining operational performance. This is discussed in Section 2.1 and 2.2.
- Alternative gyratory arrangement should be explored for the Hotwells area, in order to reduce the volume of strategic traffic which passes existing residential properties in the Hotwells area. This is discussed in Section 2.3.

2.1 Alternative Junction Arrangement at Clift House Road

The Clift House Road junction layout included within Option 8 (as presented in the Feasibility Report) is a large all-movements signal controlled crossroads, with pedestrian crossings on three of its four arms. The layout requires a significant footprint and yet is close to its operational capacity. Figure 1 shows the outline highways layout of the junction.

Figure 1: Clift House Road Junction in Option 8 (as presented in the Feasibility Report) – Not to Scale

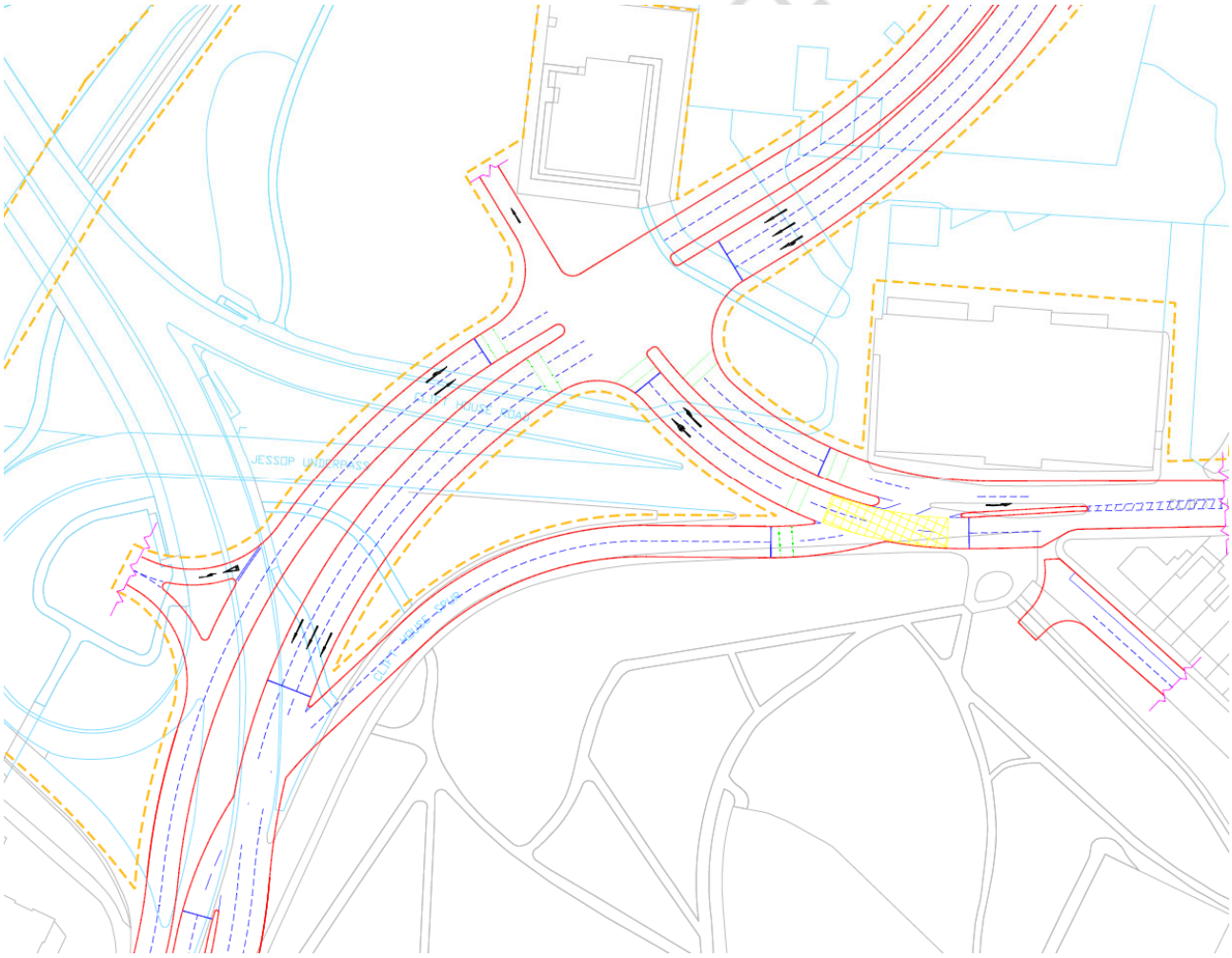


An alternative layout has been conceptualised which seeks to deliver a smaller footprint but with equal or improved operational capacity. This is achieved through:

- Providing a dedicated right turn expressway for traffic from the South Arm to Clift House Road, following the alignment of the slipway at the western extent of Greville Smyth Park;
- Providing egress from the development area to the A370 on a left-out basis only, remote from the Clift House Road junction; and
- Prohibiting right turns from the A370 North arm into the development area, at the Clift House Road junction.

Figure 2 shows the outline highways layout of the junction in its alternative form.

Figure 2: Alternative arrangement for Clift House Road Junction in Option 8 – Not to Scale



The alternative arrangement shown in Figure 2 includes pedestrian crossings at the main A370 / Clift House Road intersection – across only one side of the A370. This reflects the level of pedestrian provision included within the option shown in Figure 1, and has been designed as such in order to enable a fair comparison between the two options. The highway alignments of both options have been designed such that there is no requirement for land-take at Greville Smyth Park and that there are reasonable offsets from both the existing pumping station and the bonded warehouse.

The alternative junction arrangement presented in Figure 2 has been assessed in terms of its traffic operation in the future year of 2036 for a typical weekday AM and PM peak hour. The flows used in this assessment have been derived from the GBATS strategic model but modified to reflect expected flow-reductions through the study area for certain movements. The full detail of this flow estimation has been made can be found in the full feasibility report.

Table 1Table 3 compares the operational performance of the two junction arrangements presented in Figure 1 and Figure 2, as measured by queue length, delay per vehicle, and Degree of Saturation.

Results are presented with 'Red, Amber, Green' colour coding for ease of reference. Where the degree of saturation is lower than 90% the table is coloured green, where it exceeds 100% it is coloured red.

Table 1 – Clift House Road Junction – Operational Comparison

Link	AM			PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Arrangement as Per Feasibility Report						
A370 North Arm	11	24	45%	47	106	101%
Clift House Road	17	78	92%	31	150	103%
A370 South Arm (ahead)	31	40	93%	15	32	75%
A370 South Arm (right)	12	83	85%	30	146	101%
Alternative Arrangement						
A370 North Arm	16	31	72%	43	70	99%
Clift House Road intersection with A370 Mainline	19	50	86%	30	110	98%
Clift House Road intersection with Right Turn from A370	20	15	74%	36	30	91%
A370 South Arm (Ahead)	32	31	87%	16	18	58%
A370 South Arm (Right turn)	13	45	69%	19	50	86%
A370 Southbound Link between Clift House Road and A370 Right Turn	4	9	46%	14	13	73%

The results presented in Table 1indicate that the alternative arrangement proposed for the A370 / Clift House Road junction as part of Option 8 operates within capacity on all arms in both peak periods, with the exception of the Clift House Road intersection with the right turn from the A370, which is slightly above the conventional capacity threshold of 90% and which experiences considerable queuing.

While the queues on the Clift House Road approach to the A370 extend back towards the A370 Right Turn node, the model has been calibrated in such a way that there would be a 'green wave'

for both sets of signals on Clift House Road in order to maximise throughput and ensure proper coordination between the two movements.

The proposed alternative arrangement represents a significant improvement in operational terms when compared with the initial arrangement presented in the feasibility report. While the junction still experiences queuing and moderate delays, it is far more capable of delivering the demand flows that pass through it, in the PM peak in particular.

The improvement in performance is the result of the removal of certain movements and phases from the junction (such as the prohibition of right turns from the north arm into the potential development area), and also staggering the right turn from the A370 to Clift House road over a greater distance.

The prohibited turning movements are not considered to be a significant reduction in amenity for road users as there are adequate alternative routes that could be selected by them. For example access to the potential development area can be made via an ahead-movement from Clift House Road.

There are numerous other junctions in Bristol which employ the prohibition of certain movements in order to deliver an aggregate-level increase in junction performance and thus the alternative arrangement is by no means unconventional. The operational benefits arising from the prohibition of certain movements outweigh the disbenefits associated with a reduced amenity associated with re-assigned routes.

On that basis the alternative arrangement for the A370 / Clift House Road junction is considered to be superior in transport terms to the arrangement included in the Feasibility Report.

However, it should be noted that in selecting the preferred arrangement for this junction, other non-transport considerations should be taken into account. In particular, the relative footprints of the two designs should be considered, and their impact on street-scape, sense-of-place and urban design should be reviewed. As the designs develop, these topics should be explored in more detail alongside other technical workstreams such as 3D design and environmental and heritage impacts.

In order to inform an initial comparison of land-take, Table 2 sets out the relative footprint of the two arrangements – noting the possibility of developing land between the A370 mainline and the A370 right turn expressway.

Table 2: Footprint of A370 / Clift House Road junction in Option 8

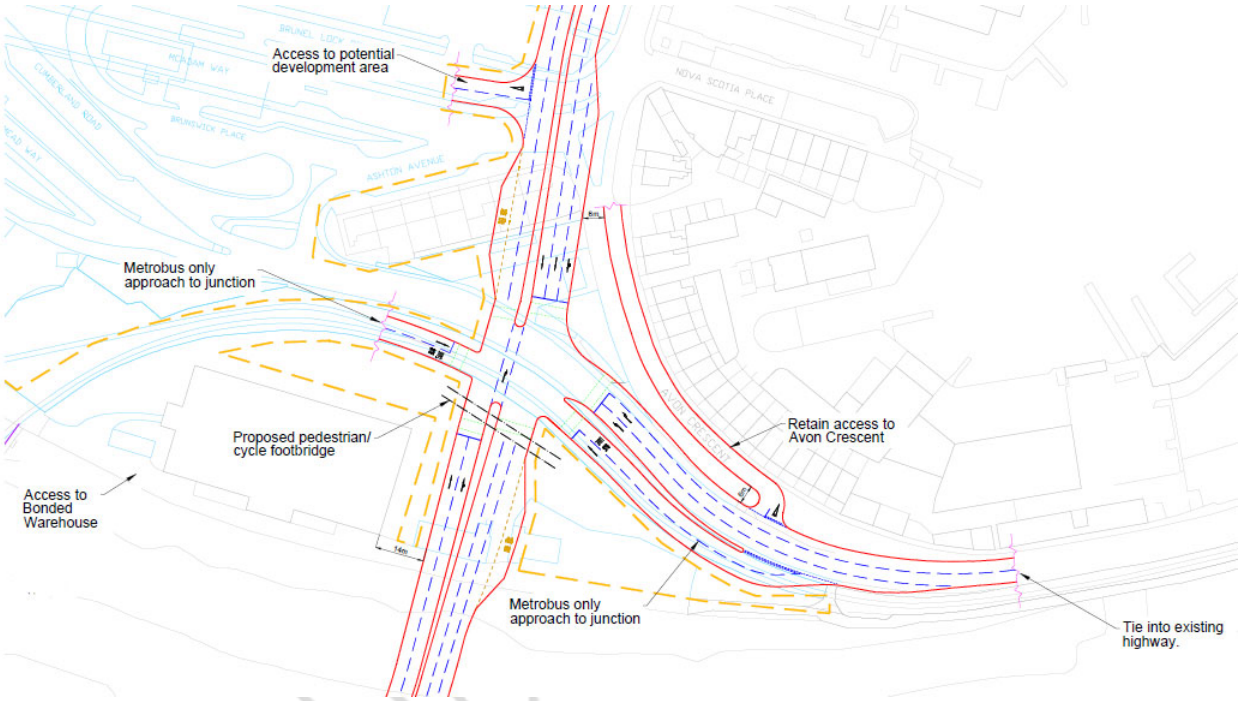
Arrangement as per Feasibility Study	Alternative arrangement (footprint includes land between A370 mainline and A370 right turn expressway)	Alternative arrangement (footprint excludes land between A370 mainline and A370 right turn expressway)
15,570 m²	17,750 m²	16,000 m²

Table 2 indicates that the alternative arrangement has a similar footprint to that of the arrangement included within the feasibility study. Given that the junction performs to a higher operational standard, and has a similar impact on walking / cycling and placemaking, it is proposed that the alternative arrangement is adopted as the preferred arrangement for the Clift House road junction within Option 8.

2.2 Alternative Junction Arrangement at Cumberland Road

The Cumberland Road junction comprised within Option 8 (as presented in the Feasibility Report) is a signal controlled crossroads, with pedestrian crossings on all four of its arms, and a bus gate for metrobus services to pass through. The signalling arrangement is complex as it provides for all turning movements, except for the bus phases which are ahead-only. Figure 3 shows the outline highways layout of the junction.

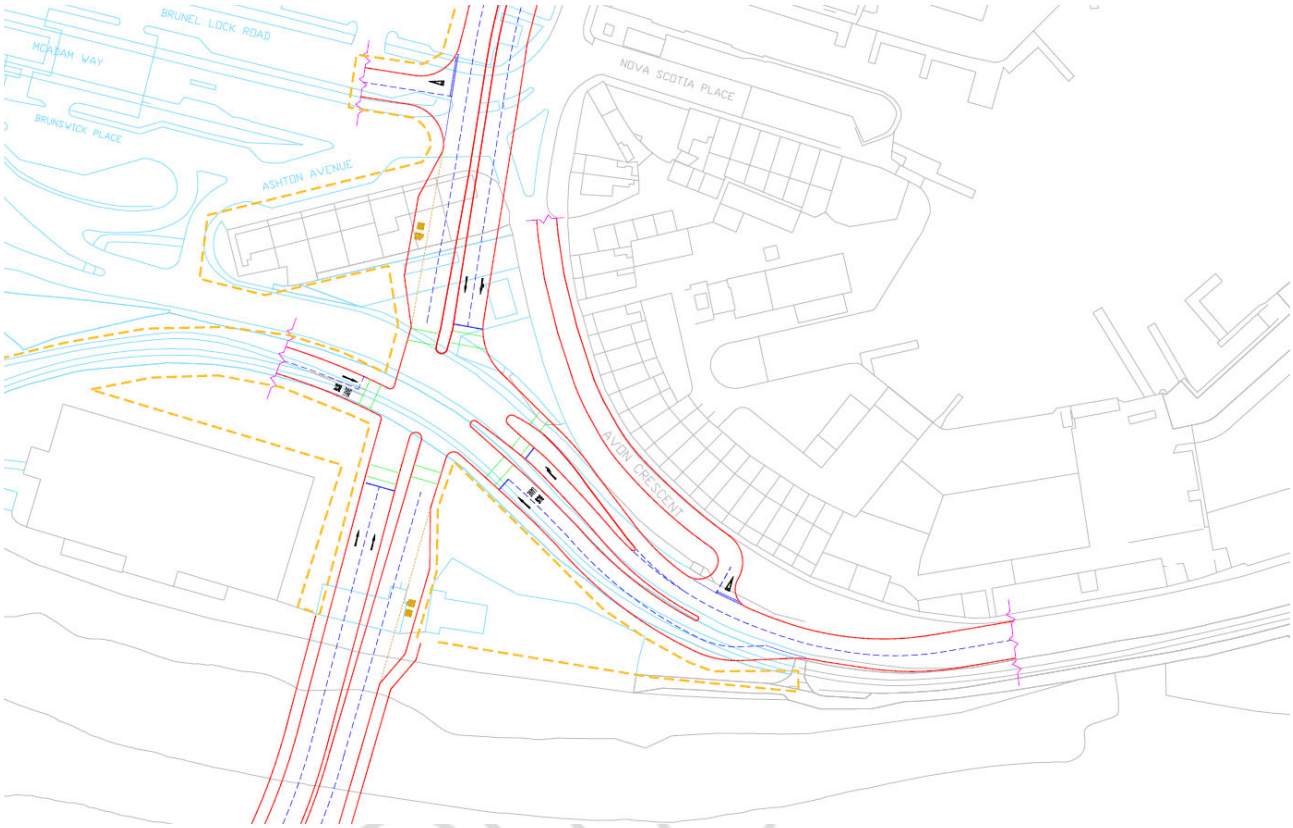
Figure 3: Cumberland Road Junction in Option 8 (as presented in the Feasibility Report) – Not to Scale



An alternative layout has been conceptualised which seeks to deliver a smaller footprint but with equal or improved operational capacity. This is achieved though prohibiting left turns from Cumberland Road, and prohibiting right turns from the southern arm. This enables the Cumberland Road phase to run concurrently with the Metrobus Phase, thus simplifying the signalling sequence and enabling the delivery of a more compact junction.

Figure 4 shows the outline highways layout of the junction in its alternative form.

Figure 4: Alternative Arrangement for Cumberland Road Junction in Option 8 – Not to Scale



As shown in Figure 4, the alternative arrangement has a reduced footprint, with only two southbound lanes on the A370 approach, and a single lane approach on Cumberland Road for general traffic.

Each junction arrangement has been assessed in terms of their traffic operation in the future year of 2036 for a typical weekday peak hour. The flows used in this assessment have been derived from the GBATS strategic model but modified to reflect expected flow-reductions through the study area for certain movements. The full detail of this flow estimation can be found in the full feasibility report.

Table 3 compares the operational performance of the two junction arrangements, as measured by queue length, delay per vehicle, and Degree of Saturation.

Table 3 – Cumberland Road Junction – Operational Comparison

Link	2036 Weekday AM			2036 Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Arrangement as Per Feasibility Report						
A370 North Arm	12	10	70%	55	57	99%
Cumberland Road	9	118	92%	28	154	103%
A370 South Arm	43	28	93%	30	28	86%
Alternative Arrangement						
A370 North Arm	14	7	62%	32	14	84%
Cumberland Road	8	142	91%	8	125	88%
A370 South Arm	37	27	90%	23	16	72%

Table 3 clearly shows that the alternative arrangement performs more strongly than the arrangement that was included within the feasibility report. The alternative arrangement generally has lower delays, queues, and degree of saturation in both peak periods.

The alternative arrangement performs more strongly through its prohibition of right turns from the A370 south arm, and the prohibition of left-turns from Cumberland road. This reduces the number of stages within the cycle while retaining specific amenity for the Metrobus.

The proposed prohibitions will cause a reduction in amenity for drivers wishing to access spike-island from the south, and to drivers wishing to turn left from Cumberland Road. However it is noted that there are alternative routes for such drivers, and that such movements can be catered for by other junctions within the study area of this report. The operational improvement associated with the prohibitions outweighs the reduced amenity for car drivers having to reroute their journeys.

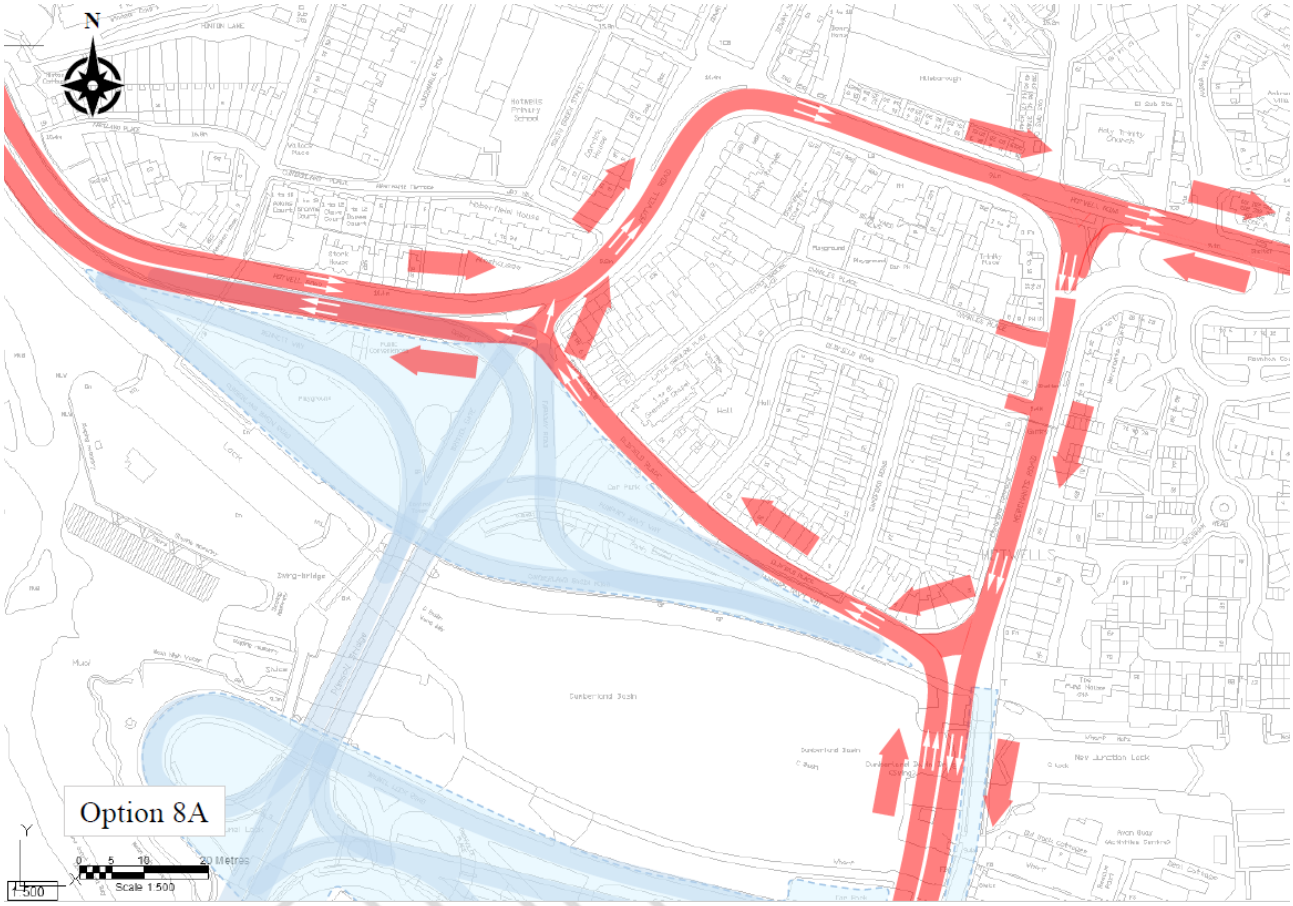
On the basis of the information presented above it is clear that the alternative arrangement is stronger in operational and land-use terms than the arrangement considered within the Feasibility report.

2.3 Alternative Hotwells Gyratory Arrangements

The Hotwells Gyratory is the road network directly to the north of Cumberland Basin which is comprised of Merchants Road, Christina Terrace, Hotwell Road and Oldfield Place.

The road layout to the north of Cumberland basin within Option 8 is greatly simplified in comparison to the existing scenario. Yet it is nevertheless required to perform a strategically important role for key traffic movements between the south of the River Avon and the Portway / City Centre. The proposal for Hotwells Gyratory (as per the Feasibility Report) is illustrated in Figure 5 below.

Figure 5: Hotwells Gyratory in Option 8 (as presented in the Feasibility Report) – Schematic - Not to Scale



This technical addendum explores alternative arrangements for the Hotwells Gyratory. In particular, it is important to develop solutions being cognisant of the impact of heavy traffic flows to residents living in the vicinity of the gyratory. As such this technical addendum has reviewed three further alternatives, each of which seek to reduce the level of traffic flows passing existing residential properties in the Hotwells area, as compared with the arrangement proposed in the Feasibility Report.

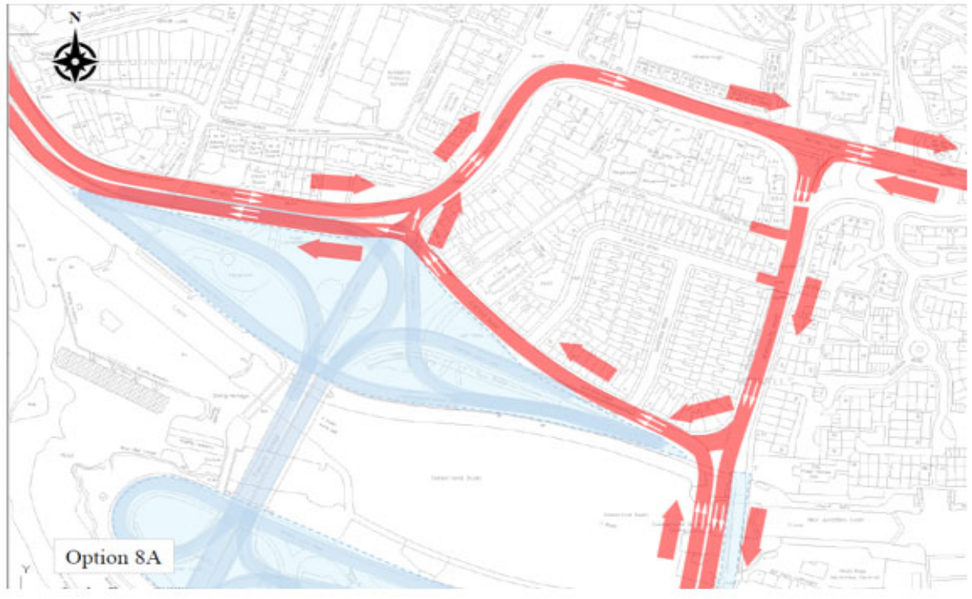
The four alternatives for the gyratory within Option 8 are presented in Figure 6 overleaf. The outline highways drawings associated with each plan are appended to this technical addendum. This report will now consider the operational performance of each sub option in turn. Junction modelling results are set out to establish the operational performance of the options, before a discussion of traffic flows is presented.

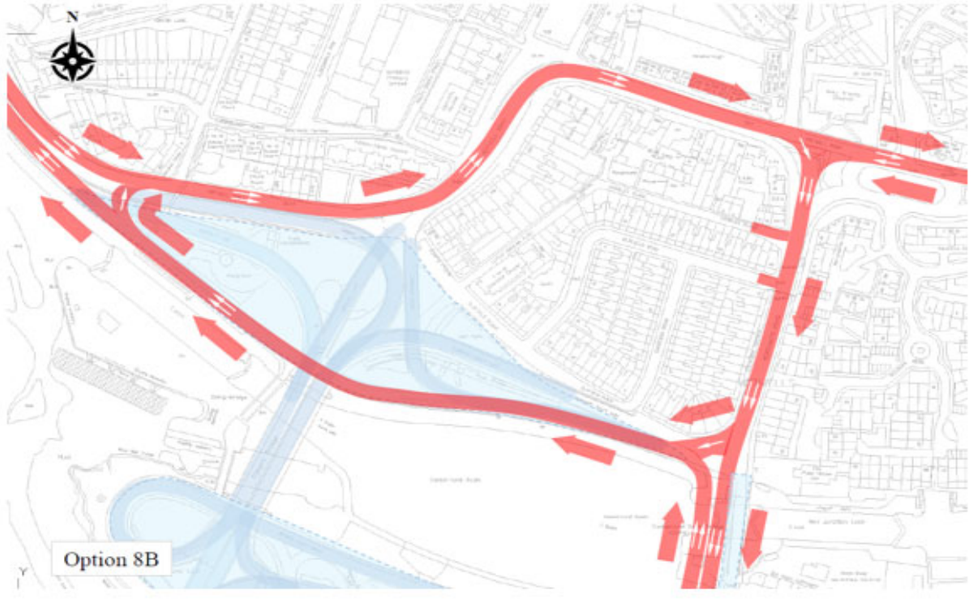
Option 8A and Option 8B retain the Hotwell Road, Merchants Road and Oldfield Place as a clockwise gyratory.

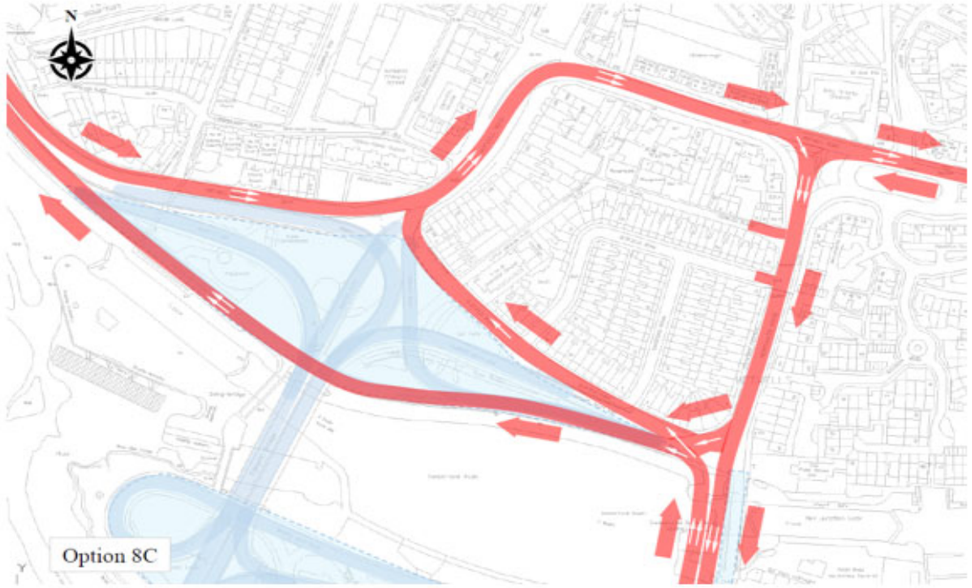
Option 8C retains the Hotwell Road, Merchants Road and Oldfield Place clockwise gyratory but provides an additional link running westbound along the northern bank of Cumberland Basin.

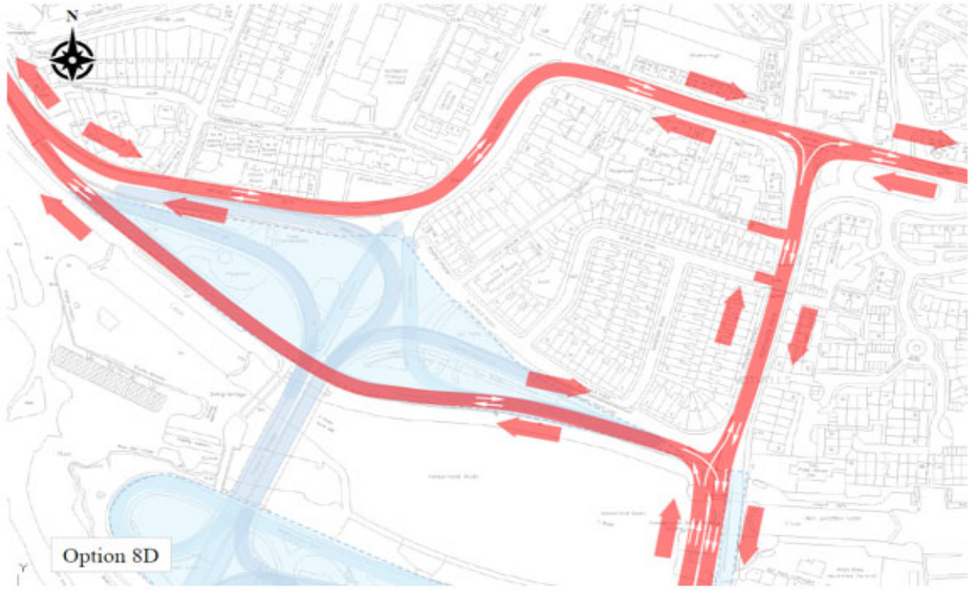
Option 8D converts Hotwell Road to a two-way road, and provides an additional link running westbound along the northern bank of Cumberland Basis. Merchants Road is also converted to a two way road.

Figure 6: Hotwells Gyratory - Option 8A, 8B, 8C, and 8D - Schematics









2.3.1 Option 8A and Option 8B

The Hotwell Gyratory arrangement within Option 8A and Option 8B remain unchanged from the Feasibility Result. However the results are repeated below for ease of reference.

Table 4 – Option 8A&8B - Merchants Road / Oldfield Place Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Merchants Road North	10	5	59%	22	9	80%
Merchants Road North (RT to Oldfield Place)	1	5	11%	1	4	7%
Merchants Road South	24	9	81%	14	6	66%

Table 4 shows that the junction operates well within capacity on all arms in both the AM and the PM peak. This is to be expected given that the only conflicting flow is from vehicles wishing to turn from Merchants Road onto Oldfield Place, a movement which gives way to northbound traffic from Junction Bridge.

Table 5 – Option 8A&8B - Hotwell Road / Merchants Road Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Hotwell Road West Ahead	16	12	89%	38	39	96%
Hotwell Road West Right Turn	20	15	73%	33	49	93%
Hotwell Road East	12	53	76%	37	66	98%

The results presented in Table 5 show that the junction operates at close to or at full capacity in both the AM and PM peak. The only conflicting movement to the Hotwell Road West Ahead arm is the pedestrian crossing from the refuge to the north side of Hotwell Road and so it should be noted that were the crossing phase to be called less than once per cycle then the performance of this arm would improve significantly.

Table 6 – Option 8A&8B - Hotwell Road / Oldfield Place Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Hotwell Road West	30	66	96%	15	18	72%
Oldfield Place Right Turn	46	71	99%	13	48	80%
Oldfield Place Left Turn	10	9	87%	11	10	88%

The results presented in Table 6 show that the junction operates well within capacity on all arms in PM peak, but approaching capacity in the AM peak. While queues are not inconsiderable, average delay does not significantly exceed one minute per vehicle and queues are expected to dissipate to zero during each green phase

2.3.2 Option 8C

The results associated with the layout for Option 8C are presented in the tables below. It should be noted that the layout and operation of the Hotwell Road / Merchants Road junction in Option 8C is identical to that of Option 8A and 8B.

Table 7 – Option 8C - Merchants Road / Oldfield Place Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Merchants Road North	12	8	62%	27	12	83%
Merchants Road South	27	11	82%	15	7	67%

The results presented in Table 7 show that the junction operates well within capacity on all arms in both the AM and the PM peak. This is to be expected given that the only conflicting flow is from vehicles wishing to turn from Merchants Road onto Oldfield Place, a movement which is fairly low and can be managed safely with a single signalised approach lane.

Table 8 – Option 8C - Hotwell Road / Merchants Road Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Hotwell Road West Ahead	16	12	89%	38	39	96%
Hotwell Road West Right Turn	20	15	73%	33	49	93%
Hotwell Road East	12	53	76%	37	66	98%

The results presented in Table 8 show that the junction operates well within capacity on all arms in the AM peak, but approaching capacity in the PM peak.

Table 9 – Option 8C - Hotwell Road / Oldfield Place Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Hotwell Road West	27	54	93%	12	14	65%
Oldfield Place Right Turn	33	42	94%	12	48	79%

The results presented in The results presented in Table 8 show that the junction operates well within capacity on all arms in the AM peak, but approaching capacity in the PM peak.

Table 9 show that the junction operates well within capacity on both arms in PM peak, but approaching capacity in the AM peak. The results are comparable to those in Table 6, as the form of the junction is very similar to that of Option 8A and 8B, with the exception that the left-turn movement from Oldfield Place to Hotwell Road is now provided for further to the west of this junction and thus does not feature within its operational arrangement.

2.3.3 Option 8D

The results associated with the layout for Option 8D are presented in the tables below.

Table 10 – Option 8D - Merchants Road / Oldfield Place Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Merchants Road North	7	26	42%	22	49	90%
Merchants Road South	32	35	91%	38	23	91%
Oldfield Place Approach	27	53	88%	27	42	85%

The results presented in Table 10 show that the Merchants Road / Oldfield Place junction is expected to operate close to or surpassing the operational threshold of 90% in the PM peak. Significant queuing is present in both peak periods. It should be noted that the queue on the Merchants Road North arm would be expected to extend back to its upstream junction.

Table 11 – Option 8D - Hotwell Road / Merchants Road Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Hotwell Road West Ahead	6	87	75%	1	68	6%
Hotwell Road East	4	3	35%	13	6	68%
Merchants Road	25	17	76%	7	8	37%

The results presented in Table 11 shows that the Hotwell Road / Merchants Road junction is expected to operate well within capacity in both the AM and PM peak on all arms. While there is a high delay per vehicle for vehicles travelling between the A4 Portway and the City Centre, the junction as a whole operates well.

Table 12 – Option 8D - Hotwell Road / Oldfield Place Junction – 2036 Reduced Flows

Link	Weekday AM			Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Hotwell Road West	6	4	41%	8	5	46%
Hotwell Road East	1	59	15%	1	59	10%
Oldfield Place	16	14	86%	19	16	88%

The results presented in Table 12 show that the Hotwell Road / Oldfield Place junction is expected to operate within capacity in both the AM and PM peak on all arms, with the exception of the Oldfield Place approach in the PM peak. While this arm experiences a PRC at the operational threshold of 90%, the delay per vehicle and queue length are not so significant as to conclude that the junction operates poorly.

2.3.4 Operational Comparison of Option 8A, 8B, 8C and 8D

The above sections present the detailed operational performance of road junctions within Option 8A, 8B, 8C and 8D. In order to determine which sub option is the strongest in terms of traffic operations, the results are summarised and compared against one another in Table 13.

Table 13 – Comparison of Junction Performance in Option 8A, 8B, 8C and 8D.

Junction	Option 8A/8B Worst Arm		Option 8C Worst Arm		Option 8D Worst Arm	
	Queue (PCU)	Deg of Sat	Queue (PCU)	Deg of Sat	Queue (PCU)	Deg of Sat
Merchants Road / Oldfield Place	24	81%	27	83%	35	91%
Hotwell Road / Merchants Road	37	98%	37	98%	17	76%
Hotwell Road / Oldfield Place	46	99%	43	94%	19	88%

The summary figures presented in Table 13 show that each of the sub-options experiences at least some capacity issues, resulting in queues and operational sub-optimality at two or more junctions.

It should be noted that in selecting the preferred arrangement for Hotwells Gyratory, other non-transport considerations should be taken into account. In particular, the relative footprints of the designs should be considered, and their impact on street-scape, sense-of-place and urban design should be reviewed. As the designs develop, these topics should be explored in more detail alongside other technical workstreams such as 3D design and environmental and heritage impacts.

As discussed in Section 2.3, a key consideration in determining a preferred arrangement for Hotwells Gyratory is the volume of traffic flow that passes along each of the links. This matter is discussed in the paragraphs that follow.

2.3.5 Flow Comparison of Option 8A, 8B, 8C and 8D

As indicated in Figure 6, the different sub-Options for Hotwells Gyratory will result in different traffic routes and circulatory arrangements, which in turn result in different volumes of traffic passing through the existing residential areas lining the gyratory.

Schematic plans appended to this report show the expected traffic flows on each link of the Hotwells Gyratory. The relative flows passing through the gyratory are shown in Figure 7, taking as its point of reference three points; Hotwell Road in the vicinity of Dowry Square; Merchants Road; and Oldfield Place.

Figure 7: Relative Traffic Flows at the Hotwells Gyratory for Option 8 Variants

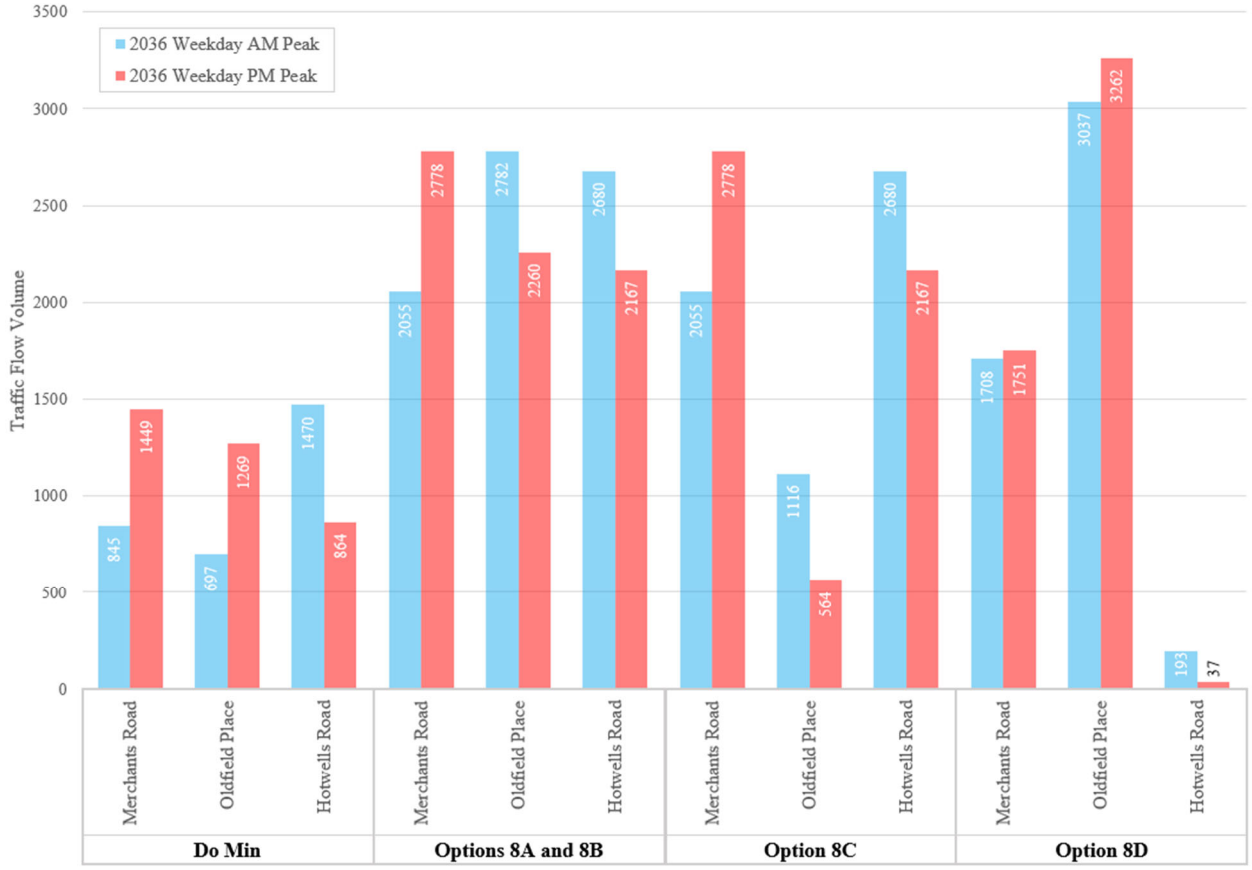


Figure 7 shows that all of the proposed options would increase traffic levels on Merchants Road, compared to the existing scenario. However, this increase should be considered in the context of the removal of grade separated infrastructure to the south of the gyratory, at Oldfield Place. Oldfield Place is aligned further from the existing residential dwellings at the gyratory in Options 8B, 8C, and 8D, which will offset the impact of increased traffic flows along this side of the gyratory. Option 8D shows a particular improvement on Hotwell Road as this link will be used solely by traffic travelling between the Portway and the City Centre.

3 Variants of Option 10 – Highway Connection South of River Avon

The Feasibility Report found that the alignment of Option 10 (the 'Hybrid') was feasible in traffic engineering terms and that it realises favourable outcomes in terms of most transport and non-transport parameters. However, it is considered that variants of the option should be explored in order to refine the design and identify a stronger solution, particularly with regards to the below issue.

3.1.1 Arrangement as Presented in Feasibility Study

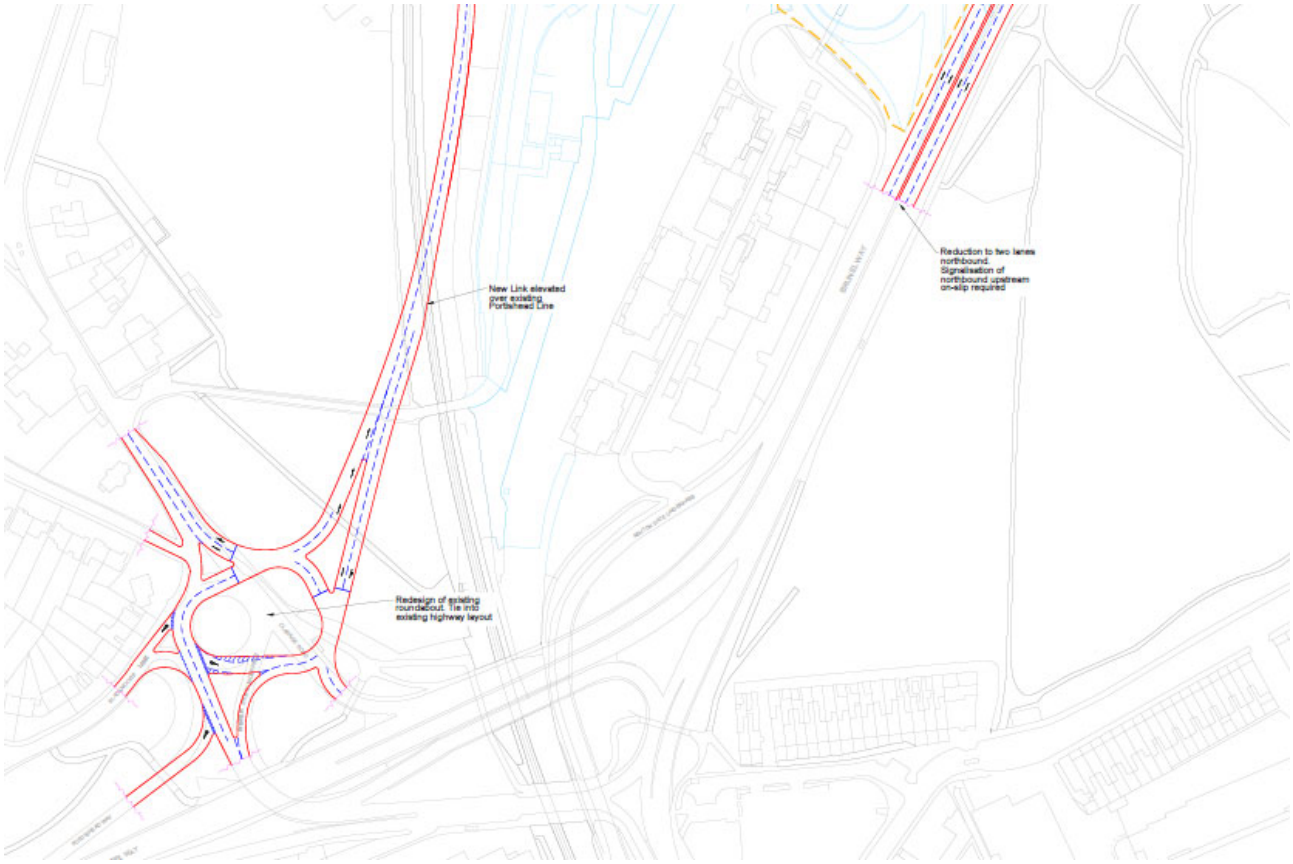
Figure 8 illustrates how the proposed New Avon Link connects with the highways network south of the River Avon at a proposed new roundabout with the A369 / Blackmore Lane and the A370. The Feasibility Report concluded that the roundabout is expected to operate reasonably well from an operational point of view.

However, it is considered that the routing of strategic traffic in proximity to the residential and educational land uses to the west of the roundabout would be disbeneficial from a community point-of-view. There are also significant constraints associated with the alignment to the north of the proposed junction – these include the prescence of the Portishead rail line and the need to cross this with an elevated structure. In addition the alignment would be routed through the allotment area to the east of the Portishead line.

On that basis it is considered that alternative alignments south of the River Avon should be explored.

This technical note has therefore explored the potential of connecting the New Avon Link with the A370 between its junction with Clift House Road and its junction with the A3029.

Figure 8: Alignment of Option 10 south of the River Avon



3.1.2 Potential Alternative Arrangement

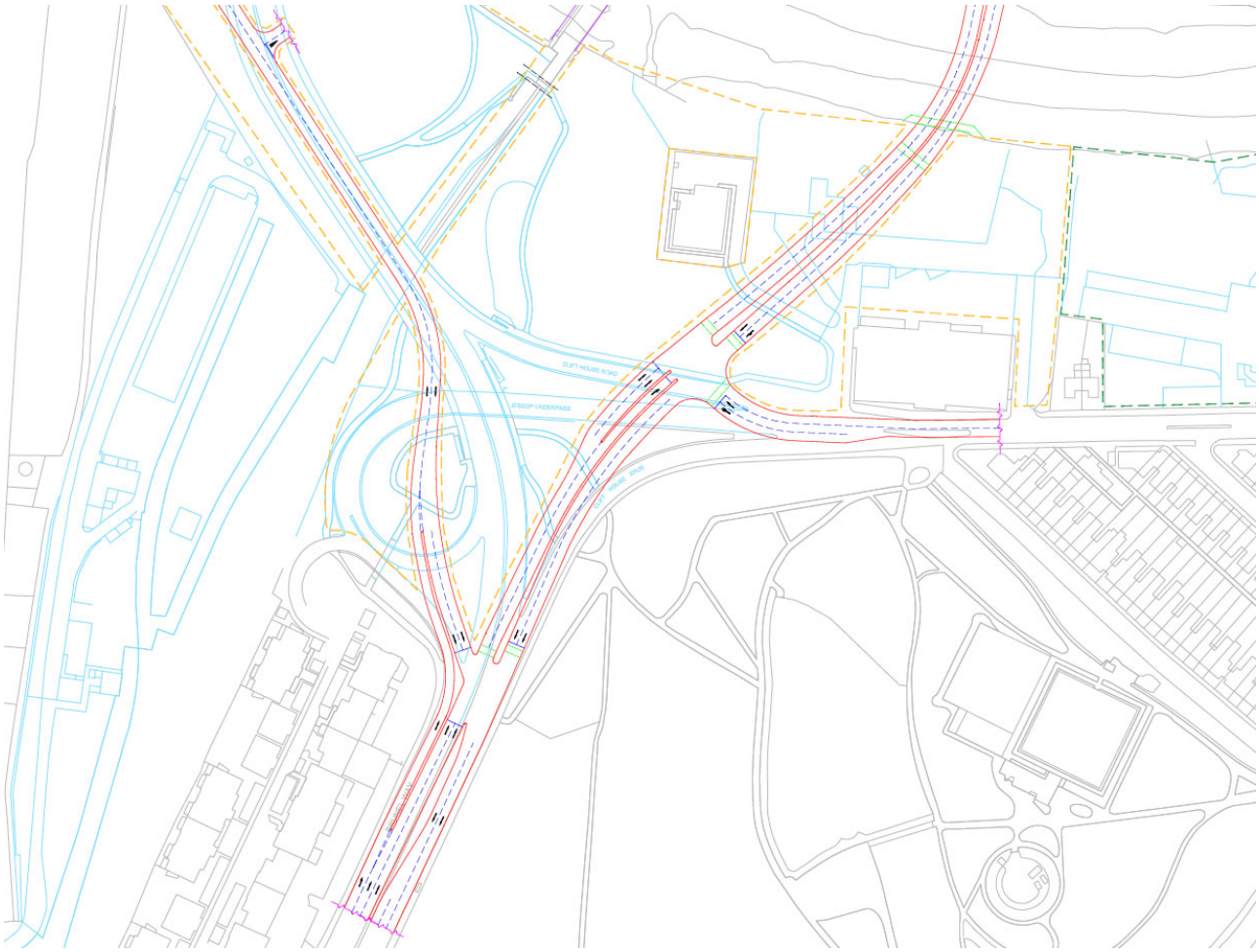
Consideration has been given to connecting the New Avon Link with the A370 around 65m south of its intersection with Clift House Road. The New Avon Link would therefore pass through the land to the north of the allotments and the Paxton Drive Estate, following the alignment of what is currently the elevated structure of Brunel Way.

Since the New Avon Link would only be for strategic traffic travelling between the A370 and the Portway, there is no requirement for the junction between the New Avon Link and the A370 to be an all-movements junction. The junction therefore does not provide a right turn from the A370 north arm onto the New Avon Link, or a left turn from the New Avon Link to the A370 North arm.

A pedestrian crossing is provided across the northern side of the junction to complement the provision at the proposed A370 / Clift House Road junction to the north, which is not provided with a pedestrian crossing on its southern side.

The proposed alternative arrangement for the connection between the New Avon Link and the A370 is illustrated in Figure 9 below.

Figure 9: Alternative Arrangement for Junction of A370 and New Avon Link



The initial and alternative junction arrangement has been assessed in terms of their traffic operation in the future year of 2036 for a typical weekday peak hour. The flows used in this assessment have been derived from the GBATS strategic model but modified to reflect expected flow-reductions through the study area for certain movements. The full detail of this flow estimation can be found in the full feasibility report.

Table 14 compares the operational performance of the two junction arrangements, as measured by queue length, delay per vehicle, and Degree of Saturation.

Table 14 – Cumberland Road Junction – Operational Comparison

Link	2036 Weekday AM			2036 Weekday PM		
	Queue (PCU)	Delay (s / pcu)	Deg of Sat	Queue (PCU)	Delay (s / pcu)	Deg of Sat
Arrangement as Per Feasibility Report						
New Avon Link Approach	6	21	57%	16	28	88%
A369 Approach	10	20	69%	9	20	69%
Worst Performing Circulatory Arm	10	20	69%	8	19	62%
Alternative Arrangement						
A370 North Arm	3.4	8.5	36%	11.8	26.8	83%
Cumberland Road	7.0	26.0	77%	11.6	24.3	89%
A370 South Arm	9.0	12.8	81%	11.5	23.6	88%

The alternative junction arrangement is forecast to operate within capacity in both peak hours with a Practical Reserve Capacity (PRC) of 11.3% and 1.3% in the AM and PM peak hours respectively. The junction is beginning to approach capacity in the PM peak hour, however the forecast delay is below 30 seconds on all entries.

When compared to the junction arrangement at the A369 / A370 junction included within the Feasibility Report, it is considered that the alternative arrangement functions with less residual capacity and thus performs slightly less well from an operational point of view. However, the delay per vehicle is comparable across the two arrangements and both junctions are below the threshold beyond which they would be described as over-capacity. As such it is considered that in selecting the preferred alignment of the New Avon Link (and its connection with the road network south of the River Avon), broader matters relating to land use, cost, and feasibility should be the deciding factors.

3.1.3 Wider Issues

There is a number of key distinctions between the two options for connecting the New Avon Link with the existring road network south of the River Avon. These are discussed below.

- **Impact on Existing Communities** – the option presented within the feasibility study would increase traffic in the vicinity of the junction of the A369 and the A370, which includes a school.
- **Impact on Development Area** – the alternative alignment would result in the New Avon Link passing through the potential development area directly to the south of the River Avon. This would have an impact on the development potential of the scheme.
- **Bridge over Metrobus route** – The alternative alignment requires a grade separated crossing of the Metrobus route. The alignment as currently drawn crosses the Metrobus

route at the location that the A370 does so presently, and as such it is considered that the construction of a bridge at this location is reasonably feasible. The gradient of the road between this Metrobus bridge and the junction of the New Avon Link and the A370 cannot be determined in detail until the vertical alignment of the proposed A370 link is defined. However, the distance over which the New Avon Link must achieve an elevation of around 4.8m (over the Metrobus line) is 100m, and thus it is considered that designing the road to have an acceptable gradient is not unforeseeable.

- **Bridge over Metrobus route** – The alternative arrangement does not require the construction of a new bridge over the Portishead Line, whereas the arrangement included within the feasibility study does. The alternative arrangement thus does not require engagement with the BAPA process and negotiation with network rail.

- **Land Ownership** - The alternative arrangement can be constructed entirely within land owned by Bristol City Council, which is not true of the alignment presented in the feasibility study, which would require interaction with Network Rail in the vicinity of the Portishead Line, and also potentially with other third part landowners close to the tie in with the A369 / A370 junction. It would also have a significant impact on the allotments located to the east of the Portishead Line.

On the basis of the wider issues presented above, it is considered that the alternative alignment of Option 10 would involve fewer construction and planning challenges, has less impact on existing communities, and is of comparable performance in terms of traffic operations. It is thus proposed that the alternative arrangement for Option 10 is adopted as the preferred alignment.

4 Summary

Arup has been commissioned by Bristol City Council to provide advice relating to the feasibility of proposals to realign road infrastructure and unlock land for development at Western Harbour. The purpose of the study is to formally assess the feasibility of the opportunity from a multidisciplinary perspective, with a particular focus on transport.

Arup issued a Feasibility Report on 9th October 2018. The report considered ten different options for the rationalisation of road infrastructure within the study area. The report found that two of the options demonstrated sufficient feasibility to be considered in more detail – Option 8 and Option 10.

Following the issue of the Feasibility report, further work has been undertaken which examines Option 8 and Option 10 in more detail.

This technical note summarises the further assessment work, focussing on traffic modelling and highways layout.

4.1 Option 8

This Note has found that there are competing alternatives for the arrangement of the Hotwell Gyratory within Option 8. Four different arrangements have been reviewed and it is found that each is feasible in terms of traffic operations and provides pedestrians and cyclists with a similar level of facility. This note has established however that the options differ greatly in terms of the amount of traffic which passes along the four sides of the Hotwell Gyratory. Therefore in selecting a preferred sub-option for the Hotwell Gyratory, consideration should be given to this issue. The selection of a revised layout will have an impact on the residents and communities of the wider Hotwell Area, as well as the residents of the potential development area to the north of Cumberland Basin.

It is also found that there are alternative layouts for the junctions at Cumberland Road and at Clift House Road which perform more strongly in terms of traffic operations than those presented in the Feasibility Study. The alternative arrangement at Cumberland Road has a reduced footprint, while the alternative arrangement at Clift House Road has a similar footprint to that of the initial design.

4.2 Option 10

This note has also developed and tested an alternative arrangement for the Tie In between the New Avon Link and the highway network to the south of the River Avon, within Option 10. It is found that the alternative alignment of Option 10 performs similarly well to that of the option as per the Feasibility study, but it may involve fewer construction and planning challenges and has less impact on existing communities than the option presented in the Feasibility Study.

Technical Note

260233 22 January 2019

DOCUMENT CHECKING (not mandatory for File Note)

	Prepared by	Checked by	Approved by
Name	Ed Whitney & Phill Ayres	Phill Ayres	Andrew Jenkins
Signature			

Appendix A – Option 8 Rev A

A1

Increased public realm at Dowry Square

Bus lane in advance of signalised junction.

Tie into existing highway.

Increased public realm on Hotwell Road

Loading bay

Tie into existing highway.

Loading bay

Existing gyratory replaced by new junction with increased public realm.

Access to potential development area

Increased public realm on Oldfield Place

Bus lane in advance of signalised junction.

'Brunel's Other Bridge' reinstated for pedestrian and cycle use.

Bus lane in advance of signalised junction.

Retain existing footbridge

Retain existing footbridge

New 4 lane lifting bridge.

Existing swing bridge removed.

Access to potential development area

Metrobus only approach to junction

No left turn to A370 south

Metrobus only approach to junction

Retain access to Avon Crescent

No right turn to Cumberland Road

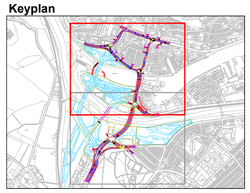
Access to Bonded Warehouse

For continuation see drawing No. CH-42_REV A

Legend:

- Proposed Roads
- Removed Highway Infrastructure
- Released Land

Keyplan



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63 St Thomas Street
Bristol BS1 6JZ
Tel +44(0)117 976 5432 Fax +44(0)117 976 5433
www.arup.com

Client
Bristol City Council

Job Title
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Drawing Title
Highway General Arrangement
Option 8 REV A
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Job No **260233-00**

Drawing Status **Information**

Drawing No **CH-041_REV A**

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A1

Access to potential development area

For continuation see Sheet 1 of 2

Metrobus only approach to junction

Retain access to Avon Crescent

Access to Bonded Warehouse

Retain Metrobus crossing point

Metrobus only approach to junction

Tie into existing highway.

Indicative internal site intersection with Metrobus

Potential pedestrian/ cycle footbridge or underpass

Pumping station to be retained

3rd party land expected to be developed

Exit-only arm from potential development area

New grade level crossroads between A370 Brunel Way and Clift House Road

Brunel Way approach and exit ramps removed

Give-way left-in-left-out access junction to the potential development area

Opportunity for public realm or development

Tie into existing highway.

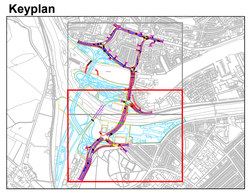
No access through Frayne Road. New turning head required.

Tie into existing highway.

Legend:

- Proposed Roads
- Removed Highway Infrastructure
- Released Land

Keyplan



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63 St Thomas Street
Bristol BS1 6JZ
Tel +44(0)117 976 5432 Fax +44(0)117 976 5433
www.arup.com

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Drawing No **CH-042_REV A**

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Appendix B – Option 8B

A1

Increased public realm at Dowry Square

Bus lane in advance of signalised junction.

Existing gyratory replaced by new junction with increased public realm.

Tie into existing highway.

Loading bay

As per option 8 (drawing CH-041)

Tie into existing highway.

Loading bay

Local traffic route only - designed as per Manual for Streets guidelines

Access to potential development area

Bus lane in advance of signalised junction.

Bus lane in advance of signalised junction.

One-way westbound on this section

'Brunel's Other Bridge' reinstated for pedestrian and cycle use.

Retain existing footbridge

Retain existing footbridge

New 4 lane lifting bridge.

Existing swing bridge removed.

Access to potential development area

Metrobus only approach to junction

Metrobus only approach to junction

Retain access to Avon Crescent

Access to Bonded Warehouse

For continuation see drawing No. CH-42

Cumberland Basin

Plimsoll Bridge

Avon Bridge

Brunel's Other Bridge

BRUNEL LOCK ROAD

CUMBERLAND ROAD

HASKARD WAY

BRUNSWICK PLACE

ASHTON AVENUE

NOVA SCOTIA PLACE

HUMPHRY DAVY WAY

FARADAY ROAD

GAUSS WAY

BRUNEL WAY

GREENDOCK WAY

GRENVILLE PLACE

GREYSTOKE ROAD

MCADAM WAY

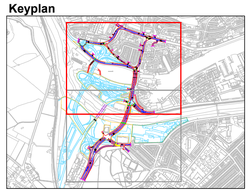
6m

14.3m

Legend:

- Proposed Roads
- Removed Highway Infrastructure
- Released Land

Keyplan



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63 St Thomas Street
Bristol BS1 6JZ
Tel +44(0)117 976 5432 Fax +44(0)117 976 5433
www.arup.com

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Bristol City Council

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Option 8B
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Drawing No **CH-043**

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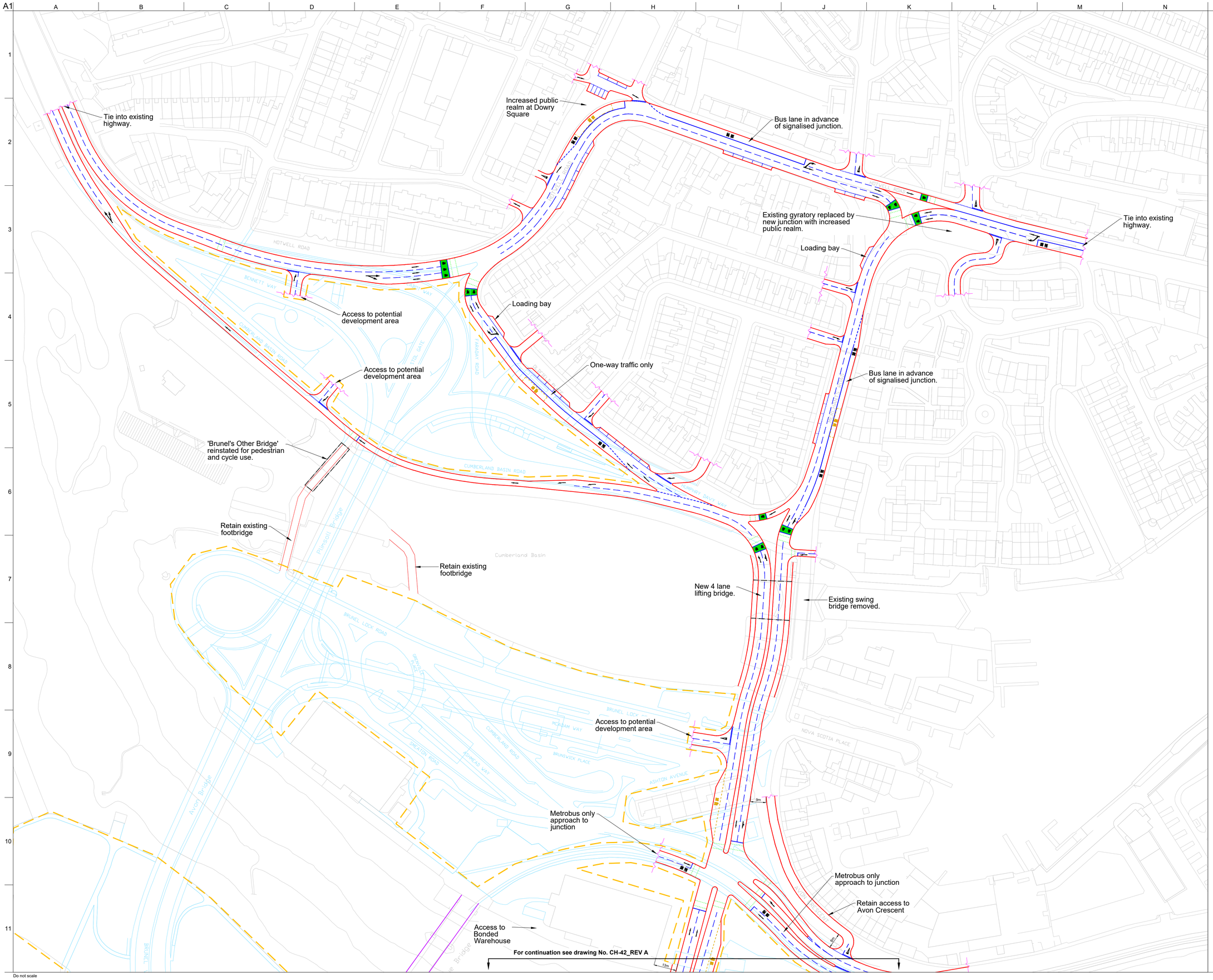
Appendix C – Option 8C



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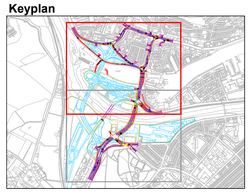
- Removed Highway Infrastructure
- Released Land

Keyplan



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63 St Thomas Street
Bristol BS1 6JZ
Tel +44(0)117 976 5432 Fax +44(0)117 976 5433
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Drawing Status Information

Drawing No CH-043C

Issue 01

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Appendix D – Option 8D

A1

Tie into existing highway.

Increased public realm at Dowry Square

Bus lane in advance of signalised junction.

Tie into existing highway.

Loading bay

Existing gyratory replaced by new junction with increased public realm.

Loading bay

Local traffic route only - designed as per Manual for Streets guidelines

Access to potential development area

Bus lane in advance of signalised junction.

'Brunel's Other Bridge' reinstated for pedestrian and cycle use.

Retain existing footbridge

Retain existing footbridge

New 5 lane lifting bridge.

Existing swing bridge removed.

Access to potential development area

Metrobus only approach to junction

Metrobus only approach to junction

Retain Metrobus crossing point

Access to Bonded Warehouse

Retain access to Avon Crescent

For continuation see drawing No. CH-42_REV A

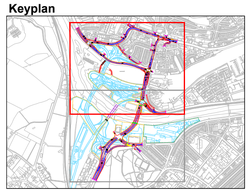
HOTWELL ROAD
BENNETT WAY
FARADAY ROAD
HUMPHRY DAVY WAY
CUMBERLAND BASIN
BRUNEL LOCK ROAD
GRENVILLE PLACE
MORGAN WAY
CUMBERLAND ROAD
BRUNSWICK PLACE
SPEEDWELL ROAD
ASHMEAD WAY
ASHTON AVENUE
NEVA SCOTIA PLACE
Plimsoll Bridge
Avon Bridge

Legend:

- Proposed Roads
- Removed Highway Infrastructure
- Released Land

N

Keyplan



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Bristol BS1 6JZ
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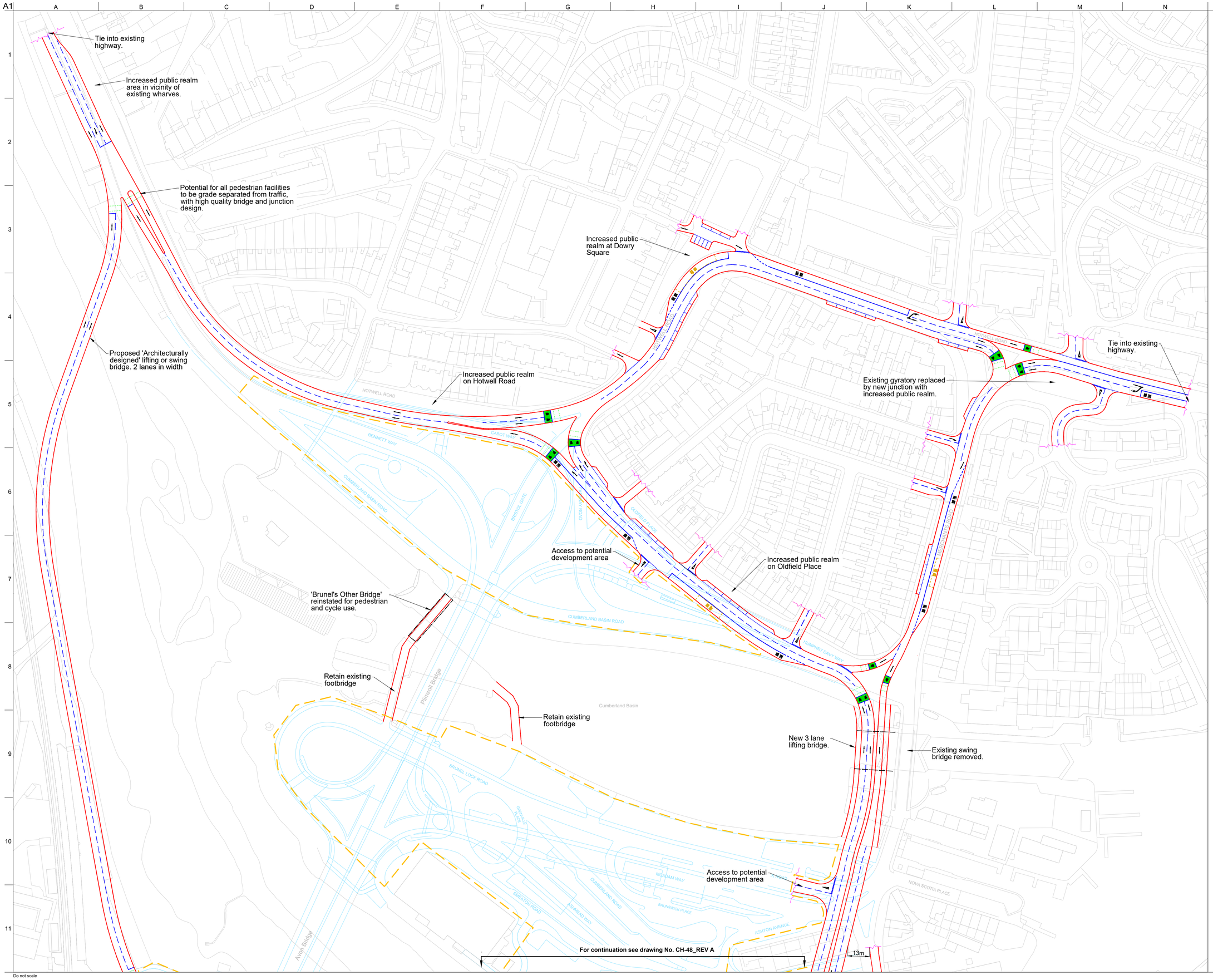
Appendix E – Option 10 Rev A



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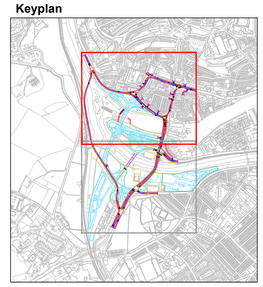

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Bristol BS1 6JZ
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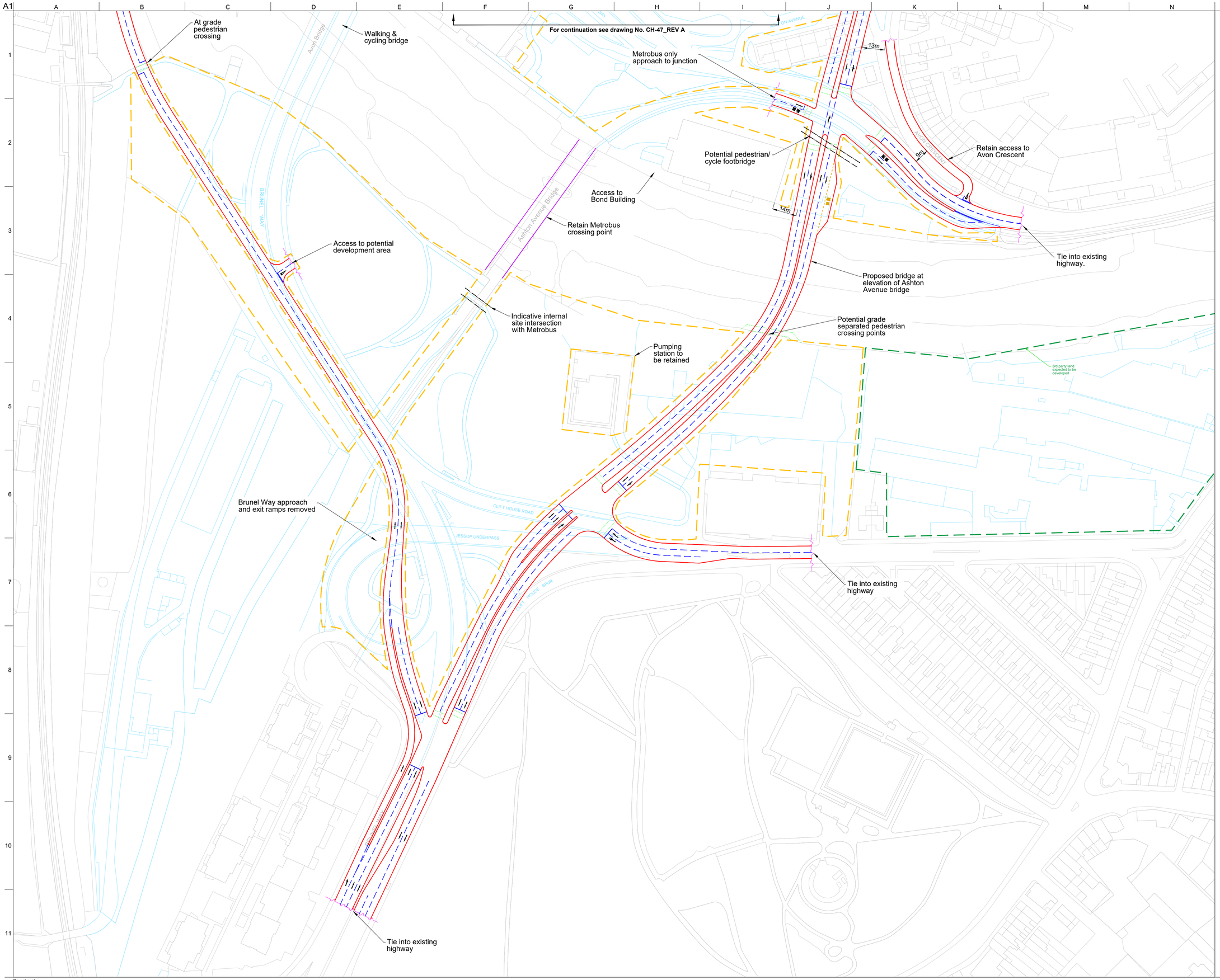

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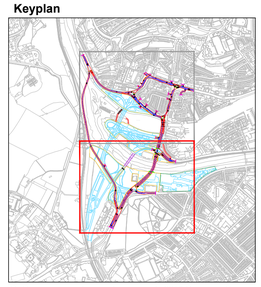

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Bristol BS1 6JZ
Tel +44(0)117 976 5432 Fax +44(0)117 976 5433
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