

3. Alternatives Considered

3.1 Introduction

- 3.1.1 The EIA Regulations require consideration of alternative solutions, and an indication of the main reasons for choices made, taking into account environmental impacts.
- 3.1.2 This chapter provides an overview of options considered throughout the Stage 1 (URS, 2014) and Stage 2 (AECOM, 2017) Design Manual for Roads and Bridges (DMRB) assessments and the reasons for taking forward options at each stage, and through to the DMRB Stage 3 assessment and the development of the preferred option.

3.2 DMRB Stage 1 Scheme Assessment

- 3.2.1 A total of eight junction options underwent DMRB Stage 1 scheme assessment:
- Option 1 – Dumbbell Grade Separation at Sheriffhall;
 - Option 2 – All slip roads provided at Gilmerton, no connection at Sheriffhall;
 - Option 3 – Squareabout at Gilmerton, A7 bridged over A720;
 - Option 4 – Collector Distributor, no connection at Sheriffhall;
 - Option 5 – Combined Gilmerton and Sheriffhall junctions;
 - Option 6 – Grade Separation at Sheriffhall;
 - Option 7 – Dumbbell Grade Separation at Sheriffhall, Gilmerton slips closed; and
 - Option 8 – Dumbbell Grade Separation west of Sheriffhall.
- 3.2.2 Options 1 to 6 were based on those which were reported in the A720 Sheriffhall Roundabout, Feasibility Study Scottish Transport Appraisal Guidance (STAG) 1. Options 7 and 8 were developed during the DMRB Stage 1 Inception Workshop. The eight options were subject to an engineering, environmental and traffic and economic assessment in accordance with DMRB Stage 1 assessment requirements.
- 3.2.3 Options 1, 6 and 8 all addressed the central objective of providing grade separation at Sheriffhall Roundabout without significantly changing the existing points of access to the A720 Edinburgh City Bypass ('the A720') at Sheriffhall Roundabout and the adjacent Gilmerton and Millerhill junctions. In contrast Options 2, 3, 4, 5 and 7 all resulted in a significant change to the main points of access to that which currently prevails.
- 3.2.4 Initial appraisal showed that Option 3 had no clear advantage over Option 2 but because Option 2 had more roundabouts it was considered to be a more complex arrangement and therefore concluded there would be little value in taking it forward to Stage 2. Similarly, Option 7 and Option 1 were alike but because Option 7 reduced access options to the A720 by closing the existing Gilmerton slip roads, it was therefore ruled out.
- 3.2.5 Option 4 removed the direct connection at Sheriffhall Roundabout, replacing it with a collector distributor road between the west facing slips at Gilmerton and east facing slips at Millerhill. Whilst this option reduced the current level of access to and from the A720 Edinburgh City Bypass, its main attraction was the additional capacity it provided to the A720 Edinburgh City Bypass, effectively adding another lane in each direction. However, there was a greater risk that Option 4 would generate high levels of opposition compared to other options and together with the significantly larger land footprint and the high capital cost, this option was also rejected.

- 3.2.6 Option 5 had the same central elements as Option 1 but because it had a greater capital cost, reduced connectivity at Sheriffhall Roundabout and an increased land footprint it was concluded, for similar reasons to Option 4, that it should not be taken forward to Stage 2.
- 3.2.7 Although Option 2 had many of the same disadvantages as Options 4 and 5, Option 2 had a much lower capital cost and therefore was considered worthy of further assessment at Stage 2.
- 3.2.8 The Stage 1 Scheme Assessment recommended that Options 1, 2, 6 and 8 were taken forward for further assessment at Stage 2. Further details can be found in the DMRB Stage 1 Scheme Assessment Report.

Environmental Assessment at Stage 1

- 3.2.9 A Stage 1 Environmental Assessment was prepared identifying the relevant baseline conditions of the area which could be significantly affected by any of the proposed Options, giving a broad indication of likely environmental effects. An overall assessment of the importance of impacts on the baseline environment was provided, highlighting any major problems or benefits. Although mitigation was not considered in detail at this stage, a broad indication of potential mitigation measures aimed at preventing, reducing or offsetting adverse environmental effects were described.
- 3.2.10 The environment team worked closely with the wider team identifying constraints and opportunities and feeding into the design development of options. The Stage 1 assessment showed that there are no major environmental constraints or designations within the immediate vicinity of the junction options, and that there were no major environmental impacts associated with any of the options that would prevent them being taken forward to Stage 2. The main efforts of the environment team at this stage were to ensure that impacts on private property, agricultural land and any designated development land were minimised. In summary, all options were considered to result in largely similar impacts, and it was concluded that the main differences in relation to environmental impact were related to the size of the footprint of each option.

3.3 DMRB Stage 2 Scheme Assessment

Initial Option Development at Stage 2

- 3.3.1 A significant level of design development was undertaken at Stage 2 to refine the layouts that emerged from Stage 1, to enable a detailed comparative assessment of the options and ultimately identification of an overall preferred junction layout.
- 3.3.2 Detailed LIDAR survey information was obtained for the study area and the vertical and horizontal geometry of layouts was refined and developed to ensure a best fit with the topography.
- 3.3.3 At Stage 1, for Options 2 and 8 it was initially proposed that the re-aligned A6106 North (Millerhill Road) would form a simple T-junction with the A7 North. However, following consideration of more detailed traffic flow information it was decided that a roundabout would be required to improve operation.
- 3.3.4 The roundabout layouts for all options were developed in line with the requirements of DMRB. Development of the roundabout entry and exit arrangements led to further amendment of the horizontal geometry of side and slip roads to ensure deflection and layout standards were achieved.
- 3.3.5 A geometry review of each layout was undertaken in accordance with DMRB, Volume 5, Section 1, Part 2 'Scheme Assessment Reporting' (TD37/93) (The Highways Agency, et al., 1993). Due to the constrained nature of the study area, relaxations in both vertical and horizontal geometry were included where necessary to minimise the impact on

the environment. Opportunities to improve the level of standard provided were considered as the design layouts evolved.

Value Management Workshop 2a – Sifting of Option 2

- 3.3.6 An initial Stage 2 Value Management Workshop was held in March 2015. Initial findings from the study were presented to the Workshop, which included the project team and representatives from Transport Scotland.
- 3.3.7 A comparative scoring exercise of the options against the scheme objectives was undertaken at the workshop. On conclusion of this exercise, it was agreed that Option 2 did not sufficiently meet the scheme objectives and that it should therefore not be taken forward for further Stage 2 assessment. The main issues identified with Option 2 were as a result of the proposal to merge both Sheriffhall and Gilmerton Junctions into one junction.

Further Development of Remaining Options

- 3.3.8 The design options were renamed as follows for the remainder of the Stage 2 Scheme Assessment:
- Option A – Dumbbell Grade Separation at Sheriffhall (Roundabout previously Option 1)
 - Option B – Grade Separation at Sheriffhall Roundabout (previously Option 6)
 - Option C – Dumbbell Grade Separation west of Sheriffhall Roundabout (previously Option 8).
- 3.3.9 As part of the scheme development, a review was undertaken of the relative merits of keeping the A720 at-grade with elevated side roads carried over the bypass in comparison to carrying an elevated A720 on embankment and bridge over at-grade local roads.
- 3.3.10 The review considered the implications on adjacent properties, nearby watercourses, material quantities, scheme land requirements, the Borders Railway and buildability. It was found that retaining the A720 at-grade for Options A and B resulted in a small reduction in the volume of imported materials required and had a lesser impact on the Borders Railway. At the same time, an at-grade A720 resulted in a larger overall land footprint, increased impact on the adjacent properties and watercourses and introduced greater difficulty maintaining traffic flows during construction. The optimum solution was found to be that the A720 mainline should be elevated on embankment and bridged over the at-grade side roads for Options A and B.
- 3.3.11 Option C adopted an offline layout with the A720 remaining at-grade and the side roads raised on embankment. No benefit in terms of buildability was apparent in the adoption of at-grade side roads and a raised A720 for Option C.
- 3.3.12 A review of stopping sight distance (SSD) was undertaken for Options A, B and C. Verge widening was applied to the design layouts as required to ensure the full visibility envelope was contained within the carriageway and verge where possible.
- 3.3.13 Further consideration was given to buildability in the refinement of the design options. Opportunities to minimise potential delays during construction were considered. As a result, the merge and diverge slips on Options A and B were lengthened to tie in to the A720 where the mainline design remains at-grade. The extended slips enabled traffic to be re-routed, along the new slip roads and through the Sheriffhall Roundabout, during the construction of the new A720 embankment sections. Option C retained the A720 at-grade through Sheriffhall Roundabout therefore no buildability refinements were applied to the design option.
- 3.3.14 Non-motorised user (NMU) provision was also incorporated into the design with offline routes using the bypassed sections of the A7 and A6106 carriageways where possible. Option C presented the best opportunity for segregated provision at the existing junction as the new Sheriffhall Junction is relocated west. Options A and B presented a bigger challenge with a number of at-grade crossings required to provide an NMU route at the existing junction location and

on the desire line. An underpass below the A720 and the west facing slips was considered for Option B however the resultant additional NMU route length was negatively received at the Emerging Options Public Exhibition. It was concluded that further consideration of opportunities to improve NMU provision on the preferred option should be undertaken at Stage 3.

Option A

- 3.3.15 Option A was a grade separated dumbbell roundabout arrangement at Sheriffhall Roundabout with the A720 elevated and passing over the A7 carried by a new overbridge with a span of approximately 35m, see Figure 3.1 'Option A – Dumbbell Grade Separation at Sheriffhall Roundabout'. The 80m diameter dumbbell roundabouts and local roads would remain approximately at-grade. The north roundabout is a 5-arm roundabout which connects the A720 eastbound diverge slip, the A7 North, the A6106 North, the A720 eastbound merge slip and the A7 Link. The south roundabout is a 5-arm roundabout which connects the A720 westbound merge slip, the A7 Link, the A720 westbound diverge slip, the A6106 South (Old Dalkeith Road), and the A7 South.

Figure 3.1 Option A – Dumbbell Grade Separation at Sheriffhall Roundabout



- 3.3.16 The A720 mainline would be raised on embankments up to 9.5m high on approach to the A7 crossing. Vertical and horizontal realignment of the A720 would be required over an approximate length of 1600m.
- 3.3.17 The A720 eastbound merge slip and A720 westbound diverge slip cross the Borders Railway and would therefore require the existing railway underbridge structure to be extended by approximately 19m. The A720 would also be raised in level at this point, compared to the existing layout. The existing railway underbridge has been designed such that it can accommodate an additional 5m depth of fill material. Therefore, the A720 mainline level increase at this location was understood to be achievable without strengthening work to the existing structure.

3.3.18 NMU facilities would be incorporated in the form of a shared footway/cycleway which utilises the existing carriageway as far as possible. NMU routes would generally be offline from live carriageway. NMU routes would be provided on the existing A7 North, A7 South, A6106 South and A6106 North. Where NMU routes run adjacent to the carriageway, shared facilities would be provided within the road verge and offset a minimum of 1.5m from the carriageway. At-grade crossings of A7 Link Road, A720 eastbound diverge slip, A720 eastbound merge slip, A720 westbound diverge slip and A720 westbound merge slip would be provided.

Option B

3.3.19 Option B provided a grade separated roundabout at Sheriffhall and had the least land-take of all emerging options, see Figure 3.2 'Option B – Grade Separation at Sheriffhall Roundabout'. Vertical and horizontal realignment of the A720 would be required over an approximate length of 1600m and the A720 would be carried across the Sheriffhall Roundabout by two new bridges each with a span of approximately 40m. The A720 mainline would be raised on embankments up to 9.9m high on approach to the Sheriffhall Roundabout crossings. The Sheriffhall Roundabout layout would be retained but would be enlarged and become an 8-arm roundabout, connecting the A7 North, the A6106 North, the A6106 South, A7 South and all A720 east and west facing slips.

Figure 3.2 Option B – Grade Separation at Sheriffhall Roundabout



3.3.20 The A720 eastbound merge slip and westbound diverge slip cross the Borders Railway and would therefore require the existing railway underbridge structure to be extended by approximately 47m. The roundabout at Sheriffhall would be enlarged to 150m diameter but retained at its existing location and would be reduced to three lanes in width. Minimal realignment of the roundabout arms would be required, with the exception of the A6106 North which would be realigned over an approximate length of 550m.

3.3.21 NMU facilities would be incorporated in the form of a shared footway/cycleway and generally provided in the road verge and offset a minimum of 1.5m from the carriageway. NMU routes would be provided within the verge of A7 North, A7 South and A6106 South. An NMU route, offline from the carriageway, would be provided on the existing A6106 North. At-grade crossings would be located on all roundabout arms and make use of splitter islands where available.

Option C

3.3.22 Option C provided a dumbbell roundabout grade separated junction west of Sheriffhall Roundabout, with the A7 carried over the A720 Edinburgh City Bypass, see Figure 3.3 'Option C – Dumbbell Grade Separation west of Sheriffhall Roundabout'. The A7 would be realigned and carried over the A720 by a new overbridge located approximately 250m west of the existing Sheriffhall Roundabout and with an approximate span of 40m. The 80m diameter dumbbell roundabouts located north and south of the A720 Edinburgh City Bypass, would be raised on embankments up to 9.8m in height.

3.3.23 The dumbbell roundabout to the north of the A720 would be a 4-arm roundabout, connecting the A720 eastbound diverge slip, the A7 North, the A720 eastbound merge slip and the A7 Link. The A7 North would be realigned for an approximate length of 585m tying in to the existing Shawfair Park roundabout. The A7 North would have embankments up to 5m in height on its approach to the north dumbbell roundabout.

3.3.24 The dumbbell roundabout to the south of the A720 would be a 5-arm roundabout, connecting the A720 westbound merge slip, the A7 Link, the A720 westbound diverge slip, the realigned A6106 South, and the realigned A7 South. The A7 South would be realigned over an approximate length of 250m tying into the existing Gilmerton Road roundabout. The realigned A6106 South would be realigned for approximately 530m and would have embankments up to 9.7m in height.

Figure 3.3 Option C – Dumbbell Grade Separation west of Sheriffhall Roundabout



- 3.3.25 The A6106 North would be realigned for a length of approximately 760m. A 3-arm roundabout would be provided at the junction of the A6106 North and the realigned A7 North. The A6106 North would be largely at-grade with minimal embankments.
- 3.3.26 The A720 would be at-grade through Sheriffhall Roundabout. The east facing slips would tie into the existing A720 mainline to the west of Borders Railway therefore no works would be required at the Borders Railway underbridge.
- 3.3.27 NMU facilities would be incorporated in the form of a shared footway/cycleway which utilises the abandoned sections of carriageway as far as possible. NMU routes would generally be offline from the live carriageway. NMU routes would be provided on the existing A7 North, A7 South, A6106 North and A6106 South. Where NMU routes run adjacent to the carriageway, shared facilities would be provided within the road verge and offset a minimum of 1.5m from the carriageway. Grade separated crossing facilities would be provided with a dedicated NMU overbridge over the A720 and an NMU underpass below the new A6106 South. An at-grade crossing on the A6106 North would be provided close to the new A7 North roundabout.

Environmental Assessment at Stage 2

- 3.3.28 The Environmental Assessment at Stage 2 considered in detail the impacts of each option across a range of environmental topics. The construction and operational effects were considered as well as the potential in-scheme cumulative effects. The environment team worked closely with the wider design team to ensure each of the options were refined to minimise environmental effects.

3.3.29 As detailed in Chapter 2- Need for the Scheme there are five scheme objectives and evaluation sub-objectives. Table 3-1 'Option Assessment Summary Table (Environment Objectives)' below provides a summary of the assessment of the options against the environmental objective.

Table 3-1 Option Assessment Summary Table (Environment Objectives)

Topic	Objective	Evaluation Sub-objective	Option A	Option B	Option C
Environment	E. Minimise intrusion of works on natural environment, cultural heritage and people whilst enhancing the local environment where opportunities arise	Minimise intrusion of works on natural environment.	Intrusion on natural environment greater than Option B but less than Option C, principally due to extent of scheme footprint and impact on Dean Burn.	Least intrusion on natural environment, principally due to having smallest scheme footprint and least impact on Dean Burn.	Greatest intrusion on natural environment, principally due to having largest scheme footprint and greatest impact on Dean Burn.
		<i>In terms of DMRB topics this sub-objective has been considered to include the topics of landscape (character), nature conservation, materials, geology and soils and road drainage and the water environment.</i>			
		Minimise intrusion of works on cultural heritage	Intrusion on cultural heritage greater than Option B but less than Option C, principally due to extent of scheme footprint.	Least intrusion on cultural heritage, principally due to having smallest scheme footprint.	Greatest intrusion on natural environment, principally due to having largest scheme footprint with potential for more effects on undiscovered archaeology.
		<i>In terms of DMRB topics this sub-objective has been considered to include the topics of noise and vibration, air quality, community and private assets, landscape (visual) and effects on all travellers.</i>			
		Minimise intrusion of works on people	Greater intrusion on people compared to Option B with road encroaching closer to properties and requiring largest amount of designated economic land allocation. Air and noise impact broadly similar for all options.	Least intrusion on people, principally due to having smallest scheme footprint. Air and noise impact broadly similar for all options.	Greater intrusion on people compared to Option B with realignment having large impact on adjacent properties and requiring largest amount of agricultural land. Air and noise impact broadly similar for all options.
		Enhance local environment where opportunities arise	It is considered that all options offer the potential to include mitigation measures to off-set any identified effects which would be detailed further at Stage 3. For landscape and visual is it suggested that Option C could provide more opportunities for landscape mitigation planting but all options would include landscape planting. Mitigation for nature conservation, community and private asset and effects on all travellers will be developed in detail at Stage 3.		
		<i>In terms of DMRB topics this sub-objective has been considered to include the topics of landscape and visual, nature conservation, community and private</i>			

*assets and effects on
all travellers.*

Source: Extract from A720 Sheriffhall Roundabout – DMRB Stage 2 Scheme Assessment Report, Part 3 - Assessment Summary and Recommendations, Volume 1 – Main Report (AECOM, 2017)

Stage 2 Conclusions

- 3.3.30 All options achieved the main scheme objective of improving the movement of traffic on the A720 between Gilmerton and Old Craighall by providing grade-separation of the A720 at the existing Sheriffhall Roundabout.
- 3.3.31 In order to determine the preferred option, the three options were assessed against the scheme objectives, as summarised in Table 2-1 'Scheme Objectives and Evaluation Sub-Criteria' in Chapter 2 – Need for the Scheme. The assessment also considered other factors including value for money, Net Present Value (NPV), Benefit-Cost Ratio (BCR) and risk. This demonstrated that no one option emerged as being preferred across all objectives.
- 3.3.32 One of the scheme objectives is to *"minimise intrusion of works on natural environment, cultural heritage and people whilst enhancing the local environment where opportunities arise"*. The assessment of the objective to minimise intrusion showed Option B as the preferred option, primarily due to its reduced footprint in comparison to Options A and C. Option C fared relatively poorly due to the large land take resulting from the "off-line" nature of this option.
- 3.3.33 Safety was assessed separately for motorised and non-motorised users. For motorised users, reservations were expressed about the potential for high circulatory speeds for the large roundabout on Option B and hence it was marked down slightly in comparison to Option A. Option C was further marked down due to increased junction movements and operational assessment showing early congestion compared to Options A and B. In contrast, Option C performed well for safety of non-motorised users due to the opportunities it provided for a segregated non-motorised user route on the line of the existing A7.
- 3.3.34 Modelling of the traffic operation of the three options showed that Options A and B performed significantly better than Option C. Whilst Options A and B performed relatively similar, Option C showed traffic congestion on the A720, with queues on slip roads impacting on the A720 from 2030 onwards. Similarly, as a result of its off-line location and the inclusion of an additional roundabout junction to accommodate the A6106 north of the Sheriffhall Roundabout, Option C showed much heavier congestion on the adjacent local road network with greater delays along the A7/A6106 compared to Options A and B.
- 3.3.35 Cost estimates ranged from £87.3M to £94.2M, with Option B having the lowest overall cost and Option A the highest. Options A and B demonstrated similar NPV benefits of £527.4M and £508.3M, however relative to the estimated cost, Option B returned a stronger BCR of 9.49 compared to 9.14 for Option A. In contrast, Option C returned a much lower NPV of £224.1M, resulting in a significantly lower BCR of 4.62.
- 3.3.36 Given the location of the scheme and the need to keep the A720 operational throughout construction, an objective was set on minimising delays during construction. A buildability review concluded that all options could be constructed whilst maintaining traffic flows albeit all would require temporary traffic signalisation and extensive traffic management. Due to its off-line location, Option C offered buildability advantages compared to the other two options and this was reflected in scoring on this objective. The review also concluded that the construction methodology for Options A and B would be similar.
- 3.3.37 All options offered benefits through the reduction in severance provided by the grade separation of the A720. The segregated NMU route within Option C offered advantage over Options A and B however all offered safer and improved facilities for NMUs. All Options would also provide improved accessibility across the A720 for public transport although it was considered Option C was slightly less advantageous due to the presence of the additional roundabout at the A6106 North tie-in to the A7 North.

- 3.3.38 In relation to integration objectives, there was little difference between options with all offering benefits in comparison to the existing situation. Similarly to severance, Option C is slightly less advantageous due to the presence of the additional roundabout at the A6106 North tie-in to the A7 North.
- 3.3.39 Consultation feedback was predominantly positive with all consultees recognising the need for improvements at Sheriffhall Roundabout. Whilst a common theme was a desire to take opportunities to improve NMU provision, most consultees acknowledged that all options offered substantial improvements on current arrangements.
- 3.3.40 Risk analysis was undertaken against cost and time and whilst scores were broadly similar for all options, Option C was assessed as presenting more risk than Options A and B which scored very similarly.
- 3.3.41 Taking into account all the above factors, an overall assessment concluded that Option B provided the best balance of benefits across the full range of environment, safety, economy, accessibility and integration objectives.
- 3.3.42 Whilst Option C offered benefits, particularly with respect to buildability and NMU provision, traffic assessment has identified significant operational issues compared to Options A and B, as reflected in the NPV and BCR results. It is also the least favourable option from an environmental viewpoint and overall had the lowest function score of all options. For these reasons it was concluded that Option C was less preferable than the other options.
- 3.3.43 Whilst Options A and B offered similar benefits, the lower capital cost of Option B represented better value for money than Option A.
- 3.3.44 In relation to Options A and B, it was recognised that the operation of the junction would require more detailed consideration at the next stage, particularly with respect to NMU routes.
- 3.3.45 It was however noted that whilst Options A and B performed much more strongly than Option C in relation to future traffic provision, it was clear that with the high levels of traffic growth predicted for the area, all options would face capacity challenges in future years. From this perspective, further operational enhancements may be required to maintain capacity and minimise congestion, and it would be sensible to take this scope for enhancement into account in scheme development and assessment. The obvious measure to improve capacity would be to signalise the junction. Whilst Options A and B could both be developed to allow future signalisation, Option B had a more propitious layout, offering better opportunities for future capacity enhancement.
- 3.3.46 Therefore, taking into account overall benefits, value for money and the future scope for enhancement, it was recommended that Option B should be taken forward as the preferred option.

3.4 Development of Proposed Scheme Design

- 3.4.1 On the basis of the Stage 2 assessment, Option B was subject to further refinement as more detailed survey information was gathered. The DMRB Stage 3 provided enhancements to NMU provision, as well as development to the mainline and junction designs. The DMRB Stage 3 assessment also included the development of accommodation works, access tracks, drainage, structures and earthworks design and the incorporation of environmental mitigation to reduce impacts on the environment.
- 3.4.2 The development of the design of the Proposed Scheme is described in detail in Chapter 4 – Iterative Design Development and Chapter 5 – The Proposed Scheme.

3.5 References

AECOM (On behalf of Transport Scotland) (2017) A720 Sheriffhall Roundabout DMRB Stage 2 Assessment Report Part 2 Volume 1 'Environmental Assessment'

The Highways Agency, et al. (1993) Design Manual for Roads and Bridges, Volume 5, Section 1, Part 2 'Scheme Assessment Reporting' (TD37/93)

The Highways Agency, et al. (2007) Design Manual for Roads and Bridges, Volume 6, Section 2, Part 3 'Geometric Design of Roundabouts' (TD16/07)

URS (now AECOM) (On behalf of Transport Scotland) (2014) A720 Sheriffhall Roundabout DMRB Stage 1 Scheme Assessment Report, Edinburgh