A720 Sheriffhall Roundabout

DMRB Stage 3 Scheme Assessment Report
Engineering, Traffic & Economic Assessment
Volume 1 – Main Report

Transport Scotland

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1 Introduction

1.1 Background

1.1.1 Sheriffhall is a six-arm roundabout at the junction of the A720 Edinburgh City Bypass, the A7 and the A6106 south-east of Edinburgh. The roundabout is the only at-grade junction on the A720. It is understood that the decision to opt for a roundabout in preference to a grade separated junction at that time was largely because of the complex ground conditions which include a geological fault and mine workings that were being worked at the time.

1.1.2 Sheriffhall Roundabout has undergone various improvements including localised widening, signalisation and provision of additional lanes to try and alleviate the delays which occur at the junction. Despite the improvements, a congestion problem persists, particularly during peak hours.

1.1.3 The Scottish Government's Strategic Transport Projects Review (STPR) published in 2008 identified locations where Scotland's strategic transport network can be improved through more efficient operation or maintenance, making better use of capacity, or implementing targeted infrastructure enhancements. Junction improvements at Sheriffhall were identified as part of Intervention 22 of the Review.

1.1.4 There are extensive plans for future residential and business development within the vicinity of Sheriffhall Roundabout, including the South East Wedge (Shawfair) development. The roundabout also provides access to a number of growth areas, including South East of Edinburgh where an enterprise area has recently been established, and large developments along the A7 Corridor. Sheriffhall Roundabout also provides access from the east of Edinburgh City to the growth areas around the West of Edinburgh and the M8 Corridor.

1.1.5 Underlying traffic volumes on the road network around Edinburgh are expected to increase by approximately 40% over the next 20 years. This increase is estimated from the impact of developments outlined in the emerging Strategic Development Plan. Congestion and delay on the A720 would increase, especially around key junctions such as Sheriffhall Roundabout, and it is anticipated that traffic conditions around the roundabout would deteriorate significantly.

1.1.6 AECOM were appointed by Transport Scotland in July 2013 to review and update the STAG 1 Feasibility Assessment work done by Atkins in 2008 ('A720 Sheriffhall Roundabout – Feasibility Study – STAG 1 Assessment', May 2008), and to identify, develop and assess the preferred junction option in line with the Design Manual for Roads and Bridges (DMRB) scheme assessment process, in light of the following changes:

- The opening of the A68 Dalkeith Bypass;
- Changes in traffic flows on the routes approaching Sheriffhall;
- Operational links between Sheriffhall, Millerhill and Old Craighall junctions and the A720 to the west including Gilmerton junction; and
- Growth in traffic from development in the Strategic Development Plan (SDP) for Edinburgh and South East Scotland, and relevant Local Development Plans.

1.1.7 Consideration was also to be given to the cost effectiveness of moving the location of the junction.

1.1.8 The scheme has progressed through Design Manual for Roads and Bridges (DMRB) Scheme Assessment Stages 1 and 2, which identified the preferred junction layout. The findings of the DMRB Stage 3 Scheme Assessment are presented in this report.

The Edinburgh and South East Scotland City Region Deal

1.1.9 The Edinburgh and South East Scotland City Region Deal is a mechanism for accelerating economic and inclusive growth in the City Region, comprising £600m investment from the UK and Scottish Governments over 15 years, the Heads of Terms was signed in July 2017.

1.1.10 One of the five themes of the City Region Deal is Transport. The deal will deliver major investments to ensure that the region is served by world class transport infrastructure. The SESplan Cross Boundary and Land Use Appraisal study of the region, published in April 2017, helped to show where transport investment will be most effectively targeted.

1.1.11 The Scottish Government is committed to investing £140m on strategic transport improvements as part of the City Region deal. This specifically includes up to £120m to support improvements to the A720 for the grade separation of Sheriffhall Roundabout. Transport Scotland will manage and deliver the upgrade of Sheriffhall Roundabout.

1.2 Scheme Objectives

1.2.1 The following scheme objectives have been agreed for the development and assessment of the scheme to address the main issues affecting Sheriffhall Roundabout.

A. Improve the movement of traffic on the A720 between Gilmerton and Old Craighall by providing grade-separation of the A720 at the existing Sheriffhall Roundabout

B. Reduce the conflict between strategic and local traffic

C. Minimise traffic impact of local proposed developments in Midlothian, East Lothian and City of Edinburgh on the A720 between Gilmerton Junction and Old Craighall Junction and approach roads

D. Improve road safety for all users on the A720 and approach roads between Gilmerton Junction and Dalkeith Northern Bypass

E. Minimise intrusion of the new works on the natural environment, cultural heritage and people whilst enhancing the local environment where opportunities arise

F. Facilitate integration for different modes of transport along and across the A720 corridor between Gilmerton Junction and the Dalkeith Northern Bypass

G. Reduce severance by improving accessibility across the A720 for all users.

1.2.2 The objectives listed above have been used throughout the assessment process and were used to help determine the performance of the options considered during the Stage 2 Scheme Assessment, which ultimately identified the preferred junction layout.

1.3 Option Development and Selection

1.3.1 A DMRB Stage 1 Scheme Assessment was carried out by AECOM and concluded in 2014. A total of eight junction options underwent DMRB Stage 1 Scheme Assessment, which concluded with the recommendation that four emerging options be taken forward for further assessment at Stage 2.

1.3.2 A DMRB Stage 2 Scheme Assessment was carried out by AECOM and concluded in April 2017. A significant amount of design development was undertaken during Stage 2. Following a Value Management Workshop in March 2015 it was determined that one option did not sufficiently meet the scheme objectives and that it should not be taken forward for further Stage 2 Assessment. Therefore, three options underwent a detailed comparative assessment:

- Option A (Dumbbell Grade Separation at Sheriffhall);
- Option B (Roundabout Grade Separation at Sheriffhall), and
- Option C (Dumbbell Grade Separation west of Sheriffhall).

1.3.3 The three options were assessed against the scheme objectives listed in Section 1.2, also considering other environmental, engineering, traffic and economic criteria. Although no one option emerged as being preferred across all of the assessment criteria, the DMRB Stage 2 report ultimately recommended that when taking into account overall benefits, value for money and the future scope for enhancement, Option B should be taken forward as the preferred option for further detailed development and assessment through the DMRB Stage 3 process.

1.3.4 Option B was announced as the preferred option in Spring 2017.

1.4 Method of Assessment

1.4.1 This Stage 3 Assessment Report has been prepared in accordance with the DMRB document TD 37/93 ‘Scheme Assessment Reporting’. The DMRB Stage 3 Assessment is divided into two parts: the Environmental Statement (ES), provided under separate cover, and this report covering all other aspects of the assessment not included in the ES (Engineering, Traffic and Economic Assessment).

1.4.2 The aim of the DMRB Stage 3 Assessment is to develop and assess the preferred option identified at DMRB Stage 2, including further detailed consideration of engineering and operational challenges identified at DMRB Stage 2. The ultimate aim of this stage of the assessment is to take the scheme forward such that draft Orders and an Environmental Statement are published for formal comment.

1.5 Consultation

1.5.1 Consultations have been undertaken in a comprehensive and open manner throughout the assessment process, ensuring that the views of all parties were properly heard, recorded and taken into consideration during the detailed development and assessment of the scheme.

1.5.2 The key stakeholders for this project include:

- Transport Scotland Branches (including Standards Branch, Construction, Geotechnical, Structures, Environment and Network Management);
- Local Authorities (Midlothian Council, City of Edinburgh Council, East Lothian Council);
- Network Rail;
- Scottish Environment Protection Agency (SEPA);
- Scottish Natural Heritage (SNH);
- Historic Environment Scotland;
- Forestry and Land Scotland
- The Strategic Development Planning Authority for Edinburgh and South East Scotland (SESplan);
- Access/Active Travel Groups (Sustrans, SEStran, BHS, Scotways, Spokes, Edinburgh Access Panel);
- Private property owners and developers;
- Public Utility companies; and
- Tourist and Transport Operators (Lothian Buses, Visit Scotland)

1.5.3 A three-part Wider Stakeholder Workshop was held in August 2017, October 2017 and August 2018 to discuss stakeholder aspirations and concerns with regards to the Non-Motorised User (NMU) facilities and inform development of the active travel proposals for the scheme. Design objectives, opportunities and assessment methodology were discussed and agreed, and several NMU options were assessed accordingly. Ultimately the preferred NMU facilities were identified and incorporated into the scheme.

1.5.4 Consultation meetings have also been held with landowners affected by the scheme to discuss potential impacts on their land, including land take extents and alternative means of access.

1.6 Report Structure

1.6.1 This document provides Part 1 of the DMRB Stage 3 Scheme Assessment, containing the report text (Volume 1) and figures for the engineering, traffic and economic assessment of the scheme. Part 2 provides the Environmental Statement and is under separate cover.

1.6.2 The format for this report follows the principles set out in the guidance for the preparation of a Stage 3 Report as defined in TD 37/93 'Scheme Assessment Reporting' and includes the following sections.

- Section 1 – background and introductory information on the scheme
- Section 2 – description of existing conditions within the scheme area;
- Section 3 – description of the scheme and the scheme cost estimate;
- Section 4 – engineering assessment of the scheme;
- Section 5 – traffic and economic assessment of the scheme; and
- Section 6 – conclusions.

2 Existing Conditions

2.1 Introduction

2.1.1 This section of the report describes the existing conditions of the Sheriffhall Roundabout scheme area. Much of the information presented in the following sections of this report is also contained in the Stage 2 Options Assessment report, but it has been reviewed and updated where necessary.

2.2 Engineering Conditions

Existing Junction and Roads

2.2.1 Sheriffhall Roundabout is a junction on the A720 Edinburgh City Bypass and connects six A-class roads of local and regional importance, namely the A7 North, the A6106 North (Millerhill Road), A720 Edinburgh City Bypass (East), the A6106 South (Old Dalkeith Road), A7 South, and A720 Edinburgh City Bypass (West). Sheriffhall Roundabout is a signalised roundabout and has four lanes on the circulatory carriageway. It has an Inscribed Circle Diameter (ICD) of 100m. A location plan is shown in Figure 2.1.

2.2.2 Sheriffhall Roundabout is the only at-grade junction on the A720 Edinburgh City Bypass. The six-arm roundabout has undergone various improvements including localised widening, signalisation and the provision of additional lanes to try to alleviate the delays which occur at the junction. Despite the improvements, a congestion problem persists, particularly during peak hours.

2.2.3 The A720 is a dual carriageway located south of Edinburgh which connects the A1 at Old Craighall Junction south-east of Edinburgh to the A8 at Gogar Junction west of Edinburgh. The A720 at Sheriffhall typically consists of two 7.3m carriageways, with 1.0m nearside and offside hard strips, and a 2.5m central reserve. The A720 widens to four lanes on the immediate approaches to Sheriffhall Roundabout.

2.2.4 Millerhill Junction is located approximately 1.9km east of Sheriffhall Roundabout at the junction of the A720 and A68 Dalkeith Road. Millerhill Junction is a dumbbell grade separated junction. Gilmerton Junction is approximately 1.5km to the west of Sheriffhall Roundabout and is a grade separated junction with west facing slips only.

2.2.5 The A7 connects central Edinburgh to Carlisle in the north of England. The A7 North and A7 South are both single carriageway roads, typically 7.3m wide with 1.0m hard strips. A footway is provided in the southbound verge of the A7 North. The A7 North widens to three lanes on the immediate approach to Sheriffhall Roundabout. The A7 South widens to two lanes on the immediate approach to Sheriffhall Roundabout. There is no footway provision on the A7 South.

2.2.6 The A6106 connects Dalkeith to Portobello on the east of central Edinburgh. The A6106 North (Millerhill Road) is typically 7.3m wide carriageway, with no hard strips, and a footway is provided in the southbound verge. The A6106 North widens southbound to two lanes on the immediate approach to Sheriffhall Roundabout. The A6106 South (Old Dalkeith Road) is approximately 8.5m wide with no hard strips, and a footway is provided in the southbound verge. The A6106 South widens northbound to two lanes approximately 140m south of Sheriffhall Roundabout, and to three lanes on the immediate approach to it.

Borders Railway

2.2.7 The Borders Railway passes under the A720 Edinburgh City Bypass via an underbridge approximately 250m east of Sheriffhall Roundabout. The underbridge was designed such that it can accommodate a depth of up 5 metres of additional fill in anticipation of possible future improvements for grade separation of Sheriffhall.

Non-Motorised User Provision

2.2.8 In accordance with the requirements of the HD 42/17 WCHAR process, a 5km radius has been used to define the study area for the assessment. The existing Non-Motorised User (NMU) provision in the study area is outlined under the relevant sections below. A summary of the existing NMU facilities within the immediate 500m vicinity of the scheme is shown on Figure 2.2.

Footways

2.2.9 Footways are located adjacent to the A7 North and A6106 Millerhill Road. Shared cycleway / footways are located adjacent to and offline from the A6106 Old Dalkeith Road and also adjacent to the A772 Gilmerton Road.

2.2.10 Although there are footways on the approaches to Sheriffhall Roundabout, there is no dedicated traffic signal phase to allow NMUs to cross the roundabout arms, instead users are required to cross the roundabout arms on the traffic signal phasing for vehicles.

2.2.11 There are several designated Core Paths located within a wider study area. Figure 2.3 highlights adopted Core Paths within the Edinburgh City Council, Midlothian Council and East Lothian Council Local Authority Areas for the study area. It also highlights aspirational core paths and other council paths. A number of Midlothian Council 'other paths' are contained within the boundaries of Dalkeith Country Park.

Cyclepaths

2.2.12 There is a network of local cycle routes within the immediate 500m vicinity of the proposed Sheriffhall roundabout improvements:

- A7 North – on-road cycle lanes on both carriageways with off-road crossing over the Sheriffhall Roundabout;
- A6106 Old Dalkeith Road – shared cycleway/footway on east side of the A6106 between Sheriffhall Roundabout and Melville Gate Road. There is also a short shared cyclepath/footpath on the west side of the A6106 linking to the south side of the Sheriffhall Roundabout; and
- A772 Gilmerton Road – shared cycleway/footway on north side of the A772 from the A7 South across the Gilmerton Junction with off-road access across the A720 Gilmerton Junction over-bridge.
- A7 South and A6106 Millerhill Road – although there is no dedicated provision, both roads provide additional on-road cycling opportunities.

2.2.13 Considering the wider 5km radius, the following National Cycle Network (NCN) routes are also located within the study area.

- NCN 1 is a long distance, east coast, cycle route connecting Dover and the Shetland Islands. The route passes through Eskbank and Dalkeith to the south of Sheriffhall before crossing the A1 to the south of Old Craighall Junction and continuing north.
- NCN 76 runs from Berwick-upon-Tweed to Edinburgh, Stirling and Kirkcaldy. The route is located on the eastern side of the A1 and at the outer extent of the study area.
- NCN 196 runs between Haddington and Penicuik. The route shares its alignment with NCN 1 as it passes through Lasswade and Dalkeith before crossing the A68 and heading east towards Haddington.

2.2.14 Figure 2.4 shows the cycle paths and other shared routes located within the 5km study area.

Equestrian Facilities

2.2.15 There are no dedicated equestrian trails or centres within the immediate 500m vicinity of the proposed Sheriffhall roundabout improvements. However, the following equestrian facilities are located within the wider 5km radius study area. These are also shown in Figure 2.5 included in Volume 2.

- The Tyne Esk Equestrian Trails pass through the 5km study area, approximately 4.3km southwest of Sheriffhall Roundabout.
- The closest riding centre is the Drum Riding for the Disabled Centre based at the Drum Estate, Gilmerton.
- The Edinburgh and Lasswade Riding Centre is located approximately 3.3km south west of Sheriffhall and offers indoor and outdoor riding facilities.
- The Edinburgh Equestrian Centre is based at Home Farm north-east of Dalkeith. Although the Centre is located approximately 4.9km east of the Sheriffhall Roundabout it manages horse riding activities in Dalkeith Country Park and part of its advertised 'Round Estate' riding trail falls within 500m of the Sheriffhall junction improvements.

Bus Routes

2.2.16 Sheriffhall Park & Ride and 14 bus stops are located within the immediate 500m vicinity of the scheme. Bus services covering this area are summarised in Table 2.1.

2.2.17 In addition to Sheriffhall Park & Ride, there are two other park and ride facilities within the 5km study area. Newcraighall Park & Ride is located 3.7km north of Sheriffhall Roundabout and Straiton Park & Ride is located 4.9km west of Sheriffhall.

2.2.18 The bus facilities within the 500m boundary are shown in Figure 2.6.

Table 2.1 Scheduled Bus Services via Sheriffhall Roundabout

Operator	Service Number	Service Route
Lothian Buses	33	Baberton to Dalkeith (via the Sheriffhall P & R) and vice versa
	X33	Mayfield to Edinburgh (via the Sheriffhall P & R) and vice versa
	49	The Jewel to Rosewell (via the Sheriffhall P&R) and vice versa
Perrymans Buses	51/52	Edinburgh to Jedburgh/Kelso (via Danderhall) and vice versa
First Bus	95A, X95	Edinburgh to Carlisle (via Eskbank) and vice versa
Lothian Community Transport Services	R3	Dalkeith to The Jewel ASDA (via Danderhall-Newton-Millerhill) and vice versa

Hydrology

2.2.19 There are a number of existing watercourses in the vicinity of Sheriffhall Roundabout, with the Dean Burn being the main watercourse within the scheme area. It is a minor tributary of the River North Esk and flows from west to east, to the south of the A720. Existing culverts carry the Dean Burn beneath the A7 South and A6106 Old Dalkeith Road to its confluence with the River North Esk to the north of Dalkeith.

2.2.20 The Dean Burn is classified as a small water body under the Water Framework Directive (WFD). No specific information on the condition of the Dean Burn is given within the WFD therefore the status is taken as 'moderate' in line with the River North Esk into which it flows.

2.2.21 A walkover study of the Dean Burn identified a number of key features within the scheme area to the west of Sheriffhall Roundabout. Poor water quality in the vicinity of the redundant Gilmerton Sewage works was noted but no outfall from the sewage works into the Dean Burn was identified. Downstream of this location, an outfall believed to be from a constructed wetland for contaminated mine drainage at Gilmerton was identified. Water quality close to this outfall was noted as being very poor due to the abundance of iron rich deposits from the ferrous mine drainage.

2.2.22 The Dean Burn flows through a number of road culverts along its course including at the A7 South and A6106 Old Dalkeith Road, south of Sheriffhall Roundabout. The existing culverts around the site were found to be very large for the size of the watercourse. The Dean Burn was identified as being approximately 2m wide in the vicinity of the existing culverts, and predominantly deeply cut and diverted from its natural alignment. It should be noted that this diversion is historic and has been shown in this location since at least 1850.

2.2.23 Further east, there is a small standing water body adjacent to the A720 at Lugton Bogs with an inlet taking some flow from the Dean Burn. The poor water quality found within this pond is thought to be attributable to the mine drainage. The location of the outfall from the pond was not confirmed and no outfalls into the pond or burn from the road drainage system were identified during the walkover study.

2.2.24 SEPA's flood extent maps were reviewed to initially identify the flood risk within the scheme area, prior to the Flood Risk Assessment (FRA) being undertaken. The Dean Burn and the pond at Lugton Bogs are shown to have a medium to high likelihood of flooding adjacent areas. Furthermore, a high likelihood of surface water flooding was also identified on the A720, A6106 and A7 North under the existing layout.

2.2.25 An FRA was undertaken to understand the baseline fluvial flood risk from the Dean Burn around the site. The upstream contributing catchment was found to be relatively small, albeit notable areas of flooding were identified around the site. The catchment consists of an urban area in the upstream reaches, with predominantly farmland and forest in the middle to lower reaches. Flooding within the site boundary was found

to occur relatively frequently, with flood extent and depths increasing as event magnitude increases. The main flood areas are located upstream of the A7 southbound and across the floodplain between the A7 and Old Dalkeith Road. The flood extents from the FRA were comparable to the flood extents shown in the SEPA mapping.

2.2.26 Groundwater data obtained during recent (2018 and 2019) ground investigation and from British Geological Survey borehole records indicate that groundwater levels vary widely across the scheme area. Predominantly, they occurred between 1.5m and 10m below ground level. Further details are provided in Section 4.

Existing Drainage Information

2.2.27 Historical as-built drawings of the A720 Edinburgh City Bypass, the A7 Dalkeith Western Bypass and the Borders Railway project, as well as historical topographical information, was reviewed in order to establish the extents, form and direction of flow of existing drainage networks.

2.2.28 Historical as-built drainage plans were very limited in their coverage and level of detail. The Borders Railway return provided a greater level of detail in regard to railway infrastructure crossing under the A720 to the east of Sheriffhall Roundabout.

2.2.29 Information was made available for Sheriffhall Roundabout from various local authority drainage records and generally considered the A7, A6106 and A68 approaches to Sheriffhall Roundabout, as well as the roundabout itself. The age of the records has made it difficult to determine their accuracy and could not be fully relied upon.

2.2.30 Exports were also received from the Transport Scotland's Integrated Road Information System (IRIS), but the information itself did not provide detail of actual pipework, chambers, or their connection levels, and could be displayed in a 2D format only.

2.2.31 More recent, unverified improvement works at Sheriffhall Roundabout have been undertaken since the production of the as-built plans or records, therefore it is likely that the drainage network may no longer reflect these plans.

2.2.32 The existing drainage networks for the area, in which as-built or record information was generally available, suggested that where gullies were not present, surface water runoff was conveyed to filter or combined kerb drainage at the edge of carriageway.

2.2.33 Generally, when on embankment, filter drainage has been provided at the toe of slopes. Carrier drainage can be seen traversing carriageways and adjoining fields, to convey multiple flows to single point discharges into the adjacent watercourse, the Dean Burn, or one of its tributaries.

2.2.34 Not all outfall locations could be mapped from the available information, but it is generally understood from as-built and topographical information, that the majority surface runoff flows from the north west in a south easterly direction, eventually outfalling into Dean Burn.

2.2.35 Apart from the provision of filter drainage, there is no evidence of any other SuDS measures constructed within the existing trunk road, or immediate local road drainage systems, that treat road related runoff. There is, however, the pond at Lugton Bogs, within the extents of this road scheme, that is understood to be fed by flows from the Dean Burn only.

2.2.36 An attenuation pond is located to the north of Sheriffhall Roundabout (off A6106 Millerhill Road). It is likely that this pond treats direct runoff from the A6106 realignment, following the Borders Railway project.

2.2.37 Another larger attenuation pond is known to be situated adjacent to the Sheriffhall Park and Ride, but as with the attenuation pond off Millerhill Road, inflow and outfall details are not known and these ponds currently remain outwith the footprint of this road scheme.

Public Utilities

2.2.38 A number of public utilities are present within the scheme area. These include high voltage electricity cables, gas mains and water mains. The utility infrastructure present within the area serves not only the adjacent residential, commercial and industrial development but also developments beyond the scheme area. There are also services (electricity, sewerage, cable, water, etc.) associated with all the properties within the scheme area and these will need to be protected or diverted as appropriate when construction takes place. The following information on the location of utilities was sourced from public utilities under procedure C3 of the 'New Roads and Street Works Act 1991'.

2.2.39 Details of the existing utilities within the scheme area are shown on Figure 2.8.

Electricity

2.2.40 Scottish Power Energy Networks (SPEN) high voltage electricity lines are present throughout the scheme area. Overhead and underground lines exist in the immediate vicinity of Sheriffhall Roundabout and the surrounding road network. Scottish Power Energy Networks provided details of their 275kV, 33kV and 11kV overhead and underground cables.

2.2.41 275kV overhead lines cross the A6106 Millerhill Road and A7 North, north of Sheriffhall. The lines also pass over the A720 at Millerhill Junction.

2.2.42 33kV overhead lines cross the eastbound approach to Sheriffhall Roundabout, intersecting the A7 both to the north and south of the junction. A second 33kV overhead line crosses the A720 at the start of the Gilmerton off-slip and continues in a north-easterly direction before relocating underground towards the A7 north of Sheriffhall.

2.2.43 A 33kV underground line passes under the A720 eastbound approach to Sheriffhall Roundabout. Further intersections occur on the A6106 and A7 south of the roundabout and again on the A7 North adjacent to the park and ride facility.

2.2.44 11kV overhead lines cross the A720 west of Sheriffhall Roundabout and cross the A7 North and A7 South. A 11kV line, running parallel, south of the A720 passes through the sewage works, then crosses the A720 towards the east of Gilmerton.

2.2.45 Underground cables cross the A7 South and A6106 Old Dalkeith Road immediately south of Sheriffhall and connect the Summerside and Sheriffhall Farm properties to the network.

Water

2.2.46 Scottish Water supply and sewer equipment is located within the scheme area mainly in the A772 Gilmerton Road and in the A7 North. There are also several crossings of the A720 main carriageway. A foul water sewer passes under the A720 north of the disused sewage works, which is located between the A720 and the A772 Gilmerton Road. The sewer then follows the A720 eastbound verge towards the Gilmerton Junction and continues north along the A772 Gilmerton Road.

2.2.47 Distribution water mains cross the A720 at the Gilmerton Junction and approximately 900m east of Sheriffhall Roundabout. The water main crossing at Gilmerton Junction follows the alignment of the A772 Gilmerton Road north and south of the junction. A further water main follows the A7 north towards the Shawfair Roundabout.

2.2.48 A water main passes under the Borders Railway to the east of Millerhill road and runs north towards Millerhill Park and then south east towards the A720.

Gas

2.2.49 A medium pressure gas main is located in the verge of the A7 South from the Gilmerton Road Roundabout to Sheriffhall Roundabout. The medium pressure gas main then crosses the A720 mainline on the eastbound approach to Sheriffhall and continues in the verge of the A7 North towards Shawfair Park.

2.2.50 A low-pressure gas main links to the Summerside properties from the medium pressure gas main on the A7 North.

Telecommunications

2.2.51 Underground cable ducts cross the Sheriffhall Roundabout and follow the A7, A6106 Millerhill Road and A6106 Old Dalkeith Road to the north and south of the junction. A further A720 crossing is located at the Gilmerton Junction overbridge. Underground Virgin Media ducts follow the A772 and cross the A7 South on the northbound approach to the Gilmerton Road Roundabout.

2.2.52 Overhead lines are present adjacent to the A7 North, along the A6106 Old Dalkeith Road south of Sheriffhall, and in both verges of the A772 Gilmerton Road north and south of Gilmerton Junction.

2.2.53 There is one mobile telecommunications mast within the scheme area. A shared T-Mobile and 3 Mobile mast is located approximately 280m west of Sheriffhall.

2.3 Environmental Conditions

2.3.1 The existing landscape of the area is characterised by a mix of settlement, urban fringe agriculture and policy woodland. The character is also influenced by the road corridors present within the area and other infrastructure such as overhead power lines and the Borders Railway. There are a number of properties in close proximity to the scheme.

2.3.2 Within 1km of the scheme there are three designated Gardens and Designed Landscapes and two Special Landscape Areas. Existing urban settlements are concentrated to the southeast and northwest and views out towards the surrounding countryside from these settlements are often restricted by a combination of topography and woodland, although some more open views are possible.

2.3.3 There are no designated sites for nature conservation within the extents of the scheme. Dalkeith Oakland Site of Special Scientific Interest (SSSI), designated for its ancient woodland and scarce and rare lichens, is located just over 1km from the scheme. There are four locally important sites for nature conservation within 2km of the scheme and a number of areas of ancient woodland.

2.3.4 Scheduled Monuments, Listed Buildings (Category A), Gardens and Designed Landscapes, Historic Battlefields and Conservations Areas were assessed over a wide area (2km from Sheriffhall) due to the sensitivity of these historical receptors. A small study area (1km) has been assessed for Category B and C listed buildings and a 500m study area of non-designated assets. A total of 117 cultural heritage assets were identified within these study areas: 50 archaeological sites, 63 built heritage receptors and four Gardens and Designed Landscapes. These include a number of listed buildings, the closest being Summerside Farm which is approximately 100m north of Sheriffhall Roundabout, and Old Sheriffhall Farmhouse which is approximately 150m south-east of Sheriffhall Roundabout. Both are Category B listed. There are three Scheduled Monuments within 500m of the scheme extents, the closest being Melville Grange which is located south of the A772 Gilmerton Road, a Roman Camp which is located south of the A6106 South (Old Dalkeith Road) and a Roman Fort which is located on the north side of B6392 Gilmerton Road.

2.3.5 There are ten designated paths both within the 500m study area and with direct path linkage to the study area. There is also footpath provision along the A7 North and the A6106 North. There are no National Cycle Network (NCN) routes within the study area however there are a number of local cycle routes both via on-road marked cycle lanes (A7 North and B6392 Gilmerton Road) and an off-road cycle lane (A6106 South and A772 Gilmerton Road). There is one community space, Dalkeith Country Park, within the study area that is connected to these paths.

2.3.6 There are several residential properties, businesses and community facilities near the scheme. There are also several Local Development Plan allocations for the future development of land. The immediate land use is predominately agricultural and consists of a mix of arable and grazing land. There are also a few swathes of woodland and the Borders Rail runs to the east of the scheme.

2.3.7 Superficial deposits are predominantly glacial till (unsorted material deposited by glacial ice) and glacial fluvial deposits (deposited by glacial meltwater): made ground associated with man-made features (such as existing roads) is present and alluvium (material left by rivers) is found along the Dean Burn. The underlying bedrock (solid rock underlying loose deposits such as soil or alluvium) comprises the Scottish Middle Coal Measures Formation and the Scottish Lower Coal Measures Formation, cycles of sandstone, mudstone, siltstone and coal seams. Further details of the ground conditions can be found in Section 4.6 of this report.

2.3.8 More details on the environmental conditions can be found in the Environmental Statement (ES).

2.4 Traffic Conditions

2.4.1 A programme of data collection surveys was undertaken to assist in establishing current traffic volumes and vehicle proportions at key locations, to quantify variations in hourly and daily traffic demand, to establish the levels of congestion and delays experienced by road users, and to estimate current vehicle speeds and journey times in the study area. Through the collection and analysis of this information, the prevailing traffic demand and operating conditions within the study area have been established.

2.4.2 The surveys included Manual Classified Counts (MCCs), Automatic Traffic Counts (ATCs) and the measurement of typical journey times. These surveys were undertaken on Wednesday 10th May 2017 and Thursday 11th May 2017 when traffic conditions were expected to be typical of average demand.

2.4.3 To assist in assessing road safety conditions, information on all road traffic collisions involving personal injury accidents on the A720 between Lothianburn Junction and Old Craighall Roundabout was obtained from Transport Scotland for the 10-year period between 2007 and 2016 inclusive.

2.4.4 Details of traffic conditions within the scheme area can be found in Section 5.

3 Description of the Scheme

3.1 Introduction

3.1.1 This section presents a description of the scheme developed at DMRB Stage 3, and also includes a summary of the option development history and preferred scheme selection.

3.2 Option Development History and Scheme Selection

DMRB Stage 1 Scheme Assessment

3.2.1 A total of eight junctions 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 reported in the A720 Sheriffhall Roundabout Feasibility Study STAG 1, whereas Options 7 and 8 were developed during the DMRB Stage 1 Inception Workshop. All eight options were subject to an engineering, environmental and traffic and economic assessment in accordance with DMRB Stage 1 Assessment.

3.2.3 The Stage 1 Scheme Assessment recommended that Options 1, 2, 6 and 8 were taken forward for further assessment at Stage 2.

3.2.4 Further details can be found in the A720 Sheriffhall Roundabout DMRB Stage 1 Scheme Assessment Report (47067662/Doc/B/003).

DMRB Stage 2 Scheme Assessment

3.2.5 The Stage 1 emerging options underwent design development at Stage 2 appropriate to allow comparative assessment and ultimately the identification of an overall preferred junction layout.

3.2.6 During Stage 2, more detailed survey information was obtained including detailed LIDAR survey information obtained for the scheme area. The geometric layouts of the options were further refined based on the more detailed survey information to better fit with the local topography and further developed and reviewed in accordance with DMRB standards.

3.2.7 A Stage 2 Value Management Workshop (VfM2a) was held in March 2015. A comparative scoring exercise of the options against the scheme objectives was undertaken at the Workshop, concluding that Option 2 did not sufficiently meet the scheme objectives and therefore should not be taken forward for further Stage 2 Assessment. Therefore, three out of the four emerging options were taken forward for further Stage 2 Assessment. The options were also renamed as follows:

- Option A – Dumbbell Grade Separation at Sheriffhall (previously Option 1)
- Option B – Grade Separation at Sheriffhall (previously Option 6)
- Option C – Dumbbell Grade Separation west of Sheriffhall (previously Option 8).

3.2.8 The three remaining options were further developed and assessed. This included a full review of stopping sight distance and associated verge widening, NMU provision and effects on adjacent properties, watercourses, quantities, land requirements, the Borders Railway and buildability.

3.2.9 As part of the scheme development, a review was also undertaken for all options to consider whether grade separation should be achieved by elevating the A720 City Bypass over the roundabout or vice versa. The optimal arrangement was found to be the elevation of the A720 on embankment and bridged over the at-grade side roads for Options A and B, whilst the reverse was the case in terms of buildability for Option C.

3.2.10 Further details on the Stage 2 option development and assessment. can be found in the A720 Sheriffhall Roundabout DMRB Stage 2 Scheme Assessment Report (April 2017).

Preferred Option Selection

3.2.11 The DMRB Stage 2 Scheme Assessment was undertaken in accordance with DMRB TD 37/93 'Scheme Assessment Reporting', identifying the factors to be taken into account in choosing alternative routes or improvement schemes and to identify the environmental, engineering, economic and traffic advantages, disadvantages and constraints associated with those schemes.

3.2.12 Options A, B and C were assessed against the scheme objectives listed in Section 1.2 of this report, which aligned to the government appraisal criteria of environment, safety, economy, accessibility and integration. Additional sub-objectives were also identified for each main objective and other factors including environmental, engineering, traffic and economic criteria were also considered as part of the assessment.

3.2.13 Options A and B generally scored better than Option C in terms of integration, traffic operation and intrusion on natural environment, cultural heritage and people. Options A and B also ranked higher in terms of NPV, BCR and risk. Due to its mostly offline nature, Option C only scored better than the other options for buildability and opportunities for improved NMU facilities.

3.2.14 Although no one option emerged as being preferred across all objectives, 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. Whilst Options A offered similar benefits, the lower capital cost of Option B represented better value for money than Option A and its more propitious layout offered better opportunities for future capacity enhancement.

3.2.15 The DMRB Stage 2 report therefore recommended that Option B be adopted as the preferred junction layout and taken forward for further development at DMRB Stage 3.

3.2.16 The DMRB Stage 2 report also recommended that NMU provision, operation and safety of the large Inscribed Circle Diameter (ICD) roundabout and need for traffic signalisation be considered as part of the detailed development and assessment of Option B.

3.3 DMRB Stage 3 Scheme Development

3.3.1 DMRB Stage 3 Scheme Assessment aims to identify clearly the advantages and disadvantages, in environmental, engineering, economic and traffic terms of the preferred scheme.

3.3.2 During Stage 3, the scheme identified as the preferred option at Stage 2 was developed in sufficient detail to allow draft Road Orders and draft Compulsory Purchase Orders (CPO) to be prepared and published. This detailed development and assessment process included:

- undertaking detailed topographical surveys;
- undertaking additional ground investigations;
- design review of the junction layout, including further development and review of the mainline and side roads geometry;
- development and assessment of several NMU options, including consultation with Stakeholders including Local Authorities and Access/Active Travel groups to determine the preferred layout for NMU facilities to be included in the overall scheme;
- developing options for the main A720 structure(s), to determine the most appropriate structure type and layout to carry A720 mainline across the extended roundabout;

- consultation with Network Rail (NR) to determine the most appropriate structure form for the extension to the Borders Railway structure;
- Flood Risk Assessment and outline drainage design, including consultation with SEPA;
- development of Intelligent Transport Systems (ITS), Road Restraint Systems (RRS) and Traffic Signs proposals to ensure verge and central reserve widths are suitable to accommodate sight lines and road furniture.
- application for Departures from Standard, including liaison with TS Standards Branch;
- a Value Engineering and Risk Workshop was undertaken with TS Stakeholders, to explore any value engineering opportunities and also identify and quantify any risks associated with the scheme;
- design of residential/field accesses, including liaison with TS and landowners;
- consultation with Public Utility companies in relation to existing equipment/apparatus and potential impact of the scheme on them (including New Roads and Street Works Act (NRSWA) C3 estimates and diversions);
- Stage 1 Road Safety Audit of the proposed scheme and response to comments raised by the Audit Team; and
- liaising with TS in relation to the preparation of the draft Road (Special and Side Road) Orders and CPO.

3.4 Scheme Description

General

3.4.1 The scheme comprises of a grade separated roundabout requiring vertical and horizontal realignment of the A720 over an approximate length of 1600m. The A720 would be carried across the Sheriffhall Roundabout by two new bridges with spans of approximately 60m and 70m. The Sheriffhall roundabout would be enlarged and become an 8 arm roundabout but is retained at its existing location and would be reduced to three lanes on the circulatory carriageway. The proposed scheme also includes NMU facilities including five dedicated NMU subways under the new roundabout providing a dedicated NMU route segregated from the carriageway.

3.4.2 The scheme layout is shown on Figure 3.1, and further details are given in the following sections.

3.4.3 Further details on the geometric design standards relevant to the scheme are detailed in Section 4 of this report.

A720 Mainline

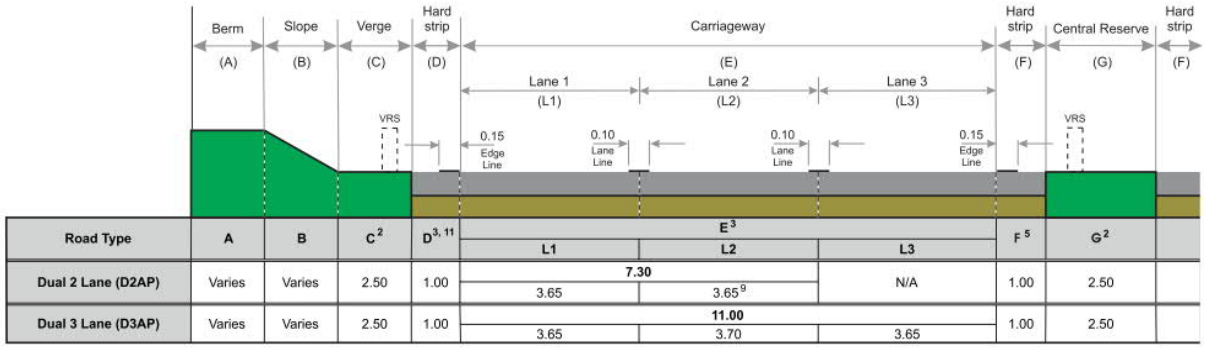
3.4.4 Vertical and horizontal realignment of the A720 is required over an approximate length of 1600m. The design parameters used to develop the proposed A720 Mainline geometry are as summarised in Table 3.1.

Table 3.1 Design Parameters for the A720 Mainline

Road	Design Speed	Desirable Minimum Horizontal Radius (m)	Desirable Minimum Vertical Crest K	Absolute Minimum Vertical Sag K	Minimum & Maximum Vertical Gradient (+/-)	Desirable Minimum SSD (m)
A720 Mainline	120Akph	1020	182	37	> 0.5% & < 4%	295

3.4.5 The proposed geometry is fully compliant with the parameters listed above, except the Stopping Site Distance (SSD) which is a one Design Speed step Relaxation below Desirable Minimum for both carriageways over the bridged sections which span the Sheriffhall Roundabout. Further details on the A720 geometry and associated Relaxations are given in Section 4 of this report.

3.4.6 The proposed A720 Mainline cross section is as set out in figure 4-3a of DMRB TD 27/05 ‘Cross-Sections and Headrooms’, for a Rural Dual 2 Lane All-Purpose Road (D2AP), as shown in Image 3.1.



Road Type	A	B	C[2]	D[3, 11]	E[3]			F[5]	G[2]	
					L1	L2	L3			
Dual 2 Lane (D2AP)	Varies	Varies	2.50	1.00	7.30		N/A	1.00	2.50	
					3.65	3.65[9]				
Dual 3 Lane (D3AP)	Varies	Varies	2.50	1.00	11.00			1.00	2.50	
					3.65	3.70	3.65			

Image 3.1 Proposed cross section for the A720 Mainline[1]

Slip Roads

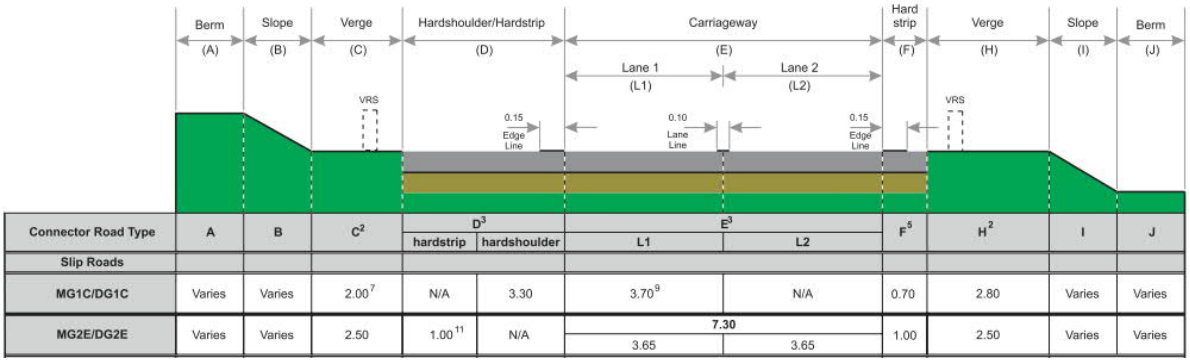
3.4.7 The proposed A720 Mainline would be connected to the extended Sheriffhall Roundabout by slip roads, designed in accordance with the geometric parameters shown in Table 3.2.

Table 3.2 Design Parameters for Slip Roads

Road	Design Speed	Desirable Minimum Horizontal Radius (m)	Desirable Minimum Vertical Crest K	Absolute Minimum Vertical Sag K	Minimum & Maximum Vertical Gradient (+/-)	Desirable Minimum SSD (m)
Slip Roads	70A	360	30	20	> 0.5% & < 6%	120

3.4.8 The proposed geometry of all slip roads is fully compliant with the parameters listed above and further details are given in Section 4 of this report.

3.4.9 The proposed cross section for the slip roads is as set out in figure 4-3c of DMRB TD 27/05 'Cross-sections and Headrooms', for a Rural 2-Lane All-Purpose Connector Road (DG2E), as shown in Image 3.2.



Connector Road Type	A	B	C[2]	D[3]		E[3]		F[5]	H[2]	I	J
				hardstrip	hardshoulder	L1	L2				
Slip Roads											
MG1C/DG1C	Varies	Varies	2.00[7]	N/A	3.30	3.70[9]	N/A	0.70	2.80	Varies	Varies
MG2E/DG2E	Varies	Varies	2.50	1.00[11]	N/A	7.30		1.00	2.50	Varies	Varies
						3.65	3.65				

Image 3.2 Proposed cross section for the A720 Slip Roads

Sheriffhall Roundabout

3.4.10 The Sheriffhall Roundabout would be retained at its existing location but would be enlarged to an inscribed circle diameter (ICD) of 150m and become an 8-arm roundabout, connecting the A7 North, the A6106 Millerhill Road, the A6106 Old Dalkeith Road, the A7 South and all A720 east and west facing slips.

3.4.11 The circulatory carriageway would consist of three lanes, with a total width of 10.95m. Entry and exit width and kerb radii are designed in accordance with the requirements laid out in DMRB TD 16/07 'Geometric Design of Roundabouts'. Two lanes are provided on all roundabout exits, tapering down to a single lane width

[1] It should be noted the scheme includes two lanes (D2AP) for each carriageway on the A720.

downstream where necessary. Two and three lane entries are provided for the slip roads and side roads, respectively.

Side Roads

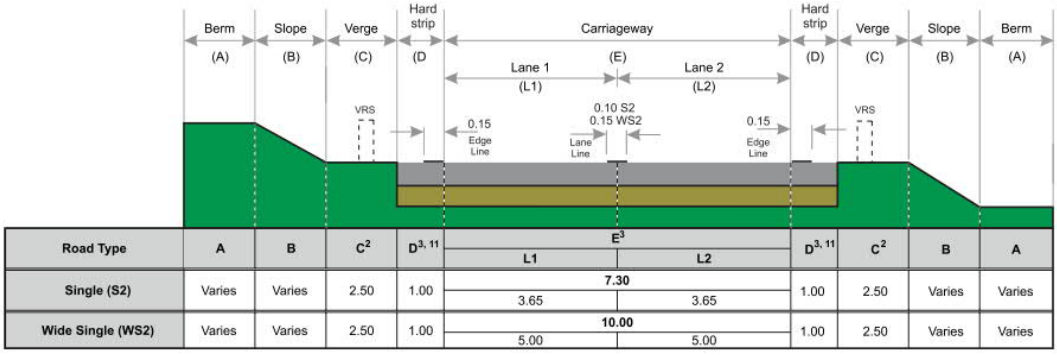
3.4.12 Some realignment of the roundabout arms is required, to tie in to the local road network, with the exception of the A6106 Millerhill Road to the north which would be realigned over an approximate length of 640m. The geometric design parameters used for the side roads is summarised in Table 3.3 below.

Table 3.3 Design Parameters for Side Roads

Road	Design Speed	Desirable Minimum Horizontal Radius (m)	Desirable Minimum Vertical Crest K	Absolute Minimum Vertical Sag K	Minimum & Maximum Vertical Gradient (+/-)	Desirable Minimum SSD (m)
A7 North	85A	510	55	20	> 0.5% & < 6%	160
A7 South	70A	360	30	20	> 0.5% & < 6%	120
A6106 Millerhill Road	100A	720	100	26	> 0.5% & < 6%	215
A6106 Old Dalkeith Road	70A	360	30	20	> 0.5% & < 6%	120

3.4.13 The proposed horizontal geometry for the A6106 Millerhill Road includes a three Design Speed step Relaxation below the Desirable Minimum horizontal curve along the initial 50m of the alignment and a two Design Speed step Relaxation below the Desirable Minimum horizontal curve at the tie-in with the existing road. These Relaxations were introduced as part of the opportunities identified at the Value Management Workshop in October 2018 and were considered appropriate to minimise the length of the A6106 realignment thereby also minimising the impact on adjacent land.

3.4.14 The proposed cross section for the realigned side roads is as set out in figure 4-3a of DMRB TD 27/05 'Cross Sections and Headrooms', for a Rural All-Purpose Single Carriageway Road (S2), as shown in Image 3.3.



Road Type	A	B	C[2]	D[3, 11]	E[3] L1	E[3] L2	D[3, 11]	C[2]	B	A
Single (S2)	Varies	Varies	2.50	1.00	7.30 / 3.65	7.30 / 3.65	1.00	2.50	Varies	Varies
Wide Single (WS2)	Varies	Varies	2.50	1.00	10.00 / 5.00	10.00 / 5.00	1.00	2.50	Varies	Varies

3.4.15

Image 3.3 Proposed cross section for Side Roads

3.4.16 The above cross section applies to all side roads except the A6106 Old Dalkeith Road, which does not include hard strips and widens to include two northbound lanes, matching the existing provision. All side roads provide a 3-lane entry onto the roundabout.

3.4.17 Further details on the geometry of side roads and associated Relaxations are given in Section 4 of this report.

Access Provision

3.4.18 The realignment of the existing roundabout arms and the inclusion of NMU facilities requires access to adjacent properties to be relocated. A number of residential and rural properties are located in the area of the scheme and, following consultation with landowners and tenants, proposals for relocated accesses have been developed as summarised below.

3.4.19 Two relocated residential accesses will be provided:

- The existing accesses to "Summerside" residential properties, directly impacted by the realignment of the A7 North, will be combined into one access relocated approximately 160m north of the roundabout. A new side road running parallel to the A7 from the new access will then provide access to the individual properties and will extend further south to provide service access to the proposed Sustainable Drainage Systems (SuDS pond).
- The existing access to Sheriffhall House and Old Sheriffhall Farmhouse, impacted by the realignment of the A6106 Old Dalkeith Road, will be relocated approximately 20m south of its existing location and the relevant access road realigned.

3.4.20 A number of field accesses will be upgraded and/or relocated to tie into the proposed scheme.

- Two existing accesses off the A7 North, located approximately at chainages 175m and 255m, will be upgraded to tie into the realigned road. The access at chainage 255m serves two fields.
- Three new field accesses are provided off the A6106 North (Millerhill Road) at chainages 280m, 320m and 440m. The access at chainage 320m serves two rural fields located either side of the existing A6106 and, partly using the existing road, the SuDS pond located further south.
- Two new accesses will be provided to serve the SuDS ponds either side of the A6106 Old Dalkeith Road. These accesses will be located beyond the point where the proposed realigned A6106 ties into the existing, approximately 195m away from the roundabout – the western access will form a junction directly with the existing A6106, whereas the eastern one will be provided off an existing access road.
- A new access on the east side of the A7 South, approximately at chainage 190m, will serve both the field located east of the A7 and the SuDS pond further north.

3.4.21 All proposed field accesses are 3.5m wide, in accordance with DMRB TD 41/95 'Vehicular Access to All-Purpose Trunk Roads'.

Non-Motorised Users (NMUs)

3.4.22 The NMU routes have been developed in line with the process described in DMRB HD 42/17 'Walking, Cycling & Horse-Riding Assessment and Review', and in accordance with the current design standards and industry best practice listed in Section 4 of this report.

3.4.23 The NMU layout has been developed to provide low-level grade-separated NMU links across the Sheriffhall Roundabout with five subways connecting to off-carriageway, 3m wide shared pedestrian/cycle routes on the A7 North, A7 South, A6106 Millerhill Road and A6106 Old Dalkeith Road. Where NMU routes run adjacent to the carriageway, shared facilities will be provided within the road verge and offset from the running edge of the carriageway by 0.5m or 1.5m, as appropriate to the speed limit of the adjacent carriageway.

3.4.24 Subways will provide a minimum 2.8m headroom and an open-aspect cross section of 9m, accommodating the 5m width of the NMU facilities and adjacent verges

3.4.25 The proposed NMU routes are shown in Figure 3.1 and further details are given in Section 4 of this report.

Intelligent Transport Systems (ITS)

3.4.26 In order to support operations and improve users' experience, and as agreed in consultation with TS, the scheme will include several Intelligent Transport Systems (ITS), including traffic detection systems, CCTV and ducting throughout the scheme in accordance with current Transport Scotland standard provision.

3.4.27 Consideration has also been given to the provision of strategic Variable Message Signs (VMS) and to any further technology to support usage and safety of the NMU routes.

3.4.28 A summary of the recommended ITS for the scheme is detailed in Section 4.

3.5 Cost Estimates

Introduction

3.5.1 This section provides a cost estimate for the scheme at Stage 3. The inclusion of grade-separated Non-Motorised User (NMU) facilities, open aspect road bridges and more extensive ground treatment result in a cost increase when compared to the cost estimate reported at Stage 2. The detail considered in development of the wider civils proposals has also progressed at Stage 3 and associated costs are factored into the estimate.

3.5.2 The cost estimate includes preliminaries, roadworks, pavement, structures, earthworks, environment and landscaping, access provision, statutory undertakers and land costs. Value Engineering (VE) proposals have been included as part of the Stage 3 design development, with a potential for further refinement as part of the contractor's input to the D&B procurement and detailed design phases.

3.5.3 The cost estimate is based on the scheme material quantities derived from the design model and comprises of the following main elements:

- An initial capital cost estimate for construction works using Q2 2018 rates from Spons 2019 Price Book and comparable schemes;
- rates indexed to Q4 2018 using Retail Price Index factors from the UK Office of National Statistics;
- preliminaries quantified as a percentage of the construction costs in line with similar schemes;
- land acquisition costs provided by the Valuation Office Agency;
- allowance for project risk as agreed at the Stage 3 Value for Money and Risk workshop; and
- adjustment factors for preparation, supervision and optimism bias.

3.5.4 The scheme cost estimate is exclusive of VAT, and is current at Quarter 4 / 2018.

3.5.5 In preparing the cost estimate, certain assumptions have been made using data from previous comparable projects and based on the information that is available at this stage. These are outlined under the relevant sections below.

Cost Estimate Summary

3.5.6 A summary of the cost estimate for the scheme is given in Table 3.4 and further details are included in the following sections of this report.

Table 3.4 Cost Estimate Summary

		Costs to nearest £1000 (£ Q4 2018 Prices)
Series 100:	Preliminaries	18,122,000
Series 200:	Site Clearance	119,000
Series 300:	Fencing	171,000
Series 400:	Road Restraint Systems	688,000
Series 500:	Drainage & Service Ducts	1,618,000
Series 600:	Earthworks	27,468,000
Series 700:	Road Pavements	5,888,000
Series 1100:	Kerbs, Footways & Paved Areas	465,000
Series 1200:	Traffic Signs & Road Markings	743,000
Series 1300:	Road Lighting	332,000
Series 2500:	Structures	18,974,000
Series 2700:	Access Provision, Works for Statutory Undertakers	3,440,000

		Costs to nearest £1000 (£ Q4 2018 Prices)
Series 3000:	Landscape & Ecology	500,000
	TOTAL CIVILS COST	**78,528,000**
Risk Allowance		8,310,000
	TOTAL CONSTRUCTION COST	**86,838,000**
Land & Property		3,076,000
	TOTAL CONSTRUCTION & LAND COST	**89,914,000**
Preparation (6%)		5,395,000
Supervision (5%)		4,496,000
	Total Scheme Cost Sub-Total	*99,805,000*
Optimism Bias (15%)		11,811,000
Optimism Bias Structures (23%)		4,844,000
	TOTAL SCHEME COST	**116,460,000**

Preliminaries

3.5.7 An allowance for preliminaries has been estimated using a cost multiplier of 30% applied to the total civils cost.

Roadworks

3.5.8 Site clearance costs are based on the land boundary. Land use was assessed to determine appropriate site clearance rates to be used.

3.5.9 Fencing costs are based on the assumption that the entirety of the scheme boundary is fenced. An allowance has also been made for additional fencing around the perimeter of SuDS ponds.

3.5.10 Road restraint system costs have been calculated based on the output of Road Restraint Risk Assessment Processes (RRRAP).

3.5.11 Drainage requirements have been established through detailed assessment of the scheme design and costs are based on quantities extracted from the modelled pipe networks and SuDS basins.

3.5.12 Kerb and footway costs are based on lengths and areas derived from the design model. A 160mm construction depth has been assumed for footways throughout the scheme.

3.5.13 Traffic signs and road marking costs are based on quantities and sizes extracted from the design model. An allowance is also made under this heading for the introduction of Intelligent Transport Systems as part of the scheme.

3.5.14 Lighting costs are based on the preliminary road and NMU lighting design. Detailed costs have been developed which include for the complete installation of new lighting infrastructure and the removal of existing.

Pavement

3.5.15 Full pavement construction has been assumed throughout the scheme. Construction depth and composition varies across the A720 mainline and side roads and has been developed based on future vehicle loading derived from the traffic model.

3.5.16 It has been assumed that 10% of surfacing and 50% of binder and base material excavated from the existing road network are recycled and used in the construction of the scheme. Only the ‘plant’ and ‘labour’ elements of the Spon’s rate have been applied to the assumed quantities of recycled material incorporated in the pavement construction.

Structures

3.5.17 Structures costs include for two open aspect A720 road bridges, extension to both sides of the Borders Railway underpass, five NMU subways and retaining walls between closely located subway portals. Structure costs are

developed using deck or face area rates as used on comparable schemes. An uplift of 25% has been added to bridge/subway costs to account for the potential cost of piling.

Earthworks

3.5.18 Earthworks quantities were derived from the design model. Cut slopes are typically 1 in 3 and embankment slopes 1 in 2 throughout the scheme. Allowance is also made for the reinforced slopes required to overcome the level difference between the A720 and the NMU route as it passes through the roundabout centre island.

3.5.19 The findings of the ground investigation have been used to assess the percentage of site-won material suitable for re-use. This has been estimated to be approximately 75% across the scheme.

Additional Geotechnical Works

3.5.20 Mine working treatment costs have been calculated from detailed review and modelling of targeted ground investigation borehole data to estimate the extents of coal seams and treatment areas. The cost estimate includes for grouting of the coal seams assessed to be of medium, medium to high and high risk.

3.5.21 Mine entry treatment costs have been developed based on the proposed treatment methodology for high risk shafts that were identified during ground investigation or documented on historic mapping sources. Grouting costs vary depending on the assessed depth of shaft. An allowance for capping has been made where shafts are located within the footprint of the scheme and capping costs vary depending on the depth to rock head.

3.5.22 Areas of soft soils have been identified. In-situ ground improvement for these areas was assessed to be more economical than excavation and replacement and an allowance for in-situ treatment with lime/cement has been included in the cost estimate.

Environment and Landscaping

3.5.23 Environment and landscaping costs are based on comparable schemes.

Access Provision

3.5.24 Residential and field access provision works have been costed based on quantities extracted from the design model.

Statutory Undertakers

3.5.25 NRSWA C3 budget estimates for divisionary works have been obtained from utility providers and incorporated into the Stage 3 cost estimate.

Land

3.5.26 Land costs are based on an estimate provided by the District Valuer (DV) from the Valuation Office Agency. This cost estimate has included assumed rates for heritable value of land, disturbance, agent's fee, severance and injurious affection, a contingency value and a DV fee allowance.

Adjustment Factors

3.5.27 Adjustment factors for preparation, supervision and optimism bias have been applied as appropriate for the assessment stage, in line with Green Book guidance. A quantified risk assessment was produced as part of the Stage 3 Value for Money and Risk workshop, enabling a reduction in the adjustment factors for the final Stage 3 scheme cost estimate.

3.5.28 A 6% uplift factor is applied for preparation costs to cover consultancy fees, public consultation, public local inquiry and the cost of any surveys carried out during scheme preparation. A 5% uplift factor is applied for supervision costs to cover site staff and on-site testing of materials.

3.5.29 Optimism bias is the demonstrated systematic tendency for appraisers to be overly optimistic about key parameters. To compensate, a 15% uplift is applied to the risk adjusted roadwork and land cost items and 23% to the structures cost.

3.6 Value for Money and Risk

3.6.1 A Stage 3 Value for Money (VfM) and Risk Workshop was held on 24th October 2018 with representatives from Transport Scotland and AECOM. Transport Scotland commissioned an independent facilitator, Capital Value & Risk Limited (CVRL), to manage the VfM process. The workshop was convened to undertake a value engineering (VE) review and risk assessment of the scheme.

3.6.2 An objective of the Workshop was to review the VE log to establish the optimal design solution for the scheme in terms of function and cost. The VE review addressed the following:

- analysis of all key elements to seek cost reductions whilst still achieving the project objectives;
- confirmation of the potential VE issues for further consideration and/or incorporation in Stage 3 design; and
- identification of any VE issues that the Contractor may raise as part of Design & Build (D&B) tender/works and confirmation of how these are to be addressed.

3.6.3 The findings of this review are reported in the Value for Money and Risk Workshop Report which is under a separate cover. The main outcomes are summarised below.

1. Relaxations in the horizontal geometry of the A6106 Millerhill Road to be considered to allow tie-in to the existing A6106 at an earlier point and minimise land-take.
2. The design speed on the A7 South to be considered as 70kph based on Midlothian Council's proposals to reduce the speed limit from 60mph to 40mph on the A7, south of Gilmerton Road, and their stated support for a similar speed limit reduction on the A7 between Gilmerton Road and Sheriffhall. The lower design speed allows earlier tie-in, reduced land-take and minimises the impact on the existing culvert below the link.
3. Wider mainline verges to be provided across the A720 bridges as a future-proofing measure, with only Relaxations or Departures from standard relating to the opening year layout to be applied for as part of the Sheriffhall scheme.
4. Pavement and cut material to be re-used wherever possible to reduce the quantity and cost of materials being imported to site and exported for disposal.
5. Structures to be designed with open-aspect through section, in accordance with Transport Scotland's Employer's Requirements for Structures. This would also enhance attractiveness of NMU facilities at the subways.

3.6.4 A review of the scheme risk register was also carried out at the Workshop. Risks were rationalised and their probability and potential impact assessed before reviewing and allocating mitigation actions. This allowed the quantification of risks and the inclusion of a risk value in the draft cost estimate. The risk register remained a live document as the Ground Investigation findings were still being assessed and the design development progressed to implement the agreed value engineering actions for the final scheme design. The risk register was finalised in March 2019 with the final quantified risk value incorporated into the scheme cost estimate.

3.6.5 The Cost Summary included in Section 3.5 includes the findings of the Workshop.

4 Engineering Assessment

4.1 Engineering Standards

4.1.1 The scheme design has been developed in accordance with current design standards and industry best practice as follows:

- Design Manual for Roads and Bridges (DMRB)
  - TD 9/93 ('Highway Link Design');
  - TD 16/07 ('Geometric Design of Roundabouts');
  - TD 22/06 ('Layout of Grade Separated Junctions');
  - TD 27/05 ('Cross-Sections and Headrooms');
  - TD 36/93 ('Subways for Pedestrians and Pedal Cyclists Layout and Dimensions');
  - TD 41/95 ('Vehicular Access to All-Purpose Trunk Roads');
  - TD 42/95 ('Geometric Design of Major-Minor Priority Junctions');
  - TD 50/04 ('Geometric Layout of Signalised Junctions and Roundabouts'); and
  - TA 90/05 ('The Geometric Design of Pedestrian, Cycle and Equestrian Routes').

The DMRB is undergoing a full review and some of the documents listed above have recently been superseded by updated guidance. However, the scheme has been assessed against the design guidance that was current at the time the design was undertaken.

- Transport Scotland Design Guidance;
  - Roads for All – Good Practice Guide for Roads (2013); and
  - Cycling by Design (2010).

4.2 Engineering Design Parameters

4.2.1 All elements of the proposed junction layout have been designed in accordance with the design standards listed in Section 4.1. The design speeds proposed for the junction are as per the existing speed limits and are listed for each element in Table 4.1.

Table 4.1 Proposed Design Speeds

Road	Design Speed (kph)
A720 Edinburgh City Bypass	120A
A7 North	85A
A7 South	70A[2]
A6106 Millerhill Road	100A
A6106 Old Dalkeith Road	70A
All slip roads	70A

[2] Following the VfM3 Workshop and consultation with TS Standards Branch, the design speed has been reduced from 100 to 70kph. Midlothian Council also confirmed their support for this at previous consultation events.

4.2.2 The following sections of this report provide further details on the geometry standards achieved for each link.

Roads Geometry

4.2.3 The junction layout aims to provide geometry appropriate for each road's design speed in accordance with DMRB TD 9/93 'Highway Link Design'. However, due to the constrained nature of the site, Relaxations are included where necessary to minimise the impact on the local environment. The geometry standards achieved are summarised in Table 4.2.

Table 4.2 Summary of Geometry Standards Achieved

Description	Design Speed (kph)	Length of Section (m)	Horizontal Geometry		Vertical Crest		Vertical Sag		Vertical Gradient	
			Desirable Minimum	Provided (min)	Desirable Minimum	Provided (min)	Absolute Minimum	Provided (min)	Desirable Min / Max	Provided
A720 Mainline	120	1600	1020mR	1200mR	182K	182K	37K	37K	0.5% / 4%	> 0.5% & < 4%
A720 Eastbound Diverge	70	370	360mR	360mR	30K	30K	20K	n/a	0.5% / 6%	> 0.5% & < 6%
A720 Eastbound Merge	70	423	360mR	720mR	30K	30K	20K	35K	0.5% / 6%	> 0.5% & < 6%
A720 Westbound Diverge	70	455	360mR	510mR	30K	170K	20K	n/a	0.5% / 6%	> 0.5% & < 6%
A720 Westbound Merge	70	411	360mR	720mR	30K	30.5K	20K	20K	0.5% / 6%	> 0.5% & < 6%
A7 North	85	286	510mR	510mR	55K	55K	20K	20K	0.5% / 6%	> 0.5% & < 6%
A7 South	70	270	360mR	360mR	30K	30K	20K	20K	0.5% / 6%	> 0.5% & < 6%
A6106 North (Millerhill Rd)	100	526	720mR	255mR	100K	100K	26K	100K	0.5% / 6%	> 0.5% & < 6%
A6106 South (Old Dalkeith Rd)	70	133	360mR	1020mR	30K	55K	20K	20K	0.5% / 6%	> 0.5% & < 6%

4.2.4 The proposed horizontal geometry for the A6106 North (Millerhill Road) includes two Relaxations. Further details are given in Section 4.3.

4.2.5 Plan & Profile drawings for each link are provided in Figures 4.1 to 4.16.

Roundabout

4.2.6 Sheriffhall Roundabout will be retained at its existing location and enlarged to become an 8-arm roundabout with an inscribed circle diameter (ICD) of 150m, connecting the A7 North, the A6106 Millerhill Road, the A6106 Old Dalkeith Road, A7 South and all A720 east and west facing slips.

4.2.7 The roundabout circulatory carriageway will be 10.95m wide and include 3 lanes. Entry and exit width and kerb radii are designed to standard as required by TD 16/07 'Geometric Design of Roundabouts' and are summarised in Tables 4.3 and 4.4.

Table 4.3 Roundabout Entry Layout Summary

Road	Min Entry Width (m)	Max Entry Width (m)	Min Entry Kerb Radius (m)	Max Entry Kerb Radius (m)
Sheriffhall Roundabout	8.9	9.7	19	20

Table 4.4 Roundabout Exit Layout Summary

Road	Min Exit Width (m)	Max Exit Width (m)	Min Exit Kerb Radius (m)	Max Exit Kerb Radius (m)
Sheriffhall Roundabout	7.0	7.3	26	40

4.2.8 Entry flaring has been applied over an approximate length of 50m on all side road approaches to the roundabout. Two lane exits are provided on all roundabout arms, with 1 in 15 exit tapers applied to return to single carriageway width downstream where necessary.

4.2.9 An assessment of the entry angle and entry path radius identified that all roundabout approaches achieve the required criteria.

Stopping Sight Distance

4.2.10 A review of stopping sight distance (SSD) has been undertaken and verge widening has been provided where necessary. Desirable minimum SSD has been provided on the immediate approaches to junctions. Otherwise the SSD has been relaxed if necessary to minimise the impact on the local environment. A summary of the minimum SSD achieved is presented in Table 4.5.

Table 4.5 Achieved Stopping Sight Distance

Road	Design Speed (kph)	On approach to a junction		Outwith approach to a junction	
		Desirable Minimum	Provided (min)	Desirable Minimum	Provided (min)
A720 Mainline	120	295m	295m	295m	265m
A720 Eastbound Diverge	70	120m	120m	295m	295m
A720 Eastbound Merge	70	120m	120m	120m	120m
A720 Westbound Diverge	70	120m	120m	295m	295m
A720 Westbound Merge	70	120m	120m	120m	120m

Road	Design Speed (kph)	On approach to a junction		Outwith approach to a junction	
		Desirable Minimum	Provided (min)	Desirable Minimum	Provided (min)
A7 North	85	160m	160m	160m	160m
A7 South	70	120m	120m	120m	120m
A6106 North (Millerhill Rd)	100	215m	215m	215m	215m
A6106 South (Old Dalkeith Rd)	70	120m	120m	120m	120m

4.2.11 The minimum SSD value achieved for the A720 mainline outwith the approach to the junction (at a distance that is over 1.5 times the required SSD), as reported in Table 4.5, refers to the minimum SSD achieved along the eastbound carriageway (265m). The SSD is one step below Desirable Minimum along the westbound carriageway (287m). As these do not occur on the approach to a junction, both are considered as Relaxations. Further details are given in Section 4.3 of this report.

Cross Sections

4.2.12 The existing A720 is a two lane all-purpose dual carriageway. The cross sections provided for realigned lengths of the A720 are as per the existing cross section: typically two 7.3m wide carriageways with 1.0m nearside and offside hard strips, 2.5m verges and 2.5m central reserve. Verge widening for stopping sight distance has been included at this stage with the central reserve and verges widened where necessary.

4.2.13 It should be noted that although the A720 mainline includes 1.0m nearside hard strips, the proposed A720 bridge structures include additional span width to allow for future improvements, such as a 3.3m wide hard shoulder/running lane. As a result of a value engineering exercise, the SSD associated with any future third lane would be a Relaxation as not the full desirable minimum SSD would be provided.

4.2.14 The proposed typical cross section of the A7 North, A6106 Millerhill Road and A7 South are consistent with the rural all-purpose single carriageway (S2) specification detailed in DMRB TD 27/05 'Cross sections and Headrooms'. These comprise a 7.3m carriageway with 1.0m hard strips and 2.5m verges as a minimum. Verge widening to provide desirable minimum SSD on approach to a junction has been incorporated where necessary. Due to the short length of section before tie-in with existing, the A6106 Old Dalkeith Road does not include hard strips and widens to include two northbound lanes, matching the existing provision. This is a Departure from Standard and further details are given in Section 4.3.

4.2.15 The cross sections for the realigned sections of road are as detailed in Table 4.6, and typical cross sections are shown on Figures 4.17 to 4.23.

Table 4.6 Proposed Cross Sections

Road	Central Reserve	Carriageway	Hard strip
A720 Mainline	2.5m (min) + 1.0m h/s	2 x 7.3m c/way	1.0m
A720 Eastbound Diverge	-	2 x 3.65m lane	1.0m
A720 Eastbound Merge	-	2 x 3.65m lane	1.0m
A720 Westbound Diverge	-	2 x 3.65m lane	1.0m
A720 Westbound Merge	-	2 x 3.65m lane	1.0m

Road	Central Reserve	Carriageway	Hard strip
A7 North	-	7.3m	1.0m
A7 South	-	7.3m	1.0m
A6106 North (Millerhill Rd)	-	7.3m	1.0m
A6106 South (Old Dalkeith Rd)	-	7.3m	-
Sheriffhall Roundabout	-	3 x 3.65m lane	kerbed

Weaving Length

4.2.16 The grade separated junction has been designed in accordance with DMRB TD 22/06 'Layout of Grade Separated Junctions', which provides guidance on weaving lengths and on merge and diverge layouts. Grade separated junctions are provided throughout the A720 Edinburgh City Bypass.

4.2.17 TD 22/06 sets out minimum criteria on the weaving lengths between adjacent grade separated junctions. The weaving length (the distance between a merge and successive diverge) is a function of the design speed, and for the A720 Edinburgh City Bypass the desirable weaving length is 1000m. TD 22/06 also sets out the minimum distance between successive merges (merge followed by a merge) and successive diverges (diverge followed by another diverge). This minimum distance is 3.75 times the design speed which for the A720 mainline is 450m.

4.2.18 The merge and diverge layouts proposed for each junction, and the weaving lengths provided, are detailed in Table 4.7.

Table 4.7 Junction Layout/Weaving Lengths

Description	Layout	Weaving Lengths Provided	Notes
Gilmerton eastbound diverge	As existing	-	-
Sheriffhall eastbound diverge	Taper diverge 2 lane slip road with 70m nosing	Gilmerton e/b diverge to Sheriffhall e/b diverge = 970m	Diverge to diverge spacing ok as greater than 450m
Sheriffhall eastbound merge	Parallel merge 2 lane slip road with 85m nosing	Sheriffhall e/b merge to Millerhill w/b diverge = 1290m	Merge to diverge spacing provided ok as greater than 1000m
Sheriffhall westbound diverge	Parallel merge 2 lane slip road with 70m nosing	Millerhill w/b merge to Sheriffhall w/b diverge = 1290m	Merge to diverge spacing provided ok as greater than 1000m
Sheriffhall westbound merge	Taper diverge 2 lane slip road with 85m nosing	Sheriffhall w/b merge to Gilmerton w/b merge = 890m	Merge to merge spacing provided ok as greater than 450m
Gilmerton westbound merge	As existing	-	-

Access Provision

4.2.19 The grade separation of Sheriffhall Roundabout and the associated realignment of sections of the A7 North, A6106 Millerhill Road, A6106 Old Dalkeith Road and A7 South will require the replacement of a number of existing direct accesses onto the local road network. The new means of access for the affected properties are described in Section 3.4.

4.2.20 The relocated/replaced accesses have been developed in accordance with the current design standards and industry best practice listed in Section 4.1, as well as DMRB TD 41/95 'Vehicular Access to All-Purpose Trunk Roads' and SCOTS National Roads Development Guide.

4.2.21 All field accesses include a 3.5m track and form a 45 degrees splay junction with the side road for the last 2m. This is consistent with the requirements of TD 41/95 for Layout 1 ('Field Access'). Residential accesses have been developed in accordance with Layout 3 ('Simple Layout'). The shared access to Sheriffhall House and Farmhouse includes a 3.5m wide carriageway and 10m corner radii at the junction with the A6106 South. The shared access to the Summerside properties includes a smaller corner radii (6m) due to the site constraints, but a wider carriageway is provided to facilitate vehicles manoeuvres.

4.2.22 All accesses fully comply with the relevant visibility requirements.

4.3 Departures from Standard

General

4.3.1 The scheme has been developed in accordance with the DMRB and provides a Departure-free design for the A720 mainline and slip roads. However, Relaxations have been considered necessary in some circumstances to minimise land take, earthworks volumes, costs and environmental impact. Two Departures from Standard are also required for the cross section of the realigned section of the A6106 South (Old Dalkeith Road). Further details on the proposed Relaxations and Departures are given in the following sections.

Relaxations

4.3.2 The proposed scheme includes a total of four Relaxations, which are summarised in Table 4.8. Justification for their adoption is provided below.

A720 Mainline – Stopping Sight Distance

4.3.3 Although the vertical alignment achieves the required desirable minimum geometry standards for a 120 kph design speed, the Stopping Sight Distance (SSD) on the proposed A720 carriageways is one Design Speed step below Desirable Minimum on the vertical crest over the bridges. However, this is outwith the approach to a junction and can therefore be considered a Relaxation.

4.3.4 Full visibility of a 0.26m high object, from an eye height of 1.05m, along Lane 1 on the eastbound carriageway (Relaxation R01) is obstructed by the kerbed verges which raise up from the carriageway which is at 2.5% crossfall. The crossfall and kerb arrangement is a requirement for the proposed structures and cannot be removed or amended. Similarly, visibility along the offside lane on the westbound carriageway (Relaxation R02) is obstructed by the kerbed central reserve.

4.3.5 To improve the SSD for both carriageways, the mainline vertical crest curve would need to be flattened further by provision of a larger crest K value. This in turn would require lowering the roundabout and NMU routes to achieve the required vertical headroom clearances, which would result in additional cut volumes and environmental impact, as well as increased costs, and would also have implications for the proposed gravity drainage. Maintaining the current proposed mainline levels to avoid lowering the roundabout and NMU routes would not be cost-effective as the larger K value crest would increase the length of the A720 realignment and, consequently, result in increased fill volumes, land take and costs. This would also result in an increased clearance over the existing Borders Railway structure, exceeding the maximum 5m fill to which it was originally designed.

A6106 North (Millerhill Road) – Horizontal Geometry

4.3.6 The proposed horizontal geometry for the A6106 North (Millerhill Road) realignment includes two Relaxations. These have been introduced as part of the opportunities identified at the Value Management Workshop in October 2018 and were considered appropriate to minimise land take and shorten the length of the required A6106 realignment.

4.3.7 A three Design Speed steps below Desirable Minimum horizontal curve (Relaxation R03) is proposed for the first 50m of the A6106 North alignment. Due to the limited space available at the roundabout, and to comply

with roundabout geometry deflection requirements, a larger radius would require a longer realignment of the A6106 North, resulting in increased impact on adjacent land and costs. The proposed alignment ties back into the existing road with a two Design Speed steps below Desirable Minimum curve (Relaxation R04), aiming to tie in as early as possible while maintaining a reasonable geometry.

Departures from Standard

4.3.8 The scheme includes a total of two Departures from Standard, as summarised in Table 4.9.

4.3.9 Both Departures are associated with the proposed cross section for the A6106 South (Old Dalkeith Road), which does not include hard strips as per the existing provision. Providing hard strips would require 35m long tapers and TD 16/07 'Geometric Design of Roundabouts' also requires hard strips to be terminated where entry widening begins, which occurs at chainage 50m. As the proposed alignment is only approximately 133m long, this would leave less than 40m of road with a full 1m wide hard strip on the approach to/exit from the roundabout. The Departures were therefore deemed necessary as the provision of hard strips over a short length close to the junction is not considered to be beneficial and may have safety implications as drivers might find the layout confusing. Providing full 1m wide hard strips over a longer section, with tapers, would not be feasible without lengthening the alignment further south. A longer alignment would result in increased earthworks and have an increased impact on adjacent land.

4.3.10 The Departures from Standard summarised above have been determined and approved by Transport Scotland.

Table 4.8 Summary of Relaxations

Relaxation No.	Location	Chainage	Departure Type	DMRB Reference	Design Speed	Required Standard	Standard Provided	Design Speed Steps Below Desirable Minimum
R01	A720 Mainline Eastbound Carriageway – Left Lane	1450 - 1780	SSD	TD 9/93	120A kph	SSD = 295m	SSD = 265m	1
R02	A720 Mainline Westbound Carriageway – Left Lane	2160 - 1880	SSD	TD 9/93	120A kph	SSD = 295m	SSD = 287m	1
R03	A6106 North (Millerhill Road)	0 - 50	Horizontal Geometry	TD 9/93	100A kph	R = 720m at 5% superelevation	R = 255m at 7% superelevation	3
R04	A6106 North (Millerhill Road)	310 - 410	Horizontal Geometry	TD 9/93	100A kph	R = 720 at 5% superelevation	R = 360m at 7% superelevation	2

Table 4.9 Summary of Departures from Standard

Relaxation No.	Location	Chainage	Departure Type	DMRB Reference	Design Speed	Required Standard	Standard Provided	Design Speed Steps Below Desirable Minimum
D01	A6106 Old Dalkeith Road - Northbound	0 - 133	Cross Section	TD 27/05	70A kph	1m Hard Strip	No Hard Strip provided	n/a
D02	A6106 Old Dalkeith Road - Southbound	0 - 133	Cross Section	TD 27/05	70A kph	1m Hard Strip	No Hard Strip provided	n/a

4.4 Topography and Land Use

4.4.1 The topography of the scheme area mainly consists of gently undulating ground with natural slope angles of typically around 5° to 10°. The land surrounding the site mainly consists of arable farm land with occasional small residential or industrial properties. The Borders Railway runs north-south to the east of Sheriffhall Roundabout. The road infrastructure is in cutting to the west of Sheriffhall and on embankment to the east.

4.4.2 The Coal Measures strata have been extensively mined in the past and the scheme is underlain by historic abandoned shallow mine workings. A number of mine entries are also present either directly beneath the scheme or within influencing distance of the scheme.

4.4.3 The historic and current land use information and ground investigation results indicate that there are potential sources of contamination across the site. These include: pesticides/fertilizers from farming activities; colliery spoil, backfilled sand pits and/or abandoned mine entries associated with historic mine workings; existing A720 embankments constructed with fill materials derived from blaes, colliery spoil; disused sewage treatment works; disused water works; disused and operational railway land; waste transfer station; fuel dealers; electrical substation; a market gardening enterprise and areas of fly-tipping.

4.5 Non-Motorised Users (NMU)

Design Aspirations and Opportunities

4.5.1 As part of the Stage 3 design development process, an optioneering exercise was undertaken looking at a wide range of NMU options for the preferred junction option selected at DMRB Stage 2.

4.5.2 The NMU route options were designed and assessed in accordance with the following design aspirations, as agreed at a series of three Wider Stakeholder Workshops held throughout the design process:

- straight through / direct NMU route;
- NMU provision on all arms, on both sides of road;
- maximum 5% gradients;
- try to avoid controlled crossings; and
- consider proposals for structures, including attractive / open designs, further development of routes and scheme extents.

4.5.3 Design opportunities were also identified and agreed at the Workshops, in line with the requirements of the DMRB HD 42/17 'Walking, Cycling and Horse-Riding Assessment and Review' (WCHAR) process. These are listed below.

1. Provide facilities which are attractive to users to encourage wider active travel and support modal shift.
2. Act as exemplar for integration of all modes in holistic solution developed in collaboration with stakeholders.
3. Ensure proposals take account of future developments and other active travel initiatives in the scheme area such as Edinburgh Orbital and A7 Urbanisation.
4. Segregate non-motorised users from motorised users to limit interaction with live traffic.
5. Improve user facilities at Sheriffhall Roundabout to provide safe passage across the trunk road. Direct /dedicated connections on the desire line which are conducive to personal safety and well integrated with the wider network should be targeted.
6. Improve user facilities along the A7 North to better facilitate integration with Sheriffhall Park & Ride.
7. Improve user facilities along the A6106 Old Dalkeith Road to provide better linkage to Dalkeith.
8. Provide user facilities along the A7 South to improve access to local amenities / A772 Gilmerton road corridor.

9. Provide user facilities north of Sheriffhall Roundabout to enable connection with the proposed development areas.

10. Provide controlled crossings, where appropriate, to integrate walking, cycling and horse-riding routes and local amenities.

11. Explore opportunities for future integration and developing links with horse-riding facilities in the study area.

Preferred Option Selection

4.5.4 In line with the requirements of HD 42/17 'Walking, Cycling & Horse-Riding Assessment and Review', an assessment was undertaken to gain a wider understanding of all relevant existing facilities within a 5km study area; to collect user information to inform the design requirements; and to identify opportunities for improvement for users.

4.5.5 A three-part Wider Stakeholder Workshop was held in August 2017, October 2017 and August 2018 to discuss stakeholders' aspirations and concerns for the NMU facilities proposed as part of the scheme. Design objectives, opportunities and methodology were discussed and agreed at the workshops, and several NMU options were assessed accordingly.

4.5.6 All NMU options satisfied the WCHAR Design Opportunities and more broadly applicable scheme objectives to varying degrees. The measurable elements that underpin the scheme objectives and WCHAR Design Opportunities were considered to examine key differences between options and help identify the preferred NMU option. Value for money was also considered when determining the preferred NMU option.

4.5.7 The overall assessment concluded that subway NMU options were preferable to those including NMU routes located mid-level between side roads and the A720. No one subway option emerged as being preferred across all assessment criteria, however on balance Option 7a was selected as the preferred option and incorporated into the scheme design. The preferred NMU option is discussed further in Section 3.4 and associated geometric standards set out in Section 4.

Geometry

4.5.8 Cycling by Design guidance specifies geometry standards based on the classification of the NMU route, either 'long distance/commuter route' or 'local access route'. These are outlined against the route classification in Table 4.10.

Table 4.10 Geometry Parameters for NMU Facilities

Description		Long Distance/Commuter Route	Local Access Route
Horizontal Alignment	Desirable Min Radius (m)	25	15
	Min Bellmouth Radius at Junctions (m)	4	4
	Min Radius of Curvature of Walls adjacent to Cycle Track (m)	68	28.5
Vertical Alignment	Desirable Min Crest (k)	14.1	6.8
	Abs Min Crest (k)	5.3	1.3
	Sag values are not likely to be a controlling factor on cycle speeds and are therefore not specified.		

4.5.9 With the aspiration to provide exemplar NMU facilities as part of the scheme, the standards for long distance/commuter routes have been adopted where possible. Where specific constraints exist that would result in disproportionately high impacts in terms of environment and cost, the lower local access route standards have been adopted.

4.5.10 Transport Scotland's 'Roads for All' guidance requires gradients of 5% and above to be considered as ramps and, as such, level landing platforms of at least 1.5m should be included at regular intervals. However, the guidance also notes that above a certain length, even with the appropriate gradient and number of rest points, a ramp is a barrier to independence for many people with mobility impairments. All NMU routes have therefore been developed with gradients of limited length and never exceeding 4.3% gradient, which is equivalent to the provision of a 5% gradient with 1.5m landings at 10m intervals.

4.5.11 The NMU cross section adopted for the scheme includes a 3m shared cycleway/footway with 1m verges on either side. The 5m total cross section width is retained through the subways to maximise visibility and attractiveness to users. This cross section applies to NMU routes provided within the central island of the roundabout, along the A7 North and A7 South, on the west side of the A6106 North and east side of the A6106 South. Due to the limited space available, NMU facilities linking the existing provision on the east side of the existing A7 North to the new facilities are 2m wide (desirable minimum for a two-way cycleway). The NMU route on the west side of the A6106 South is also 2m wide. This was included, at the request of the City of Edinburgh Council, to provide a link from the existing on-road cycle facilities on the A6106 South to the new NMU facilities through Sheriffhall Junction.

4.5.12 As required by 'Cycling by Design', where the shared cycleway/footway runs adjacent to a live carriageway with speed limit in excess of 40 mph, a desirable minimum clearance of 1.5m (including any hard strips) is provided. In cases where the carriageway speed limit is less than 40mph, the required clearance is reduced to 0.5m.

4.6 Ground Conditions and Earthworks

Summary of Ground Conditions

4.6.1 The ground conditions have been determined from detailed review of geological mapping, historical mine plans and historical borehole data in conjunction with the findings of the 2018 and 2019 ground investigations, undertaken by Soil Engineering Geoservices Ltd. Further detail can be found in the Factual Reports produced for the ground investigations (Soil Engineering, 2019) and the Ground Investigation Report (AECOM, 2019).

Superficial Deposits

General

4.6.2 Superficial deposits are present across the site. There are no rock outcrops. Thickness of the superficial deposits varies from about 5m in the north and west of the site increasing to between 10m and 15m at the Sheriffhall roundabout. To the south of the roundabout along the A7 South the depth to bedrock increases and reaches 30m below ground level. At the Borders Railway overbridge and east of the roundabout superficial thickness to the north of the A720 is 6m but at the south increases to 17m.

Made Ground

4.6.3 Made ground of varying thicknesses and types is present at the location of all man-made development and engineering infrastructure. Fly tipping is also common. Made ground is present as infill to, and possibly surrounding, old mineral extraction pits, abandoned mines and mine shafts. The made ground under the previous temporary re-alignment of the A720 comprises reworked natural soils. The made ground bunds at the west end of the scheme, and the mound in the centre of the roundabout, comprise reworked soils and variable quantities of man-made material including tarmac, colliery spoil (locally referred to as blaes), brick, sandstone masonry and natural organic materials such as branches and logs.

Alluvial Deposits

4.6.4 Published geological mapping does not show alluvial deposits beneath the scheme. Ground investigation encountered isolated alluvial deposits (in the form of silty sediments) on the south banks of the Dean Burn, where the alluvial soils were described as firm slightly sandy slightly gravelly clay. More extensive alluvial deposits are expected along the Dean Burn and within areas susceptible to flooding, e.g. the flood plain of the Dean Burn.

Glaciofluvial Deposits

4.6.5 Glaciofluvial deposits extend from the west of the roundabout to the eastern end of the scheme and tend to be only present south of the A720. Where encountered in exploratory holes, these deposits were typically described as 'loose to medium dense sand' and locally 'sand & gravel', with varying (sometimes substantial) proportions of clay and silt. Published geological mapping indicates that an esker, comprising glaciofluvial deposits of sand and gravel, runs in a north westerly direction through the centre of the site, from Sheriffhall Mains in the south to beyond Campend in the north.

4.6.6 Groundwater is often present in the granular glaciofluvial deposits and a 'running sand' effect ("quicksand" conditions) was reported in excavation work during the Borders Railway construction immediately south of the existing rail structure.

Glacial Till

4.6.7 The superficial geology underlying the scheme predominantly comprises cohesive glacial till of varying thickness and depth. Weathered glacial till is encountered across the site and is typically described as soft to firm sandy gravelly clay with low to medium cobbles and boulders content. Fresh glacial till is present beneath the weathered till and is typically described as stiff becoming very stiff with depth, sandy gravelly clay, with low to medium cobbles and boulders content. Ground investigation records boulders in many of the boreholes, and often the presence of cobbles and boulders hindered or prevented the drilling progress.

Engineering Fill

4.6.8 The existing A720 embankments are formed from general fill comprising dense to very dense black sandy clayey gravel, with occasional bands of sandy gravelly clay. The black clayey gravel is likely to be unburnt colliery spoil which is occasionally interbedded with thinner layers of sand fill and cohesive fill derived from natural soil deposits. A thin layer of red blaes (either well burnt colliery spoil or spent oil-shale waste) had been deposited at the base of the embankment. The embankment foundation is understood to comprise a 0.5m thick granular layer deposited onto in-situ soft to firm weathered cohesive glacial till, which was left in place under the new fill.

4.6.9 Beneath the roundabout, at the positions shown on Figure 2.7, special earthworks are recorded to be present in the form of two reinforced earth 'rafts', comprising selected engineering fill strengthened by galvanised steel reinforcing strips. The rafts were designed to mitigate damage to the A720 from ground subsidence movements across the Sheriffhall fault, caused by planned deep mining activity in the area.

4.6.10 Engineering fill is also present as backfill around and beneath the Borders Rail structure and in the A7 embankment, which comprises sandy clayey gravel.

Solid Geology

Bedrock

4.6.11 The solid geology underlying the scheme is recorded to comprise the Scottish Middle Coal Measures Formation and Scottish Lower Coal Measures Formation, which contains seams of coal and other minerals which are known to have been commercially exploited in the past. The Carboniferous Scottish Coal Measures comprise cyclical repeating sequences of coal, seatearths, sandstone, grey siltstone, grey/ brown often micaceous and carbonaceous mudstone. The sandstones and siltstones are typically weak to moderately strong. The mudstones and coal are typically weak. Sandstone was the predominant rock type encountered across the site during recent ground investigation. An upper 3m thick weathered zone typically occurs immediately below rockhead level.

Structural Geology

4.6.12 The ground within the scheme area is significantly faulted, with a series of east-west and north south trending faults. The most persistent of these faults, the major Sheriffhall Fault (see Figure 2.7), is recorded to trend broadly east-west through the centre of the scheme downthrowing the strata to the north by approximately 175m. It has been inferred that the fault is inclined to the north by around 50º from the horizontal. The bedrock strata in the vicinity of the fault are shattered and heavily fractured and faulted. Several smaller southeast-northwest trending faults are also recorded, primarily to the north of the Sheriffhall Fault and generally terminating against this feature. The strata beneath the scheme are generally inclined towards the east by around 5° to 10º, although there are local variations associated with folding and faulting.

Seismicity

4.6.13 Seismic activity has been recorded in the past. Most of the recorded locations of the seismic activity near Sheriffhall Roundabout correlate with the postulated location of the Sheriffhall Fault. Most of the seismic events recorded in the immediate vicinity of the scheme were of low magnitude and are understood to be attributed to deep mining activity, which has now ceased. Future seismic activity is not considered in the design as there have been no recent seismic events, all past seismic events were of low magnitude and the deep mining, which was considered to have the potential to trigger seismic events ceased during the 1980's.

Coal Mining – Mine Workings

4.6.14 The coal seams of the Scottish Middle Coal Measures and Scottish Lower Coal Measures are present at shallow depth beneath the scheme to the south and north of the Sheriffhall Fault respectively. The coal seams

of the Middle Coal Measures comprise the Whitehill Great Upper B, Whitehill Great, Whitehill Rough, Whitehill Splint, Whitehill Parrot Rough, Whitehill Jewel and Dalkeith Under Coal. The seams of the Lower Coal Measures comprise the Splint, the Rough and the Clayknowes coal.

4.6.15 Several of these seams are recorded to have been worked at shallow depth beneath the scheme in the past. Evidence of workings has also been recorded in historic boreholes drilled prior to the city bypass construction and in boreholes drilled in 2018 and 2019 for the Sheriffhall scheme. There is also a potential for unrecorded workings to exist throughout most of the site. The method of working in the shallow seams is likely to be stoop and room. Gas monitoring during ground investigation drilling did not detect any elevated levels of combustible gases in the coal seams. Groundwater levels are such that old abandoned workings are likely to be flooded.

4.6.16 Figure 2.7 illustrates where the above coal seams are at shallow depth beneath the scheme, as well as highlighting areas where the seams are assessed to pose a risk to the earthworks and structures.

Coal Mining – Mine Entries

4.6.17 Based on information from the Coal Authority (CA), mine abandonment plans and geology maps there are several potential mine entries within the scheme area which could pose a risk to surface stability. Figure 2.7 shows the location of potential mine entries which may pose a risk to the scheme if located and summarises what is known or recorded about their existing condition.

4.6.18 Mine entry investigation completed during 2018 and 2019 ground investigation proved the absence of several potential mine entry features in the surveyed areas. It is therefore considered there are potentially at least eight mine entries under or within influencing distance of the scheme.

Non -Coal Minerals

4.6.19 Carboniferous stratigraphic units (the Limestone Coal Formation, Lower Limestone Formation, West Lothian Oil-Shale unit and Gullane unit) present beneath the scheme, at -500mOD or deeper, contain organic-rich variably mature mudstone at suitable depths for shale gas and shale oil. These strata have potential for shale gas but have not yet been exploited and there are no proposals to do so but they may be an economically viable resource in the future.

Groundwater

4.6.20 Groundwater levels vary across the site with water levels typically higher in the south, central and west and lower in the north-east. Environmental geology maps show a groundwater contour at around 60mAOD.

4.6.21 Groundwater strikes, where recorded in historic boreholes, range widely between 0.6m and 22.5m below ground level, predominantly between 1.5m and 10m below ground level. Groundwater monitoring from the 2018 and 2019 boreholes found that in superficial deposits depths to groundwater level varied between 0.04mbgl (59.95m AOD) and 11.16mbgl (50.35m AOD). Groundwater is considered to be present in discrete zones of permeable granular glaciofluvial deposits and, within the glaciofluvial deposits, is often ‘perched’ on the underlying lower permeability glacial till. In the bedrock groundwater is typically confined and sub-artesian. Groundwater levels in the Coal Measures bedrock is as high as 3.92m below existing ground level.

4.6.22 The remains of an old disused farmhouse water well are recorded in the vicinity of the NMU SuDS pond, south of Sheriffhall Farm.

Potential Contamination

4.6.23 Within the vicinity of the A720 Sheriffhall Roundabout, both former and present land use may have resulted in the presence of potentially contaminated material, which may pose a threat to human health, controlled water or other sensitive receptors. The contaminated land risk assessment has identified potential contamination risk categories from very low to moderate/ low. The higher risk categories are associated with the water environment.

4.6.24 There are exceedances for human health screening with respect to PAH’s for samples from near A7 North and potential hydrocarbons in soils at the A6106 South. There are also exceedances of soil leachate PAH GAC’s in localised areas of the site. There is the possible presence of coal tars in the existing pavement of the A7 North.

4.6.25 The ground gas monitoring results recorded the following: Methane: <0.1 – 1.4%v/v; Carbon dioxide: <0.1 and 14.8%v/v. Oxygen: minimum 0.4%v/v; and Hydrogen sulphide: <1 – 2ppm. Carbon dioxide readings were elevated above the HSE long term and short- term workplace exposure limits on a number of occasions. Depleted oxygen levels were also recorded in a number of boreholes. The risk assessment categorised the existing risk for ground gases as low as long as adequate health & safety management practices are in place during the construction of the works and operation of the assets, particularly confined spaces due to the potential risk of asphyxiation.

4.6.26 Details of the potential sources of contamination sources and investigations carried out are included in the DMRB Stage 3 Environmental Statement September 2019 (Geology and Soils Chapter 16) and the AECOM Ground Investigation Report (GIR) November 2019.

Geotechnical Design - Foundations

A720 West Bridge and A720 East Bridge

4.6.27 The structures are east and west of the Sheriffhall fault. The weak to medium weak sandstone and siltstone bedrock in the fault zone is severely fractured and shattered. The bridge supports will be founded on piled foundations and, due to the magnitude of loading, the foundation piles will extend through the superficial deposits (glaciofluvial and glacial till) and weathered rock into competent bedrock. Potentially worked coal seams, which are present at shallow depth below the proposed structures, will be consolidated by infill grouting to ensure the long-term stability of the new infrastructure. Construction techniques will allow for the presence of sizeable boulders within the glacial till Shallow groundwater in the upper glaciofluvial deposits will require groundwater control measures during construction and the sub-artesian groundwater conditions in the bedrock will require groundwater control measures during piling.

NMU subways

4.6.28 The five NMU subways will be founded on superficial deposits comprising stiff to very stiff glacial till potentially permitting the use of spread foundations. High groundwater levels, as shallow as 1m below ground level in the glaciofluvial deposits overlying the glacial till, mean that temporary dewatering measures will be required during construction. Permanent groundwater lowering will require drainage measures to prevent flooding or buoyancy of the subways.

Borders Rail extensions

4.6.29 The existing portal structure has foundations 4.5m wide sitting on Class 6N upfill on stiff glacial till. Raising the carriageway by 5.5m over the structure imposes new loading on the structure, the foundations and underlying soil. The existing foundations are anticipated to be acceptable providing that the new fill comprises normal weight fill and lightweight aggregate (or similar) to limit the new loading. Slight settlement of the structure, and railway track within it, will occur under the new loading. The thickness of lightweight fill can be increased to reduce settlement magnitude and construction phasing will dictate the settlement over time.

4.6.30 New integral span bridge structures at the north and south of the existing Borders Rail overbridge will be provided to accommodate the widened A720. The bridge abutments will require piled foundations, with the piles extending through superficial deposits into competent bedrock. Potentially worked coal seams, which are present at shallow depth below the proposed structures, will be consolidated by infill grouting to ensure the long-term stability of the new infrastructure. Temporary works to allow piling will require steep strengthened (e.g soil nailed) temporary excavations into the existing road embankment.

4.6.31 Low strength soils will require ground improvement or removal beneath wing wall foundations. Temporary excavation support and groundwater control measures will require careful consideration due to the need to limit impact on the adjacent Borders Railway.

Borders Rail UTXs

4.6.32 Undertrack crossings (UTX) beneath the railway to the south and north of the A720 are required. The ground conditions at the south crossing comprise water bearing glaciofluvial sands and a high groundwater level which will make trenchless installation difficult. The north UTX is in glacial till so is less challenging.

Geotechnical Design – Cuttings

4.6.33 Generally, cuttings on the scheme have 1V in 3H side slopes where possible but are steeper where space is restricted. Slope face drainage will be required in many locations due to the high groundwater levels, in addition to permanent and temporary groundwater lowering in the form of toe drainage. Crest drainage will control surface water run-off.

4.6.34 The deepest and most extensive cut slopes are 1V in 3H and up to 8m deep, to accommodate the NMU routes as their alignments fall towards the subways under the roundabout. The cut slopes are formed in water-bearing glaciofluvial deposits, with high groundwater levels up to 3m above the base of the cutting. The final design shall incorporate permanent drainage systems to lower the groundwater levels to below the base of the cutting. Slope face drainage and slope strengthening are required to control groundwater during construction and after completion, to ensure long term slope stability, particularly where there is groundwater ingress. Additionally, made ground in the A6106 South southbound NMU cut slopes will require special design measures.

4.6.35 Inside the roundabout the NMU route is in cutting up to 5m deep with 1V in 3H slopes, locally steepened up to 60 degrees and locally retained by the wingwalls near the subways. Where the cut slopes are steepened up to 1V in 1.4H to fit within the limited space between NMU and roundabout, slope strengthening measures will be required, which will be modified to locally to accommodate the piling and piers. Where the 1V in 3H NMU cut slope at the base of the strengthened embankment steepens to 60 degrees at the east bridge abutment, strengthened earthworks integrated with the sections of reinforced soil embankment supporting the elevated A720 can be used to form the slopes. Groundwater at the roundabout occurs at 1m below ground level which will require the final design to incorporate permanent drainage systems to lower the groundwater levels to below the base of the cutting. Slope face drainage systems will be required to control groundwater both during construction and in the permanent case after completion of the works. The reinforcing earth raft will be encountered during excavation at the roundabout. Where the steel reinforcing are in the cut face measures will be taken to prevent them being permanently exposed (for safety and maintenance reasons).

Geotechnical Design – Embankments

4.6.36 Proposed embankment slopes on the scheme generally have 1V in 2H side slopes. Where the proposed fill slopes are steeper than 1V in 2H reinforced soil or high friction fill will be required to ensure long term stability.

4.6.37 New low height embankments are expected to be formed of site won fill. The higher A720 embankments are envisaged to be formed of imported Class 1 fill, and other imported selected fill will be required to form the reinforced soil, strengthened earthworks and structural backfill. Ultra-lightweight fill will be required in the A720 embankment at the Borders Railway bridge. This manufactured fill material will require a Departure from Standards.

4.6.38 The existing road embankments of the A720 will be widened and raised to form the proposed alignment. Where the existing A720 embankments are raised, settlement will be a design and programming consideration due to the presence of low strength weathered glacial till beneath the existing embankment which will compress under new loading. Potentially large differential settlements between the embankment and structures (in particular from Borders Rail west to Bridge 02 East) can be reduced by use of ultra-lightweight fill. Transition zones between lightweight and normal weight fill will be used to avoid sudden differences in settlement profile along the new embankment. Measures such as hold periods and surcharging may also be required.

4.6.39 Ground improvement, for instance by deep soil mixing, a mass in-situ cement stabilisation process, is proposed to improve low strength compressible deposits beneath the new slip road embankments and avoid significant volumes of excavation, imported fill and related vehicle movements. The increased stiffness of the soil will reduce both the total settlement, and the differential settlement between new and existing embankment. Local deposits of made ground will require removal and replacement with suitable fill.

4.6.40 Between the Bridge 01 west and Bridge 02 east, the A720 carriageway is supported on a strengthened earthwork embankment. Parallel to the road the strengthened earthwork embankment, will be at a profile no steeper than 60 degrees to allow creation of a green vegetated slope face. At the east ‘abutment’, where the bridge deck is supported by ‘hidden’ columns which are sleeved through the embankment fill, a steeper hard-faced reinforced soil slope is proposed. Once the made ground ‘mound’ in the centre of the existing roundabout is removed the predominantly granular glaciofluvial soils with stiff glacial till at depth will be suitable founding soils with minimal long-term settlement, although compaction of looser glaciofluvial soils may be required.

4.6.41 The 1V in 2H slopes of the proposed westbound on-slip embankment will extend into and partly infill the adjacent privately-owned irrigation pond (which will be extended to the east to compensate for the loss of storage). Silty sediment and low strength soils in the pond will be removed prior to placing fill for the new embankment. Slope strengthening measures are required to ensure stability of the composite embankment and cut slopes at the pond extension. Nearby the Dean Burn will be realigned 40m south. Nevertheless, the embankment slopes remain in the flood plain of the Dean Burn so free draining granular fill will be required to form the embankment up to a level above the flood level plus freeboard.

4.6.42 Locally on the A6106 North and beneath the widened A7 South in-situ ground improvement of the soft clay is proposed to ensure stability and limit settlement of the low height 1V in 2H embankments.

Geotechnical Design - SuDS Ponds

4.6.43 The in-situ soils at proposed SuDS pond locations are relatively low permeability as is normal for fine-grained glacial till and glaciofluvial deposits with high fines content. Infiltration of stored water from unlined ponds into the soil would therefore be slow. However, as all the ponds are proposed to be lined this does not impact pond capacity or design.

4.6.44 At the north-east, south and south-east ponds the groundwater level is at least 0.3m above the proposed level of the base of the pond, and at the south-east pond is 1.1m above the pond base. The resulting hydrostatic

pressure on the underside of the impermeable liner (due to the higher groundwater) can cause uplift of the liner. It is also difficult to construct a lined pond if these groundwater levels exist during the construction period. Prevention of liner material uplift during the service life of the pond can be achieved by 'surcharging' the liner i.e placing a calculated thickness of soil and fill above the liner to resist the uplift pressures. At the south-east pond the resulting uplift pressure is greater so extending the proposed flood wall around the pond to form a 'cut-off' wall is proposed, which will protect the liner but also avoid substantial excavation below the water table.

4.6.45 A number of SuDS ponds are formed by excavation, up to 1.8m deep, into the natural ground. In most cases the proposed 1V in 3H cut slope will be stable but locally made ground, low strength natural soils and / or groundwater levels at or above the pond base will require measures to ensure long-term stability, lower groundwater and deal with water ingress during construction.

Geotechnical Design – Shallow Mine Workings

4.6.46 There are several coal seams beneath the proposed scheme that have evidence of or a confirmed presence of workings and are at shallow depth with insufficient rock cover to protect against possible future surface subsidence and ground instability if mine workings collapse.

4.6.47 Mine workings treatment, comprising infill consolidation grouting or a near-surface protection by high strength geosynthetic, is proposed in the scheme to protect the new and existing infrastructure. There is no record of infill grouting or any other protection measures (other than the raft) having previously been completed as part of the city bypass construction or under the local roads. The mine workings treatment proposed in the scheme comprises infill grouting to shallow worked coal seams beneath new and existing roads and structures. NMU routes are often protected by infill grouting for the adjacent highway but NMU routes away from the highway are protected from the immediate effects of future subsidence by installation of a high strength geosynthetic (geotextile or geogrid) at the subgrade of the route, prior to placing the pavement layers. Treatment is not proposed beneath SuDS ponds and access routes, nor for the minor kerbing and carriageway surfacing works at the A7 North at Campend.

4.6.48 Mine workings treatment of shallow worked coal seams is therefore envisaged to be required: at the roundabout; to the west and south of the roundabout (ie. along the A7 South and A6106 South corridors); at the northern part of the A7 North; and beneath the Borders Railway bridge extensions.

4.6.49 Further pre-construction ground investigation is considered necessary to establish with more certainty the potential for workings in several seams. The extents of mine workings treatment may change on review of the further ground investigation.

Geotechnical Design – Mine Entry Treatment

4.6.50 Mine entries beneath the scheme, if left untreated pose a risk to ground stability due to the potential for void migration and subsequent crown hole at the ground surface or surface subsidence. In order to ensure the long-term ground stability of the scheme any positively located mine entries which are present below or within influencing distance (i.e. a horizontal distance equivalent to the depth of superficial deposits) of the proposed or existing roads, NMU routes and structures will be covered with a reinforced cap placed on solid stable bedrock (i.e 'capped') and grouted (to the full depth of the mine entry) as part of the construction works. Mine entries which are beneath SuDS ponds or are within the land boundary but not within influencing distance of the roads, NMU routes or structures will be stabilised by infill consolidation grouting.

4.6.51 Where the mine entries are recorded to have been infilled and grouted or capped as part of the city bypass construction, but as there are no as-built records of the work, it is assumed that these mine entries will require new works to stabilise them.

4.6.52 Where recorded mine entries have not yet been proven, further ground investigation is required to either prove the location, depth and condition of the mine entry, or prove the absence within the influencing distance of the scheme and/or within the land boundary.

Re-Use of Site Won Fill

4.6.53 All material excavated from the cut sections of the scheme will require to be classified according to Series 600 of the Manual of Contract Documents for Highway Works (MCHW) Volume 1 (Earthworks) to determine suitability for re-use as fill material in other parts of the scheme. The scheme design optimises the requirements for cut and fill and where possible aims to reduce the import and export of materials and waste. A summary of estimated earthworks quantities for the scheme is presented in Table 4.11 below.

Table 4.11 Estimated Earthworks Quantities

Import / Export Summary	Volume (m^3)
Estimated bulk excavation (acceptable and unacceptable excavated topsoil and general cut)	152,375
Estimated excavation suitable for re-use (general fill, landscape and topsoil)	108,844
Estimated bulk excavation which will require disposal (non-hazardous/hazardous)	43,531
Estimated total earthworks fill required (general fill, topsoil and landscape)	448,203
Estimated earthworks imported fill required	339,359

Geotechnical Assessment

4.6.54 The majority of excavated material will be generated from the NMU cuttings on approach to and within the roundabout. The excavated material is expected to comprise glaciofluvial sand, occasionally sand and gravel or weathered cohesive glacial till and cohesive glacial till. It is expected that the excavated glaciofluvial sand and gravel and weathered glacial till will be suitable for re-use but will likely require drying out, or lime / cement improvement, to render it acceptable for use as general fill.

4.6.55 During the widening of the A720 the new fill will be benched into the existing embankment after topsoil has been excavated. The existing embankment comprises fine and coarse grained materials with boreholes recording slightly sandy gravelly clay and sandy clayey gravels, some oversize material may also be present. The existing embankment fill materials are generally likely to be suitable for re-use as engineering fill.

4.7 Drainage and Flooding

4.7.1 This section should be read in conjunction with Chapter 11 – Road Drainage and the Water Environment of the Environmental Statement.

4.7.2 As is standard for all new roads schemes, the Scottish Environmental Protection Agency (SEPA) has requested that Sustainable Drainage Systems (SuDS) principles are applied in accordance with the technical guidance set out in the Construction Industry Research and Information Association (CIRIA) Report C697 'The SUDS Manual'.

4.7.3 The main issues which SEPA highlighted related to flood risk, surface water drainage, the protection of the water environment, contaminated land and management of waste. Further information relating to the consultation with SEPA is set out in Chapter 11 - Road Drainage and the Water Environment of the Environmental Statement (Part 2 of this Report).

4.7.4 In response to this an outline drainage system has been developed in accordance with above requirements and incorporated into the proposals. Consultation with SEPA and Midlothian Council is ongoing and will continue to inform development of the detailed design.

Carriageway Drainage and SuDS

4.7.5 SEPA require the runoff from the proposed road to be treated and attenuated by SuDS in accordance with the DMRB and the principles of The SuDS Manual. Several levels of treatment are required to be provided prior to discharge into watercourses.

4.7.6 SuDS ponds attenuate the surface water runoff from prescribed flood events and control discharge rates to equivalent greenfield runoff.

4.7.7 The drainage design is built up of eight drainage networks. A summary of the drainage networks is given below, and a Drainage Overview plan is shown in Figure 4.24.

Network 1

4.7.8 This network is the main drainage network for Sheriffhall Roundabout, the realigned A720 western and eastern approaches (from approximate A720 mainline chainages 1000-2080m), and associated slip roads on the western and eastern side of the roundabout (beyond approximate chainage 150/190m).

4.7.9 Network 1 also conveys runoff from the A6106 Old Dalkeith Road (A6106 South), the A7 North, the majority of the A6106 Millerhill Road (A6106 North, up to approximate chainage 340m) and a section of the A7 South between the Dean Burn and Sheriffhall Roundabout (up to approximate chainage 75m).

4.7.10 Runoff from the A720 West will be intercepted by over the edge filter drainage, which will be conveyed by carrier drainage to an attenuation pond, located beyond the north western corner of Sheriffhall Roundabout. The attenuation pond will restrict flows before merging them with runoff from the A7 North, runoff which will be intercepted by a combination of gullies and combined kerb drainage units.

4.7.11 The merged flows will be conveyed under the western edge of Sheriffhall Roundabout, accepting flows from the roundabout itself (drained using combined kerb drainage units), the A720 West slip roads, and a portion of runoff from the A7 South, runoff which will be intercepted by a series of gullies on the kerbed section of road.

4.7.12 The combined flows outfall into the largest attenuation pond, located to the south east of Sheriffhall Roundabout, and will be restricted before outfalling into the Dean Burn.

4.7.13 Runoff from the A720 East will be intercepted by over the edge filter drainage, which will be conveyed by a combination of carrier and filter drainage to an attenuation pond, located beyond the north eastern corner of Sheriffhall Roundabout. The attenuation pond will accept runoff from the A6106 North, runoff which will be intercepted by a combination of gullies and combined filter drainage.

4.7.14 Similarly to the A720 West, the attenuation pond will restrict flows and merged flows will be conveyed under the eastern edge of Sheriffhall Roundabout, accepting flows from the A720 East slip roads, and from the A7 South, runoff which will be intercepted by a series of gullies on the kerbed section of road. As above, the combined flows will outfall into the largest attenuation pond, before outfalling into the Dean Burn at a controlled rate.

4.7.15 All embankment slopes, and slip roads, will be drained via filter drainage.

Network 2

4.7.16 Network 2 comprises the drainage of the A720 main carriageway, specifically the catchment area immediately to the east of the Borders Railway tunnel (whose presence marks a clear separation between the road drainage on either side).

4.7.17 Therefore, whilst all the A720 drainage west of the Borders Railway falls back towards the Sheriffhall Roundabout, the area to the east has been designed to tie into the existing mainline A720 drainage, within a constrained carriageway width, and where the existing pipework falls away from the roundabout at further constrained elevations.

4.7.18 The section of the A720 to the east of the Borders Railway will therefore continue to drain into the existing drainage system, with the increase in area being minimal. The drainage to the east of the Borders Railway will retain the same level of treatment as currently exists, although additional measures, such as wrapping filter pipework in filtering geotextiles (capable of capturing residual hydrocarbons and removing pollutants by biodegradation) may be provided at detailed design stage.

Network 3

4.7.19 Network 3 comprises the drainage of the central NMU network of the roundabout, from the interface points where new NMU routes deviate from the existing roadside, to around the centre of Sheriffhall Roundabout.

4.7.20 Runoff from the NMU network will be intercepted by over the edge filter drainage located adjacent to proposed NMU routes. Carrier drains will then convey the runoff to an attenuation pond, located towards the south eastern extent of the scheme, adjacent to the Borders Railway. The attenuation pond will restrict the combined NMU network flows before outfalling into the Dean Burn at a controlled rate.

Network 4

4.7.21 Network 4 comprises the drainage of the remaining portion of the existing A7 South carriageway that currently falls towards Sheriffhall Roundabout (beyond approximate chainage 75m), south of the Dean Burn.

4.7.22 Existing areas of the A7, located outside the extents of the scheme will be drained as per the existing arrangement, however runoff from new lengths of carriageway (from the interface point), will be intercepted by a series of gullies. Carrier drainage will then convey the runoff to an attenuation pond, located towards the south

of Sheriffhall Roundabout. The attenuation pond will restrict flows before outfalling into the Dean Burn at a controlled rate.

Network 5

4.7.23 Network 5 comprises the drainage of a relatively short length of existing A6106 North carriageway from a high point (beyond approximate chainage 340m) that currently falls away from Sheriffhall Roundabout, in a northerly direction.

4.7.24 The existing drainage will retain the same level of treatment as currently exists. Given the geometry of the road at this location, and the very short section affected, it was not considered proportionate to provide additional SuDS measures to treat this runoff.

Network 6A & 6B

4.7.25 Network 6 comprises the drainage of a large area of existing greenfield to the north west of Sheriffhall Roundabout (from approximate mainline chainages 1000-1700m), a portion of existing land to the eastern edge of the A7 North (from approximate chainage 60m and beyond), and a smaller area of land located on the southern side of the A720 West (from approximate mainline chainages 1000-1250m).

4.7.26 These large (and small) pockets of land are considered natural slopes that currently drain towards the Dean Burn via existing carrier drainage located under the A720 West and Sheriffhall Roundabout.

4.7.27 Ditches have been proposed to intercept the A7 North greenfield flows and convey them under the A7 North via carrier drainage (located at approximate chainage 170m).

4.7.28 Filter drainage (between approximate mainline chainage 1255-1700m) has been proposed to intercept greenfield flows from the large pocket of land north of the A720 and, combined with A7 North greenfield flows, will be conveyed under the A720 West (at approximate mainline chainage 1570m), before outfalling into the Dean Burn (Network 6A outfall).

4.7.29 Additional filter drainage (between approximate mainline chainage 1000-1255m) has been proposed to intercept greenfield flows from the remaining pocket of land north of the A720 West. These flows will be conveyed under the A720 West (at approximate mainline chainage 1255m) and, combined with greenfield flows south of the A720 West, will outfall into the existing pond, located between approximate mainline chainages 1250-1370m, before outfalling into the Dean Burn (Network 6B outfall).

Network 7

4.7.30 Network 7 comprises the drainage of areas of existing greenfield to the west and east of the A6106 North (from approximate chainages 80-480m and 130-280, respectively), and a portion of existing land, located to the east and west of the Borders Railway line.

4.7.31 These large pockets of land are considered natural slopes that are understood to drain in a south westerly direction towards the existing A720 East embankment drainage, which conveys runoff away from Sheriffhall Roundabout in a north easterly direction.

4.7.32 Filter drainage will intercept the A6106 North (western side) greenfield flows and convey them under the A6106 via carrier drainage located (at approximate chainage 225m).

4.7.33 Ditches will intercept the A6106 North (eastern side) greenfield flows and convey them via carrier drainage and, combined with the A6106 North (western side) flows, will outfall into a proposed filter drain at the toe of the A720 East (north embankment at approximate chainage 1980m). The filter drain will continue in a north easterly direction, intercepting greenfield flows from the eastern and western sides of the Borders Railway towards the end of the scheme (at approximate chainage 2480m) before tying back into the existing embankment drainage system.

Network 8

4.7.34 Network 8 comprises drainage of areas of existing greenfield to south east, and east, of Sheriffhall Roundabout (from approximate mainline chainages 1880-2470, east and west of the Borders Railway).

4.7.35 These pockets of land are considered natural slopes that are understood to drain in a northerly direction towards the existing A720 East embankment drainage, that conveys runoff away from Sheriffhall Roundabout in a north easterly direction, potentially into a tributary of the Dean Burn.

4.7.36 Filter drainage would intercept the greenfield flows and convey them in a north easterly direction towards the end of the scheme (at approximate chainage 2470m) before tying back into the existing embankment drainage system.

Flooding

4.7.37 Identification of areas at flood risk within the study boundary has been established by undertaking a Flood Risk Assessment (FRA) of the Dean Burn at the Sheriffhall Roundabout. The results of this assessment have then been used to identify mitigation measures required as part of the scheme.

4.7.38 The FRA has shown that there are several areas at risk of flooding from the Dean Burn, primarily upstream of the A7 South and between the A7 South and A6106 South (Old Dalkeith Road). This flooding occurs relatively frequently, with flood extent and depths increasing as event magnitude increases. Whilst it is preferable for schemes to be built out with the floodplain, sometimes there are local constraints such as space and gradient requirements, that means elements cannot be relocated and require to be mitigated against. Mitigation measures are required for localised removal of floodplain to ensure there are no negative impacts to flood risk elsewhere.

4.7.39 Several areas of functional floodplain are required to be raised or bunded to allow for the proposed scheme and are as follows:

- Land between A7 South and A6106 South (Old Dalkeith Road) to provide space for SuDS pond that cannot be located elsewhere due to space and gradient constraints;
- Section of the Dean Burn that runs close to the proposed slip road embankment close to Lugton Pond.

4.7.40 The proposed mitigation measures for these areas consist of compensatory storage provision. Small scale compensatory storage is proposed at three locations, one between the A7 South and Old Dalkeith Road and two upstream of the A7 South. These areas allow for the loss of floodplain storage as a result of the scheme and is to be provided elsewhere, resulting a neutral impact on flood risk.

4.7.41 To improve channel functioning in and around the scheme area, and to reduce erosion risks, it is also proposed that a length of channel around Lugton pond be diverted approximately 50m to the south. The channel is proposed to be meandering and a two stage channel. It is also proposed that the existing unnatural right angle bend in the channel between the A7 South and A6106 South (Old Dalkeith Road) be removed and replaced by a more natural curve.

Culverts

4.7.42 The Dean Burn is the main watercourse in the scheme area. It has been identified as being approximately 2m wide in the vicinity of the existing roads. It is a minor tributary of the River North Esk and flows from west to east, to the south of the A720.

4.7.43 Within the scheme area, the Dean Burn is culverted under 2 major roads, the A7 South and the A6106 South (Old Dalkeith Road). Like the channel, these existing culverts were seen to be somewhat oversized. The culvert under the A7 South is a 1.75m diameter concrete pipe, approximately 35m in length, with a relatively shallow gradient. The culvert under the A6106 South (Old Dalkeith Road) is an arched culvert, 2.4m wide and 1.8m high, and approximately 39m in length. The gradient on this culvert was extremely flat.

4.7.44 The Dean Burn is culverted under several other crossings downstream of Old Dalkeith Road. These crossings include an access track from the A6106 South (Old Dalkeith Road), the railway culvert and smaller pedestrian access bridges through Dalkeith Country Park. These bridges and crossings are generally smaller than the 2 road culverts and are primarily arched openings. Whilst these structures are smaller, they do not cause backing up into the scheme area.

4.7.45 The existing culvert on the A6106 South (Old Dalkeith Road) will remain unchanged as this is not affected by the proposed scheme. Minor modifications to the earthworks at the existing A7 South culvert are currently proposed to allow the proposed NMU route to cross the structure without major modifications.

4.8 Public Utilities

4.8.1 Preliminary information was sourced from utility companies during Stage 2 Scheme Assessment under Appendix C2 of the New Roads and Street Works Act 1991(NRSWA). It was identified that BT, Virgin Media, Vodafone, Scottish Water, SP Energy Network and the Scottish Gas Network all have apparatus within thearea. A budget estimate request was made to each of the companies under Appendix C3 of the Code of Practice of the NRSWA.

4.8.2 Numerous services are present within the area, which include high voltage electricity cables, gas mains and water mains. The utility infrastructure present within the area serves the adjacent residential, commercial and industrial development , and also developments beyond the scheme. There are also services (electricity, sewerage, cable, water, etc.) associated with all the properties within the scheme area and these will need to be

protected or diverted as appropriate during construction. The following information on required diversions, was sourced from the public utilities companies under procedure C3 of the 'New Roads and Street Works Act 1991'.

Electricity – SP Energy Network

4.8.3 Diversions are required for the 33kV overhead line which crosses the eastbound approach to Sheriffhall Roundabout, intersecting the A7 both to the north and south of the junction. The overhead towers POA19 to POA21 will be disconnected and dismantled. The existing overhead cables will transition from overhead lines to underground cables and be buried below a minimum depth of cover varying between 775 and 910mm, in accordance with SP Energy Network guidelines.

4.8.4 11kV overhead lines cross the A720 west of Sheriffhall Roundabout and cross the A7 North and A7 South. At some sections overhead lines will need to be transitioned to underground cables and buried below the minimum depth of cover varying between 600 and 910mm, in accordance with SP Energy Network guidelines.

Water - Scottish Water

4.8.5 A foul water sewer crosses the A720 north of the disused sewage works, which is located between the A720 and the A772 Gilmerton Road. The earthworks for the realigned A720 impact on a manhole for the sewer, which will require to be relocated.

4.8.6 The 63mm HPPE water main which runs parallel to the A7 North Northbound is impacted by the proposed access provision at Summerside. Approximately 52m of the pipe and a fire hydrant would require to be relocated.

Gas - SGN

4.8.7 A medium pressure gas main is located in the verge of the A7 South from the Gilmerton Road Roundabout to Sheriffhall Roundabout. The medium pressure gas main then crosses the A720 mainline on the eastbound approach to Sheriffhall and continues in the verge of the A7 North towards Shawfair Park. This would require to be diverted west of its existing location between Summerside and the A7 South northbound approach to the roundabout. The gas main section currently serving the Summerside properties will be decommissioned and a new short section of medium pressure gas main will reconnect the properties to the main gas provision along the west side of A7 North.

Telecommunications – BT Openreach, Virgin Media and Vodafone

4.8.8 Underground cable ducts cross the Sheriffhall Roundabout and follow the A7 North and A7 South, A6106 Millerhill Road and A6106 South (Old Dalkeith Road) to the north and south of the junction. Approximately 675m of the existing Vodafone equipment at this location would require to be diverted.

4.9 Structures

4.9.1 In order to provide grade separation of the Sheriffhall Roundabout, three underbridge structures will be required. Two road underbridge structures will span over the new enlarged Sheriffhall Roundabout and the existing Borders Railway underbridge, approximately 250m to the east of the roundabout, will be extended on both its north and south sides.

4.9.2 In addition, to make provision for NMUs, a series of five NMU Underpasses will be constructed. These will be located under the new enlarged Sheriffhall Roundabout.

4.9.3 The three-level junction will also require the construction of a number of retaining structures.

4.9.4 A culvert which carries the Dean Burn under the A7 to the south of the roundabout has been assumed to be in an acceptable condition to allow for the new A7 and NMU route, with only minor modifications as detailed in the following sections. However, no condition surveys or structural assessments have been carried out at this stage and will be considered in more detail during detailed design.

4.9.5 The design of the structures will be in accordance with the 'Employers Requirements for Structures' provided by Transport Scotland and the DMRB. The main criteria required by Transport Scotland include:

- Design Headroom over the Sheriffhall Roundabout
- Structural form shall have open aspect
- Bankseat end supports shall have an exposed height below deck soffit of not greater than 1.8m
- Leaf piers are not permitted

- Bridge deck shall be structurally continuous under live load over intermediate piers
- Pier crosshead beams shall not be permitted
- Where steel girder construction is used, conditions shall apply to location of splices and stiffeners
- The use of weathering steel shall be permitted
- Plain concrete finishes shall not be permitted for large areas of exposed vertical surfaces except for the interior and wingwalls of drainage culverts
- All exposed vertical concrete surfaces shall have a patterned profile finish
- Drip checks on concrete parapet copes shall take the form of projections below the adjacent soffit.

4.9.6 In addition, structures over the railway require to be in accordance with the requirements of Network Rail.

4.9.7 A Structures Location Plan is provided in Figure 4.25.

A720 Road Underbridges

Key considerations

4.9.8 The vertical profile of the existing A720 will be raised to provide a grade separated alignment over the enlarged Sheriffhall Roundabout. The horizontal alignment of the main line at the structures will be on a horizontal curve of 1200m radius. In devising the most suitable bridge type, the Employer's Requirements and the following criteria were key considerations:

- A safe, reliable structure
- Ease of construction
- Avoidance of disruptive possessions on the road network
- Minimise disruption to the travelling public
- Ease of maintenance
- Cost
- Aesthetics.

4.9.9 Transport Scotland also required that creation of a 'family of structures' be considered, so that the new structures would in some way be consistent with other bridges nearby on the A720. However, after due consideration of the variety of structures in the vicinity, it was determined that there is no existing 'family of structures' on the A720. As a result, during the development of the proposals, the following options were considered:

- Single-span structures
- Two-span structures
- Viaduct or multi-span structures.

Structural Form

4.9.10 The proposed structures are shown on the following Figures:

Bridge	Figure	Drawing Number
Mainline Bridge 01 (West)	Figure 4.26	60572241-ACM-SBR-SW_BR_M10_Z-DR-CB-0101
	Figure 4.27	60572241-ACM-SBR-SW_BR_M10_Z-DR-CB-0102
Mainline Bridge 02 (East)	Figure 4.28	60572241-ACM-SBR-SW_BR_M20_Z-DR-CB-0101
	Figure 4.29	60572241-ACM-SBR-SW_BR_M20_Z-DR-CB-0102

4.9.11 It is proposed that both road underbridge structures be 3-span, non-integral structures supported on piled abutments and intermediate piers.

Substructure

4.9.12 The foundation conditions at the structures are poor and will require piled foundations, with areas of mineral consolidation in some areas. As the total length of each structure will be in excess of 60m, it is proposed that the structures are non-integral.

4.9.13 Transport Scotland has stated that an 'open' aspect is required for the structures, thus the end supports are reinforced concrete abutments with galleries for inspection and maintenance purposes. The side slopes will be generally 1 vertical: 2 horizontal, although some elements on the roundabout section will be steeper and comprise of reinforced soil embankments.

4.9.14 The intermediate piers will comprise reinforced concrete columns supported on a pilecap and piled foundations.

Superstructure

4.9.15 The west structure is relatively straightforward with 'square' spans of approximately 17m, 28m and 17m. However, the east structure is asymmetrical with 'square' spans of approximately 25m, 28m and 17m, as it accommodates the NMU route within span AB and requires an additional retaining wall or steepened reinforced soil slope.

4.9.16 The overall structural depth of the west bridge deck will be governed by the main span of 28m (approx.). However, for the east bridge, either the maximum main span of 28m (approx.) or the back span of 25m (approx.) may govern the design (as the back span is longer than normal due to the presence of the NMU route). At this length of span, either steel or precast concrete beams could be used, although a composite steel beam/concrete deck bridge would offer a shallower structural depth.

4.9.17 A beam and slab type deck could be installed relatively quickly during a partial overnight closure of the roundabout and would allow placement of permanent formwork, reinforcement and concreting of the deck slab to be carried out with minimal disruption. Normal containment N2 steel parapets are proposed for ease of construction and will tie-in to Vertical Restraint System (VRS) barriers at either side of the roundabout on the mainline. Vehicle parapets will be required at the top of retaining walls and steepened slopes adjacent to the NMU route.

A720 Railway Underbridge

Key considerations

4.9.18 The A720 mainline currently crosses the Borders Railway approximately 250m to the east of Sheriffhall Roundabout. At present, the structure is a single-span precast concrete portal over the existing twin track railway. The Approval in Principle document for the existing structure made some allowance for works associated with junction improvements at Sheriffhall Roundabout. In particular, it noted that the structure was to be designed for 5.0m of additional fill material over the structure, although the future-proofing did not address any need for extending the length of the bridge.

4.9.19 The grade-separation of Sheriffhall Junction will require the mainline to be increased in level by an additional 5.5m of fill over the existing railway bridge, resulting in a maximum total fill depth of 6.9m. In order to satisfactorily achieve this depth of fill without overstressing the existing structure and founding strata, a layer of lightweight aggregate will be required over the existing structure and the approach embankments. In addition, the structure will need to be extended by approximately 26m on the north side and 32m on the south to allow for the construction of the new slip roads down to the new roundabout.

4.9.20 In devising the most suitable bridge type, the Employer's Requirements and the following criteria were key considerations:

- A safe, reliable structure including re-use of the existing rail bridge structure
- Ease of construction
- Avoidance of disruptive possessions on the road network
- Avoidance of disruptive possessions on the rail network
- Minimise disruption to the travelling public
- Ease of maintenance

- Cost
- Aesthetics.

Structural Form

4.9.21 The proposed structure is shown on the following Figures:

Bridge	Figure	Drawing Number
Rail Bridge	Figure 4.30	60572241-ACM-SBR-SW_BR_MR0_Z-DR-CB-0101
	Figure 4.31	60572241-ACM-SBR-SW_BR_MR0_Z-DR-CB-0102

4.9.22

4.9.23 The existing Borders Railway structure will be retained. In addition, in order to comply with Network Rail requirements for construction in the railway environment, the extensions to the existing structure are proposed to be formed from precast concrete beams with insitu concrete infill, supported on in-situ concrete walls on piled foundations. The single clear internal span of the structural extensions is proposed to be approximately 17m.

Substructure

4.9.24 The foundation conditions at the structures are reasonable. However in order to retain control of any settlement around the existing structure, the bridge extensions will require piled foundations.

4.9.25 The existing structure has a series of wingwalls of varying sizes that will be affected by the construction of the bridge extensions. It is proposed that the smallest wall section at each end is removed in its entirety, with the two larger sections at each end being partially retained. It is further proposed that the new piling for the north east and south west abutment walls be constructed through holes cut through the existing wingwall bases. This will require substantial excavation and temporary works at these locations to create a suitable working space to install the piling. The remainder of the piles will be installed in the normal way by piling through natural ground and previous fill material from a prepared piling platform. A pilecap will be constructed on top of the group of piles on each side and the abutment walls constructed to deck soffit level.

4.9.26 In order to allow the cutting out of the existing wingwall base slabs, temporary works will be required to support the excavation in close proximity to the A720 carriageway above.

Superstructure

4.9.27 The bridge superstructure will comprise of precast concrete beams with insitu concrete infill.

4.9.28 The precast beam and infill slab type deck could be installed relatively quickly during overnight possession working on the railway line. The enclosed soffit of the deck could also allow placement of reinforcement and concreting of the deck slab with minimal requirement for further possessions.

4.9.29 High containment H4A concrete barriers are proposed at each end over the railway. Pedestrian parapets with solid infill will be required at the top of retaining walls and headwalls adjacent to the railway.

NMU Underpasses

Key considerations

4.9.30 Five underpasses will provide for the NMU routes through the roundabout. The underpasses will be provided with a wide span to promote an open aspect within the underpasses. As the NMU routes are at a lower level than the roundabout through the junction, a number of wingwalls and retaining walls will also be necessary to retain the earthworks.

4.9.31 It is proposed that the NMU underpasses will be formed from precast concrete sections supported on spread foundations, with a clear internal span of approximately 9m. This comprises of a 3.0m running lane, 2x1.0m hard strips and 2x2.0m (approx.) slopes to provide an ‘open’ aspect to the users.

4.9.32 The underpasses are shown on the following Figures:

Bridge	Figure	Drawing Number
NMU Underpasses	Figure 4.32	60572241-ACM-SBR-SW_SW_R10_Z-DR-CB-0101
	Figure 4.33	60572241-ACM-SBR-SW_SW_R20_Z-DR-CB-0101
	Figure 4.34	60572241-ACM-SBR-SW_SW_R30_Z-DR-CB-0101
	Figure 4.35	60572241-ACM-SBR-SW_SW_R40_Z-DR-CB-0101
	Figure 4.36	60572241-ACM-SBR-SW_SW_R50_Z-DR-CB-0101

Structural Form

4.9.33 The substructure and superstructure will be formed from precast segmental concrete box sections. Wingwalls will be insitu concrete cantilever type. Their support will be on spread foundations on a layer of 6N fill.

4.9.34 N2 containment parapets are proposed at each end of each underpass. Pedestrian parapets with solid infill will be required at the top of retaining walls adjacent to the carriageway.

A7 Culvert Extension

Key considerations

4.9.35 An existing culvert which carries the Dean Burn under the A7 South, south of Sheriffhall roundabout, has been assumed to be in an acceptable condition to allow for the new A7 and NMU alignments, with only minor modifications. However, no condition surveys or structural assessments have been carried out, and this will be considered further during detailed design.

Structural Form

4.9.36 It is anticipated that the existing culvert will need to be extended to the east side by approximately 5m to allow for widening and lowering of the A7 South and adjacent NMU route. The extension of the structure will comprise of either: precast concrete box units, or (if it is necessary avoid working directly in the watercourse) precast L-shaped foundations with precast reinforced concrete cover slabs or sheet pile walls with a reinforced concrete cover slab. Minor modifications to the earthworks are also proposed.

4.10 Vehicle Restraint System

4.10.1 The provision of vehicle restraint systems (VRS) at the location of hazards will be provided in accordance with the requirements of DMRB TD 19/06 ‘Requirement for Road Restraint Systems’. This requires a Road Restraint Risk Assessment Process (RRRAP) be undertaken to identify potential hazards and the need for VRS.

4.10.2 A RRRAP has been undertaken and the major hazards identified within the site are the Borders Railway, the new A720 bridges and major earthworks. All the factors considered in the design process have been formally recorded in the RRRAP, including the nature and location of hazards and the VRS parameters (position, containment level, extents, etc.).

4.10.3 A preliminary design reflecting the findings of the RRRAP has been undertaken. Verges have also been widened where required to allow for the provision of VRS.

4.11 Road Pavement

4.11.1 An indicative pavement design has been developed in accordance with DMRB HD 26/06 ‘Pavement Design’.

4.11.2 The road pavement has been assumed to be of flexible construction throughout the scheme, including an asphalt-based surface, binder and base courses. TS2010 low noise surfacing is proposed on the A720 mainline and slip roads, and HRA surfacing on the new roundabout and local road network. The total asphalt thickness has been calculated for each road based on the relevant traffic flows and Foundation Class, using HD 26/06, Figure 2.1.

4.11.3 The pavement design assumes a California Bearing Ratio (CBR) of 2.5%, and that pavement layers will be laid on top of a Foundation Class 2 (subbase on capping) throughout the scheme. In accordance with HD 26/06, Foundation Class 2 must not be used for design traffic in excess of 80msa (e.g. the A720 Mainline), unless 150mm or more of a bound subbase is provided.

4.12 Fencing and Environmental Barriers

4.12.1 Permanent fencing is anticipated to be erected along the property boundaries where agreed with relevant landowners as part of accommodation works negotiations. This is assumed to generally be post and wire fencing.

4.12.2 Boundary features will also be provided at SuDS ponds for health and safety reasons. This will be provided in the form of hedgerows, rather than traditional fences, to provide greater biodiversity benefits and minimise visual intrusion.

4.12.3 Existing natural stone boundary walls within the scheme extents will be retained as key landscape features wherever possible, or rebuilt elsewhere where directly impacted by the works.

4.12.4 Otter fencing will be provided on either side of roads at Dean Burn crossings prior to construction works, in accordance with DMRB guidance, and this will be retained to permanently discourage otters from crossing the roads.

4.12.5 No environmental mitigation barriers are proposed as part of the scheme.

4.13 Traffic Signs and Road Markings

4.13.1 A signing strategy for the scheme has been developed as part of the Stage 3 design work, in accordance with the Traffic Signs Regulations and General Directions 2016 (TSRGD) and the Traffic Sign Manual (TSM), and relevant industry best practice.

4.13.2 The directional signing requirements have been determined for the A720 and associated slip roads, the roundabout and all side roads. Verges have been widened where necessary to ensure the appropriate visibility is provided for all signs.

4.13.3 An indicative road markings layout has also been developed for completeness as part of the Stage 3 design.

4.14 Traffic Signals

4.14.1 The operational assessment of the scheme has identified the need for the provision of traffic signals at the eastbound and westbound diverge entry junctions with the roundabout. Traffic signals would help control circulatory traffic allowing slip road traffic to more easily merge on the roundabout, and therefore avoid potential queueing traffic on the slip roads extending onto the mainline during peak hours. Signals would be operational from the year of opening to optimise the operational performance of the scheme.

4.14.2 Signals will be provided following the layout included in Figure 6/2 of TD 50/04 'The Geometric Layout of Signal-controlled Junctions and Signalised Roundabouts' for a large roundabout with partial signalisation. Two primary traffic signals will be provided on either side of each diverge slip road entry and on the roundabout approaches to the signalised junctions. Secondary signals will also be installed for all junction approaches on the opposite side of the junction, located in direct line of sight of the driver or displaced no more than 30º for angled approaches.

4.14.3 Further details on the operational assessment that determined the provision of signals are given in Section 5.

4.15 Lighting

4.15.1 A preliminary design to illuminate the scheme has been undertaken in accordance with the DMRB and specific Transport Scotland requirements. Other documents used for the preliminary design are listed below.

- BS 5489-1 Code of Practice for the Design of Road Lighting Part 1: Lighting of roads and public amenity areas
- BS EN 13201-2 Road Lighting – Part 2: Performance Requirements
- Sustrans Technical Information Note 29 on Lighting of Cycle Paths
- Cycling by Design

4.15.2 DMRB TD 22/06 'Layout of Grade Separated Junctions' and TD 34/07 'Design of Road Lighting for The Strategic Motorway and All Purpose Trunk Road Network' make reference to the design extents for conflict areas, including and allowing for grade separate junctions and safe SSD. This was the primary method used for the assessment of the lighting design extents.

4.15.3 All luminaires are proposed to be G4 glare rated (full cut-off) and post top mounted at 0° tilt from the horizontal, to minimise light spill and potential environmental impacts whilst allowing an economical design.

4.15.4 Column setbacks are determined by road speed as detailed in Table 4.12 (BS 5489-1:2013)

Table 4.12 Required Lighting Column Setback

Design Speed (km/h)	Horizontal Clearance (m)
≤50	0.8
80	1.0
100	1.5
120	1.5

4.15.5 Column heights will be kept as low as possible within design tolerances, with the majority being 10m high. This is to assist the visual aspect whilst still achieving an economical spacing and required light levels. Columns higher than 10m will only be used if there is no alternative to achieve the lighting levels required.

4.15.6 A summary of the anticipated lighting for each road is given in the following sections.

A720 Mainline & Slip Roads

4.15.7 The mainline will remain unlit, but the merge and diverge slip roads will be partially lit on their approach to the roundabout. Based on current and projected traffic flows, the slip roads would fall into lighting class M4. Lanterns will be mounted on single-sided 10m high columns on the slip roads.

Sheriffhall Roundabout

4.15.8 Sheriffhall Roundabout is classed as a conflict area and will be lit across the full extents. The lighting class appropriate for this area is C2 as calculated by the highest approach class being M3. Lanterns will be mounted on 12m high columns around the junction in order to achieve the lighting levels and uniformity requirements.

A7 North

4.15.9 The proposed lighting will extend along the A7 North just past the current lighting extents, approximately 180m from the roundabout (as per one step below desirable sight stopping distance extents) to include the realigned farm access. This is to ensure that the lighting will be no less than the current arrangement. The projected traffic flow falls into the low to moderate traffic flow category, therefore the lighting class for this road would be M3.

4.15.10 A staggered LED lighting arrangement suits this location, with lanterns set on 10m high columns. However, as there are overhead power cables in the immediate vicinity of the columns outside the farm access, a change in the lighting equipment will be required.

A6106 North (Millerhill Road)

4.15.11 The lighting will extend past the extents of the current lighting arrangement approximately 240m from the roundabout (as per one step below desirable sight stopping distance extents). The projected traffic flow falls into the low to moderate traffic flow category, therefore the lighting class for this road would be M3.

4.15.12 The lighting is proposed to be a staggered arrangement, except at the approach to the junction where it will be single sided on the outside of the bend with LED lanterns post top mounted on 10m high columns.

A7 South

4.15.13 The proposed lighting will extend along the A7 South to the next junction at the scheme extents. The projected traffic flows for this road fall into the low to moderate traffic flow category, therefore the lighting class for this road would be M3.

4.15.14 A staggered LED lighting arrangement suits this location, with lanterns set on 10m high columns. However, there is existing LED lighting currently installed on this road and investigations will need to be undertaken to determine whether it is suitable for retention.

A6106 South

4.15.15 The proposed lighting will extend along the A6106 South (Old Dalkeith Road) to the scheme extents approximately 130m from the roundabout and tie in with the existing lighting. The projected traffic flows fall into the low to moderate traffic flow category, therefore the lighting class for this road would be M3.

4.15.16 A staggered LED lighting arrangement suits this location, with lanterns set on 10m high columns. However, there is existing LED lighting currently installed on this road and investigations will need to be undertaken to determine whether it is suitable for retention.

NMU Routes

4.15.17 Lighting will be provided throughout the dedicated NMU route network, and will extend to existing NMU sections adjacent to lit carriageways.

4.15.18 Assuming a low ambient illuminance zone (E2) and worst case scenario of busy traffic flow, a P3 lighting class is proposed.

4.15.19 A LED lighting arrangement that accounts for changes in direction would be most suitable for these elements of the scheme. This would involve a mix of column locations, with lanterns installed on 5m high columns.

4.15.20 A more diverse lighting strategy could be adopted in relation to the predicted usage of specific sections: column-mounted lanterns could be used in areas requiring a higher light level of illumination and, perhaps, equipment that is less vulnerable to vandalism. In other areas where usage may be lower or there may be environmental considerations, bollards or other low level lighting could be adopted.

4.15.21 The proposed lighting on NMU routes will extend through all the subways within the scheme extents.

4.15.22 British Standards require that relatively high light levels be provided day and night in enclosed subways. Some level of lighting control would be required in order to achieve the differing light levels, as well as for energy and cost savings.

4.15.23 An LED lighting arrangement with either cornice or wall mounted units will be most suitable for these locations. Continuous trunking systems could also be employed for cable management or incorporation of CCTV.

Environmental and Landscape Considerations

4.15.24 The proposed lighting is G4 glare rated (full cut-off) and lanterns will be mounted with zero degree uplift to minimise potential light spill. Column heights are proposed to be kept as low as practicably possible to minimise any negative impact on the landscape and surrounding area, as well as costs. LED lanterns to be utilised should have a range of shield options available to further minimise potential light spill or intrusion, especially in areas of increased sensitivity such as close to residential properties.

4.15.25 Consideration should also be given to the provision of dimming across the scheme extents. This would enable areas that are likely to have reduced traffic flow during certain hours to dim to a lower light level, further reducing potential light intrusion. Dimming would also have the added benefit of reducing energy consumption, C02 emissions, and therefore provide cost savings over the life of the installation.

4.16 Intelligent Transport Systems (ITS)

4.16.1 Intelligent Transport Systems (ITS) provision shall be made in accordance with Series 1500 of the Manual of Contract Documents for Highway Works, as amended for Scotland, and Transport Scotland's NDX Standard Drawings.

4.16.2 A summary of the recommended ITS for the scheme is detailed in the following sections.

CCTV

4.16.3 In accordance with TD 17/85 'Criteria for the Provision of Closed Circuit Television on Motorways", CCTV provision is proposed as follows.

- Two 10m mast CCTV located at Ch 1465 (Eastbound verge) and Ch 2100 (Westbound verge) to provide 100% coverage of the scheme.
- Maintenance hardstandings co-located with the CCTV on the mainline to allow adequate access for maintenance personnel.

- One CCTV camera mounted on the ceiling in the centre of each subway.

Detection Systems

4.16.4 Inductive loops will be placed in each approach road to the roundabout and will be used to provide traffic count data.

Variable Message Signs

4.16.5 To ensure comprehensive operational management of the A720 can be achieved, a review of the existing provision of variable message signs (VMS) on the surrounding network was carried out to determine if any more should be provided. This review concluded that drivers are given an adequate supply of information on the M8, A720, A68 and A1, therefore no further VMS is proposed within the scheme extents.

4.17 Construction Sequence and Maintenance

Construction Sequence

4.17.1 A potential construction sequence has been identified for assessment purposes considering the main issues that are likely to arise from construction activities. The buildability assessment focused on the likely impacts of construction on the existing A720 trunk road, the local road network and the Borders Railway. Overall the construction period is expected to last approximately 28 months

4.17.2 One of the main challenges is associated with the footprint of the scheme, which is predominantly online and includes raising the A720 mainline above its current vertical alignment over side roads, which remain approximately at-grade.

4.17.3 The Borders Railway underbridge is located approximately 250m east of the existing Sheriffhall Roundabout and currently is not wide enough to accommodate the proposed A720 westbound diverge and eastbound merge slip roads. Widening the bridge presents a significant challenge with the operational railway.

4.17.4 Sheet piling or similar may be required at the subway locations to allow excavations to take place for installation whilst maintaining a live carriageway in close proximity.

4.17.5 It is considered the new junction can be constructed whilst maintaining traffic flows, however, extensive traffic management during some phases, and diversions during the overnight partial closure of the roundabout during phase 5 is anticipated as described below.

4.17.6 Each construction phase is outlined in the following sections and shown in Figures 4.37 to 4.43. It should be noted the proposed phasing s that which has been assumed for assessment purposes and will be subject to comprehensive planning as part of the scheme detailed design and construction methodology put forward by the selected contractor for the works.

Phase 0: Temporary Works

4.17.7 Advanced GI works will be undertaken prior to starting construction. Any potential utility diversions will also be identified and undertaken during this phase. It is assumed that mining works will be carried out in Phase 0 before the main construction phasing begin, but this may overlap into Phase 1.

Phase 1A: Temporary Works

4.17.8 To allow Subways 1, 2 and 5 to be installed the A7 approaches to the roundabout will need to be slightly realigned as shown in Figure 4.38. This will require the construction of temporary pavement and the use of barriers along the edge of the temporary carriageway. Temporary sheet piling or similar will be used to stabilise the ground between the live carriageway and the excavation.

Phase 1B: Construction

4.17.9 The Borders Railway underbridge would be extended to accommodate the new slips roads. The temporary works detailed at Phase 1A will allow Subways 1, 2 and 5 to be installed. Once the subways are in place the earthworks can be reinstated along with any existing pavement.

Phase 2A: Temporary Works

4.17.10 The A7 North and South arms can be moved back to their original positions. The splitter island on the A6106 South (Old Dalkeith Road) will be removed and then paved, allowing the roundabout exit to be moved slightly.

This will allow the construction of Subway 3 at Phase 2B. Temporary sheet piling or similar will be used to stabilise the ground between the live carriageway and the excavation.

Phase 2B: Construction

4.17.11 Offline works will be undertaken in this phase, including large sections of the new roundabout, the A6106 South (Old Dalkeith Road), A6106 North (Millerhill Road), A7 North and A7 South. The slip roads will be partially constructed, tying in at-grade to the A720 mainline at the extents of the scheme. Traffic management on the A720 mainline, A7 North and A7 South will be required to construct the tie-ins, however traffic will continue to occupy the existing carriageway with no vehicle movement restrictions.

4.17.12 The temporary works detailed at Phase 2A will allow Subway 3 to be installed. Once this is in place, the earthworks will be reinstated and the new pavement completed.

Phase 3A: Temporary Works

4.17.13 Temporary paving on the A6106 South (Old Dalkeith Road) will allow the roundabout entry to be moved slightly to give room for the installation of Subway 4 at Phase 3B. Temporary sheet piling or similar will be used to stabilise the ground between the live carriageway and the excavation.

4.17.14 Temporary pavement is also required to allow A720 traffic to access the roundabout from the newly constructed slip roads during this phase.

Phase 3B: Construction

4.17.15 Traffic will be diverted off the existing A720 mainline onto the partially constructed slip roads, with temporary carriageway linking back into the existing Sheriffhall Roundabout to maintain all vehicle movements. Construction of the raised A720 on embankments will commence in the areas hatched yellow on Figure 4.40. Traffic management will be required on the slip roads to maintain safe clearance between the construction activity and the live traffic.

4.17.16 The temporary works detailed at Phase 3a will allow Subway 4 to be installed. Once this is in place, the earthworks will be reinstated and the new pavement completed. The at-grade tie-ins at the extents of the side roads and the remaining sections of the new circulatory carriageway will also be completed during this phase. Vehicle movements will change considerably throughout this phase with a comprehensively planned evolving traffic management layout required.

Phase 4

4.17.17 The A7 North and South traffic will be moved onto the newly constructed roads allowing the final areas of their verge and earthworks to be completed. The retained earthworks in the centre island of the new roundabout will be formed. Traffic management will be required to provide access to the work area and maintain safe clearance between the works and the live traffic.

Phase 5

4.17.18 Works will be completed within the central island of the new roundabout, including the remaining sections of the NMU routes. The underbridges (including abutments) will be installed and the new A720 carriageway completed. A partial overnight closure of the roundabout will be required for the completion of the works.

Phase 6

4.17.19 Work will be carried out to complete all outstanding areas of work such as areas of pavement, street furniture and road markings. Vehicle movements will change throughout this phase with a comprehensively planned evolving traffic management layout required.

Maintenance

4.17.20 Transport Scotland will be responsible for the maintenance of the A720, all slip roads and the new overbridges. The new roundabout, as well as all realigned side roads, will be passed to Midlothian Council who will be responsible for their future maintenance through the Operation Company.

4.17.21 The proposed A720 mainline is dual carriageway, therefore any maintenance to the road pavement will require traffic management to keep the road operational. One-way working will be required for side roads. The proposed cross sections for all roads, except the A6106 South, includes 1m hardstrips which will allow easier maintenance of verges and ‘over the edge’ filter drains. A maintenance strip will be provided at the toe of the earthworks slopes to enable access to slopes for grass cutting and general maintenance.

4.17.22 Maintenance of the SuDS ponds will be required and vehicle access for all of them will be provided from the side roads, as shown on Figure 3.1. Where the access road to the pond serves other fields or private properties, the access will be shared with other landowners up to the location of their private accesses, with the rest of the access road to the pond restricted to authorised personnel only. No access will be directly provided from the trunk road.

Health and Safety

4.17.23 There are a number of significant health and safety issues associated with the construction and operation of the scheme. Most issues are associated with the construction of the new A720 alignment and overbridges, new Borders railway bridge extensions and tie-ins to the existing carriageways. It is not possible to eliminate these elements, however, the hazards will be substantially reduced since much of the construction will be carried out offline away from live traffic. Where work is required adjacent to the existing roads and the railway, traffic management measures and 'failsafe' working procedures will be adopted at all times. These measures and procedures will be continually monitored at all stages of the project.

During Construction

4.17.24 One of the main aspects is that the scheme requires tie-ins to the existing carriageways at both ends of the A720 and on all side roads; this work will therefore take place adjacent to a live carriageway. This poses risks for both site operatives and the general public using the road. The key mitigating factor will be to ensure a safe working zone is in place at all times along with appropriate traffic management. All traffic management will be in accordance with Traffic Signs Manual Chapter 8.

4.17.25 There are recorded mine entries ('mine shafts') at the site which pose a risk to stability of the overlying ground. Exclusion zones around all potential mine entries should be set-up on site to limit risk to site operatives. Investigation to locate recorded mine entries will be required, but even then there may be unrecorded features encountered during construction.

4.17.26 Furthermore, the construction of the scheme will involve working adjacent to and over a live railway. 'Rules of the Route' railway possessions will be required for the construction of the railway bridge extensions. Network Rail has been consulted throughout the design process to discuss the form of construction for the railway overbridge, possessions and all associated issues.

During Operation/Maintenance

4.17.27 After the scheme has been constructed the operational health and safety issues associated with it are mainly associated with road safety. No direct private access is provided from the A720 and the scheme rationalises the direct accesses off the side roads. Minor junctions have been provided with appropriate visibility splays in both directions. It is therefore likely that the risk of accidents associated with direct access will be lower since the number of conflict points has been reduced.

4.17.28 NMU safety will be improved. The scheme provides NMU routes that are fully separated from road traffic, either on kerbed facilities when running next to the road carriageway, or on dedicated and grade-separated routes crossing the roundabout through subways rather than at grade, as currently occurs.

4.17.29 In terms of maintenance, traffic management will be required for maintenance of the road pavement, therefore requiring operatives working close to the running carriageway. This cannot be avoided but safe working practices will be followed to reduce any risk of accidents. The scheme will also require long lengths of road restraint systems which will have to be repaired and maintained. Any verge/drainage maintenance will also be facilitated by the provision of hard strips throughout the scheme.

4.17.30 Vehicle access for maintenance of the drainage SuDs basins is provided off the side roads, remote from the A720 and slip roads, therefore removing any potential conflicts on the trunk roads.

4.18 Road Safety Audit

4.18.1 In accordance with the requirements of DMRB Volume 5, Section 2, Part 2 GG 119, a Stage 1 Road Safety Audit (RSA) of the scheme was carried out in November and December 2018. The findings and recommendations of the audit are summarised in the RSA report issued by the RSA team to Transport Scotland in December 2018. A Designer's Response and Decision Log were then prepared in agreement with Transport Scotland and sent to the Road Safety Auditor in January 2019.

4.18.2 Further to the inclusion of traffic signals into the proposed scheme, which represents a significant change to the scheme audited in 2018, a Stage 1 RSA Addendum was deemed necessary to capture any safety implications at an early stage. The audit was undertaken in November and December 2019 and the RSA Addendum Report was issued by the RSA team on 9th December 2019.

5 Traffic and Economic Assessment

5.1 Introduction

5.1.1 The operational and economic assessment of proposed road improvement schemes requires the development and application of various computer models. In the case of the A720 Sheriffhall Roundabout, this has involved the development of a Paramics micro-simulation traffic model to examine the likely effects of high traffic demand in a congested network and the interaction with adjacent junctions. A TUBA economic assessment model was also developed using data from the traffic simulation model to assess the costs and benefits of the proposed scheme. In addition, a separate NESA computer model was created to examine changes in road safety between the existing at-grade roundabout and the proposed grade-separated roundabout. The results from the models have been used to undertake the operational and economic assessment of the proposed scheme.

5.1.2 In addition to the above models which were developed specifically to assess the effects of the proposed scheme, information from the Sestran Regional Model (SRM12) and the Traffic Model for Scotland (TMfS14) was used to define future traffic levels within the modelled area.

5.1.3 The purpose of this section of the report is to summarise existing traffic conditions within the scheme area, to describe the development of the Paramics models and to set out the work undertaken to estimate future traffic conditions over the economic life of the scheme. The results of the economic assessment of the proposed scheme, based on the development and application of TUBA economic models and NESA accident models, are also presented in this section of the report.

5.1.4 A general location plan for the area indicating the locations of the key junctions is shown in Figure 5.1.

5.2 Traffic Surveys

Introduction

5.2.1 A programme of data collection surveys was undertaken to assist in establishing current traffic volumes and vehicle proportions at key locations, to quantify variations in hourly and daily traffic demand, to establish the levels of congestion and delays experienced by road users, and to estimate current vehicle speeds and journey times. Through the collection and analysis of this information, the prevailing traffic demand and operating conditions have been established.

5.2.2 The surveys included Manual Classified Counts (MCCs), Automatic Traffic Counts (ATCs) and the measurement of typical journey times. These surveys were undertaken on Wednesday 10th May 2017 and Thursday 11th May 2017 when traffic conditions were expected to be typical of average demand.

5.2.3 An overview of the survey locations is shown in Figure 5.2.

Manual Classified Counts

5.2.4 Manual Classified Counts (MCCs) were undertaken at 6 locations along the A720 on Wednesday 10th May 2017 to define current traffic volumes and turning movements. An additional 11 locations were surveyed on Thursday 11th May 2017 to provide information on the traffic flows surrounding Sheriffhall.

5.2.5 Based on the results of the DMRB Stage 2 MCC surveys, the DMRB Stage 3 survey period was extended from 12 hours to 14 hours to collect additional information earlier in the morning and later in the evening. The MCC data for each site was therefore collected in 15-minute intervals between 06:00 hours and 20:00 hours over the survey period to provide a 14-Hour record of turning movements.

5.2.6 The results of the May 2017 surveys indicate that 69,100 vehicles passed through the at-grade Sheriffhall Roundabout during the 14-Hour survey period.

5.2.7 The 14-Hour traffic flows on the roads around Sheriffhall Roundabout are as follows:

- A7 (North) 14,100 vehicles
- A6106 (North) 7,400 vehicles
- A720 (East) 45,300 vehicles

- A6106 (South) 11,900 vehicles
- A7 (South) 13,600 vehicles; and
- A720 (West) 45,700 vehicles

5.2.8 The results of the May 2017 surveys also indicate that 61,800 vehicles passed through the at-grade Sheriffhall Roundabout during the 12-Hour survey period between 07:00 hours and 19:00 hours. To provide an indication of recent growth at Sheriffhall Roundabout, 59,000 vehicles were recorded passing through the junction in October 2014 and 57,700 vehicles were recorded passing through the junction in October 2013. It should be noted that the changes in local trip patterns are likely to have been influenced by the temporary closure of the A6106 (North) of Sheriffhall Roundabout during the October 2014 surveys.

5.2.9 The traffic profile at Sheriffhall Roundabout indicates an AM Peak Hour of 07:15 hours to 08:15 hours and a PM Peak Hour of 16:00 hours to 17:00 hours.

5.2.10 The observed two-way 14-Hour A720 mainline and side road traffic flows recorded in May 2017 for all vehicles are shown in Figure 5.3.

5.2.11 From the 14-Hour counts observed in May 2017, the following overall vehicle composition was derived:

- Cars – 79.9%;
- Light Goods Vehicles (LGV) – 13.3%
- Other Goods Vehicles 1 (OGV1) – 3.3%
- Other Goods Vehicles 2 (OGV2) – 2.1%; and
- Buses and Coaches (PSV) – 1.4%.

Additional Surveys March 2018

5.2.12 Additional traffic surveys were undertaken in March 2018 at Old Craighall Roundabout to provide information on turning movements at the A720/A1 intersection.

5.2.13 Comparison of the May 2017 and March 2018 survey data indicates that the flows entering/exiting the roundabout on the A720 were within 1.4% and the circulatory traffic flows were within 4.4%. The turning proportions derived from the new survey were used to refine the trip patterns at this location.

Permanent Automatic Traffic Counts

5.2.14 Transport Scotland maintains a series of permanent Automatic Traffic Counters (ATCs) which provide traffic flow information across the Scottish trunk road network. The information collected by the permanent ATCs represents the most continuous data from which daily, seasonal and annual variations and trends in traffic along the A720 can be derived.

5.2.15 Permanent ATCs NTC00608 and NTC00609 are located on the A720 eastbound and westbound carriageways respectively near the Lasswade junction to the west of Sheriffhall Roundabout and provided the most reliable long-term and up to date traffic data for the A720. The locations of these counters are shown in Figure 5.4.

5.2.16 The data available from these counters indicates that the 24-Hour Annual Average Daily Traffic (AADT) on the A720 in 2017 was 59,100 vehicles per day.

Journey Time Surveys

5.2.17 A survey of journey times was undertaken to assist in defining current operating conditions. Three routes were defined to include the A720 mainline (Blue Route) and the surrounding area (Red and Green Routes).

5.2.18 The Blue Route surveys on the A720 were carried out on Wednesday 10th May 2017 and Thursday 11th May 2017 using one vehicle on each day survey. The Red and Green Route surveys of the surrounding area were carried out on Wednesday 10th May 2017 using one vehicle on each route.

5.2.19 Multiple runs were carried out in both directions of travel during the AM Period between 06:00 and 10:00 hours, the Inter-Peak Period between 11:00 and 15:00 hours and the PM Peak Period between 16:00 and 19:00 hours to record variations in journey times throughout the day.

5.2.20 The average daily eastbound and westbound speeds observed during the surveys for the Blue Route are shown in Figure 5.5.

5.2.21 Examination of the average daily directional speeds on the A720 indicates that eastbound speeds at Straiton are 60mph but reduce to 45mph between Lasswade and Gilmerton, and to 23mph on the approach to Sheriffhall Roundabout before increasing thereafter to 60mph at Millerhill.

5.2.22 Examination of the average daily directional speeds also indicates that westbound speeds are 58mph at Millerhill but reduce to 31mph on the approach to Sheriffhall Roundabout. Although westbound speeds increase to 52mph west of Sheriffhall Roundabout, speeds reduce again to 31mph at Straiton.

5.2.23 The average daily directional speeds observed for the Red and Green journey time survey routes are shown in Figures 5.6 and 5.7 respectively.

5.2.24 As anticipated, the average speeds recorded along the Red and Green Routes on the non-trunk road network are lower than the speeds on the A720. In addition, the average speeds on the approaches to Sheriffhall Roundabout are significantly lower than speeds on the adjacent sections of the A720 due to the delays and congestion at the roundabout.

Road Traffic Collision Data

5.2.25 To assist in assessing road safety conditions, information on all road traffic collisions involving personal injury accidents on the A720 between Lothianburn Junction and Old Craighall Roundabout were obtained from Transport Scotland for the 10-year period between 2007 and 2016 inclusive.

5.2.26 Analysis of road traffic collisions on the A720 indicates that the total number of personal injury accidents between 2007 and 2016 has fluctuated between 24 accidents in 2009 and 2010, and 37 accidents in 2014 with an annual average of 30 accidents.

5.2.27 Analysis of road traffic accidents between 2007 and 2016 indicates that there has been a total of 299 personal injury accidents with 1.3% recorded as fatal accidents, 6.4% recorded as serious accidents and 92.3% recorded as slight accidents.

5.2.28 A network plot indicating the locations and severities of road traffic collisions along the A720 during the 5-year period between 2012 and 2016 inclusive is shown in Figure 5.8.

5.3 Paramics Model Development - Network

Introduction

5.3.1 The operational and economic assessment of proposed road improvement schemes requires the development and application of various computer models. In the case of the A720 Sheriffhall Roundabout, the operational assessment has involved the development of a Paramics micro-simulation traffic model.

Paramics Base Model Network

5.3.2 The Paramics Base model network has been defined to allow modelling of traffic conditions on the existing road network based on the traffic survey data collected during the programme of surveys undertaken in May 2017.

5.3.3 The extent of the modelled network was defined to include road sections that are likely to experience a significant change in operating conditions as a result of the proposed scheme. The model therefore extends outwards from Sheriffhall Roundabout along the A720 to Straiton junction in the west and Old Craighall junction in the east. The Paramics model also includes the local road network within a distance of 1km from the proposed scheme to provide information for the environmental assessment.

Zoning System

5.3.4 A zoning system was developed to represent the main origins and destinations of trips within the modelled area. A total of 30 zones were defined to model trip patterns in the area.

5.3.5 A network plot indicating extent of the Base model network the locations of these zones is shown in Figure 5.9.

Link Categories

5.3.6 The Paramics network was constructed using node points at key locations such as junctions, speed limit change points, road narrowing / widening and any changes in the alignment of the road. These nodes were connected by a series of links to represent the road network.

5.3.7 The key parameters defined for each link include speed limit, lane width and number of lanes. Each link was specified as either Major or Minor, and Urban or Highway, to influence driver behaviour on the modelled road network.

5.3.8 The perceived cost of driving on a Minor link is double the cost of an equivalent Major link for non-familiar drivers, which encourages the majority of vehicles to travel using the major signposted routes, whilst allowing for familiar drivers who have local knowledge to use alternative routes. The default ratio of 85% familiar drivers to 15% unfamiliar drivers was adopted in the Paramics model.

5.3.9 On an Urban link, drivers are more likely to consider which lane they should use on approach to a turning manoeuvres, whereas on a Highway link, drivers are more likely to use the faster lane to make use of overtaking opportunities.

5.3.10 Details of the link characteristics defined for different sections of the modelled network are shown in Table 5.1.

Table 5.1 Link Characteristics

Road Section	Speed Limit (mph)	Single / Dual Carriageway	Link Category	Urban / Highway
A720 Mainline	70 mph	Dual 2-Lane Carriageway	Major	Highway
A7 North of Sheriffhall Rb	50 mph	Single Carriageway	Major	Urban
A7 South of Sheriffhall Rb	60 mph	Single Carriageway	Major	Urban
A6106 North of Sheriffhall Rb	60 mph	Single Carriageway	Major	Urban
A6106 South of Sheriffhall Rb	40 mph	Single Carriageway	Major	Urban

5.4 Paramics Model Development – Trip Matrix

Modelled Time Periods

5.4.1 The Paramics Base model was split into ten distinct time periods, namely four hourly AM Periods, a single 5-hour Inter-Peak Period and five hourly PM Periods. The start and end times of the modelled time periods are as follows:

- AM Period 1 – 1 hour period from 06:00:00 hours to 06:59:59 hours;
- AM Period 2 – 1 hour period from 07:00:00 hours to 07:59:59 hours;
- AM Period 3 – 1 hour period from 08:00:00 hours to 08:59:59 hours;
- AM Period 4 – 1 hour period from 09:00:00 hours to 09:59:59 hours;
- Inter-Peak Period – 5 hour period from 10:00:00 hours to 14:59:59 hours;
- PM Period 1 – 1 hour period from 15:00:00 hours to 15:59:59 hours;
- PM Period 2 – 1 hour period from 16:00:00 hours to 16:59:59 hours;
- PM Period 3 – 1 hour period from 17:00:00 hours to 17:59:59 hours;
- PM Period 4 – 1 hour period from 18:00:00 hours to 18:59:59 hours; and
- PM Period 5 – 1 hour period from 19:00:00 hours to 19:59:59 hours.

Vehicle Composition

5.4.2 Based on the MCC information collected within the scheme area, the 2017 14-Hour weekday vehicle proportions defined in the Paramics Base model are as follows:

- 79.9% Cars;
- 13.3% Light Goods Vehicles (LGV);
- 3.3% Other Goods Vehicles 1 (OGV1);
- 2.1% Other Goods Vehicles 2 (OGV2); and
- 1.4% Buses and Coaches (PSV).

5.4.3 To provide a reasonable representation of trip patterns in the area, separate trip matrices were developed for each of the modelled time periods and for Light Vehicles (Cars & LGVs) and Heavy Vehicles (OGV1, OGV2 & PSVs). The proportions of each vehicle type applied to each matrix within each time period are as follows:

- Demand Matrix 1 (Light Vehicles) - Cars (85.75%) and LGVs (14.25%); and
- Demand Matrix 2 (Heavy Vehicles) - OGV1s (48.5%), OGV2s (31.1%) & PSVs (20.4%).

Demand Profiles

5.4.4 A set of demand profiles was derived from the observed 2017 traffic data to model the release of vehicles on to the network from each zone, using the 15-minute traffic flow patterns observed during the 14-Hour MCC surveys for both Light Vehicles and Heavy Vehicles.

5.4.5 A separate demand profile was derived and applied to each zone in the Paramics network using the traffic flows counted entering the junctions from the approach closest to each zone location. The demand profiles were derived in 15-minute intervals and were further separated into Light Vehicle and Heavy Vehicle profiles for each zone.

Trip Matrix Building

5.4.6 To represent trip patterns in the area, separate trip matrices were developed for each of the modelled time periods and for Light Vehicles and Heavy Vehicles.

5.4.7 Turning counts from the 14-Hour MCC traffic data were processed for each time period and for Light Vehicles and Heavy Vehicles to create the trip matrices.

5.4.8 The total number of Light Vehicles and Heavy Vehicles in each modelled trip matrix by time period is summarised in Table 5.2.

Table 5.2 2017 Day of Survey Trip Matrices

Time Period	Light Vehicles	Heavy Vehicles	All Vehicles
AM Period 1 (06:00 - 07:00 hours)	6,567	663	7,230
AM Period 2 (07:00 - 08:00 hours)	12,082	854	12,936
AM Period 3 (08:00 - 09:00 hours)	10,747	928	11,675
AM Period 4 (09:00 - 10:00 hours)	9,331	1,085	10,416
Inter-Peak Period (10:00 - 15:00 hours)	48,666	4,914	53,580
PM Period 1 (15:00 - 16:00 hours)	11,579	858	12,437
PM Period 2 (16:00 - 17:00 hours)	13,308	664	13,972
PM Period 3 (17:00 - 18:00 hours)	13,247	478	13,725
PM Period 4 (18:00 - 19:00 hours)	11,504	385	11,889
PM Period 5 (19:00 - 20:00 hours)	7,569	256	7,825
14-Hour Period (06:00 - 20:00 hours)	144,600	11,085	155,685

5.5 Model Calibration and Validation

Introduction

5.5.1 As the principal benefits associated with the proposed scheme at Sheriffhall Roundabout are likely to result from savings in transit time, it is necessary to calibrate and validate the Paramics Base model to provide a reasonable representation of trip patterns and journey times within the modelled area.

Paramics Base Model Simulations

5.5.2 Paramics models include random variations to simulate the daily variations that can occur in traffic conditions on the road network.

5.5.3 Due to the variability that occurs between multiple Paramics model runs, a standard statistical analysis was undertaken to establish how many simulations were required to have confidence that the modelled journey times were representative. The modelled journey times along six main routes through Sheriffhall Roundabout were included in the analysis, namely the A720 (eastbound and westbound), the A7 (northbound and southbound) and the A6106 (northbound and southbound).

5.5.4 The results of the statistical analysis indicated that 15 simulation runs were required to achieve a 95% confidence level that the journey times were within 5% of the average of all runs on the A720, and within 10% of the average of all runs on the A7 and A6106 during each of the three modelled time periods.

5.5.5 The average results from 15 simulations of the Paramics model have been used as the basis for comparison against observed data as part of the calibration process.

Model Calibration Approach

5.5.6 The Paramics Base 2017 model was calibrated to provide a reasonable representation of the conditions observed during the May 2017 journey time surveys. The main parameters used as part of the calibration process were as follows:

5.5.7 The initial modelled signal times at Sheriffhall Roundabout were based on on-site observations. The green times and offsets were then adjusted to calibrate the model to reflect observed traffic conditions on the approaches to the junction.

5.5.8 Examination of the model indicated that the free-flowing traffic was generally travelling too fast in comparison to the speeds observed during the May 2017 journey time surveys. The maximum vehicle speed in the model was therefore reduced from default values for each vehicle type and the speed limits on various links were reduced to adjust the speeds to more closely represent observed free-flowing conditions.

5.5.9 Examination of operating conditions on the A720 to the west of Sheriffhall Roundabout indicates that traffic merging from the A701 on-slip at Straiton on to the westbound carriageway interrupts traffic flow on the A720 which results in significant queueing along the A720. Similar congestion is observed on the A720 to the west of Straiton. To provide a better representation of the effects of merging traffic at Straiton Junction and the effects of junctions beyond the western limits of the Paramics network, the incidents modelling parameter in Paramics was used in the AM and PM Periods to introduce temporary reduced speed limits on the A720. The slowing of vehicles as they reach the temporary reduced speed limit on the A720 has the effect of causing queues to build up on the mainline as observed during the May 2017 survey programme.

5.5.10 The default visibility in Paramics for links entering non-signalised roundabouts and priority junctions, which results in vehicles coming to a complete stop at all junctions before looking for a gap in opposing traffic, was adjusted to calibrate the flow of traffic through the junctions to observed conditions.

5.5.11 The global mean headway and minimum gap driver behaviour parameters in Paramics were also adjusted as part of the calibration process.

Trip Assignment

5.5.12 The standard GEH statistic is used in computer modelling to quantify the difference between observed and modelled traffic flows. The GEH statistic takes into account that when traffic flows are low the percentage difference between observed and modelled flows may be high but the significance of this difference is small.

5.5.13 In accordance with DMRB Guidelines, a model should return a GEH statistic of <5 for 85% of individual flows.

5.5.14 Analysis of the Sheriffhall model indicates that the GEH statistic is <5 for 95% to 100% of junction link flows in each of the hourly time periods, which exceeds the 85% target.

5.5.15 Analysis of the Sheriffhall model also indicates that the GEH statistic is <5 for 95% to 100% of junction turning flows in each of the hourly time periods, which exceeds the 85% target.

5.5.16 Analysis of the Sheriffhall model also indicates that the GEH statistic is <3 for 87% to 97% of junction turning flows in each of the hourly time periods, which exceeds the 85% target.

5.5.17 Therefore, the overall results indicate a high level of correlation between modelled and observed traffic flows across the modelled network and at Sheriffhall Roundabout.

Journey Times

5.5.18 As the principal economic benefits associated with the proposed scheme are likely to result from savings in transit time, it is necessary to calibrate the Paramics Base model to provide a reasonable representation of journey times within the modelled area.

5.5.19 The DMRB acceptability guidelines for the comparison of modelled and observed journey times indicates that journey times should be within 15% or 1 minute, in 85% of cases.

5.5.20 A comparison of the observed journey speeds and times along the A720 and the corresponding modelled journey speeds and times for the eastbound and westbound directions of travel is shown in Tables 5.3 and 5.4 respectively.

Table 5.3 Comparison of Observed and Modelled Journey Speeds and Times on A720 E/b

Time Period	Direction	Observed Speed (mph)	Modelled Speed (mph)	Speed Diff. (mph)	Observed Time (mm:ss)	Modelled Time (mm:ss)	Time Diff. (mm:ss)	Time Diff. (%)
AM (06:00 - 07:00)	E/b	55	53	-2	07:01	07:19	00:19	4%
AM (07:00 - 08:00)	E/b	48	51	4	08:10	07:32	-00:37	-8%
AM (08:00 - 09:00)	E/b	51	51	0	07:37	07:35	-00:01	0%
AM (09:00 - 10:00)	E/b	46	51	5	08:30	07:38	-00:51	-10%
IP (10:00 - 11:00)	E/b	-	52	-	-	07:25	-	-
IP (11:00 - 12:00)	E/b	52	52	0	07:31	07:28	-00:04	-1%
IP (12:00 - 13:00)	E/b	51	52	1	07:35	07:26	-00:09	-2%
IP (13:00 - 14:00)	E/b	52	52	0	07:29	07:31	00:02	0%
IP (14:00 - 15:00)	E/b	51	52	0	07:33	07:29	-00:04	-1%
PM (15:00 - 16:00)	E/b	-	45	-	-	08:34	-	-
PM (16:00 - 17:00)	E/b	30	30	0	12:59	13:04	00:05	1%
PM (17:00 - 18:00)	E/b	24	24	0	16:22	16:08	-00:14	-1%
PM (18:00 - 19:00)	E/b	29	25	-4	13:26	15:19	01:53	14%

Note: The above results are based on the average of 15 simulation runs.

Table 5.4 Comparison of Observed and Modelled Journey Speeds and Times on A720 W/b

Time Period	Direction	Observed Speed (mph)	Modelled Speed (mph)	Speed Diff. (mph)	Observed Time (mm:ss)	Modelled Time (mm:ss)	Time Diff. (mm:ss)	Time Diff. (%)
AM (06:00 - 07:00)	W/b	44	41	-4	08:45	09:34	00:50	10%
AM (07:00 - 08:00)	W/b	21	23	2	18:17	16:54	-01:23	-8%
AM (08:00 - 09:00)	W/b	29	31	2	13:11	12:24	-00:47	-6%
AM (09:00 - 10:00)	W/b	53	51	-2	07:22	07:37	00:15	3%
IP (10:00 - 11:00)	W/b	-	54	-	-	07:13	-	-

Time Period	Direction	Observed Speed (mph)	Modelled Speed (mph)	Speed Diff. (mph)	Observed Time (mm:ss)	Modelled Time (mm:ss)	Time Diff. (mm:ss)	Time Diff. (%)
IP (11:00 - 12:00)	W/b	54	53	0	07:14	07:16	00:02	1%
IP (12:00 - 13:00)	W/b	47	52	4	08:11	07:32	-00:39	-8%
IP (13:00 - 14:00)	W/b	45	50	5	08:34	07:46	-00:48	-9%
IP (14:00 - 15:00)	W/b	50	51	1	07:47	07:34	-00:13	-3%
PM (15:00 - 16:00)	W/b	-	27	-	-	14:22	-	-
PM (16:00 - 17:00)	W/b	25	23	-2	15:16	16:53	01:37	11%
PM (17:00 - 18:00)	W/b	45	43	-2	08:41	09:06	00:25	5%
PM (18:00 - 19:00)	W/b	53	53	-1	07:17	07:23	00:07	1%

Note: The above results are based on the average of 15 simulation runs.

5.5.21 The results of this comparison indicate that modelled eastbound and westbound journey times have been calibrated to within 1 minute or 15% of observed journey times in each hourly time period and are therefore within the criteria defined in the DMRB acceptability guidelines.

5.5.22 The results of this comparison also indicate that observed and modelled average speeds on the A720 are within 5mph in each hourly time period.

5.5.23 A comparison between the modelled minimum, maximum and average speeds for the A720 eastbound and westbound traffic and the journey time survey speeds recorded over the two days of survey is shown in Figure 5.10. This figure indicates that the observed speeds are within the range of speeds derived from the 15 simulations of the model.

5.6 Traffic Annualisation and Forecasting

Introduction

5.6.1 The Paramics Base model was initially developed to represent traffic conditions observed during the 14-Hour traffic survey period in May 2017.

5.6.2 For the purposes of the traffic and economic assessment of the proposed scheme, the model was further developed to represent the 24-Hour annual average daily traffic flows and to incorporate the forecasted growth in traffic after the 2017 Base Year.

5.6.3 Details of the traffic annualisation and forecasting procedures are described below.

Traffic Annualisation

5.6.4 Transport Scotland maintains a series of permanent Automatic Traffic Counters (ATCs) which provide traffic flow information across the Scottish trunk road network.

5.6.5 Permanent ATCs NTC00608 and NTC00609 are located on the A720 eastbound and westbound carriageways respectively near the Lasswade junction to the west of Sheriffhall Roundabout. These counters recorded the most complete traffic data throughout 2017 and were used as a basis for annualising the traffic volumes recorded on the day of survey for the purposes of the economic assessment.

5.6.6 The two-way 14-Hour (06:00 - 20:00 hours) traffic flow recorded by the permanent ATCs on Wednesday 10th May 2017, the day of the MCC survey on the A720, was 55,970 vehicles. This compares favourably and is within 0.6% of the observed MCC traffic flow of 55,620 vehicles.

5.6.7 The average two-way 14-Hour and 24-Hour traffic flows recorded by the permanent ATCs on Wednesday 10th and Thursday 11th May 2017, the days of the MCC survey across the scheme area, were 56,660 and 63,995 vehicles. A 14-Hour to 24-Hour factor of 1.13 was therefore derived and applied to create trip matrices for the overnight period between 20:00 hours and 06:00 hours.

5.6.8 The average two-way 24-Hour weekday traffic flow recorded by the permanent ATCs in 2017 was 61,912 vehicles. As a result, a day of survey to AAWDT factor of 0.97 has been used to create annualised weekday 2017 trip matrices.

5.6.9 The factors described above have been used to estimate the volumes of traffic on the road network by factoring the 14-Hour day of survey information to derive the overnight and annual average weekday traffic flows.

Traffic Growth – Base Network

Growth from 2017 Observed Year to 2024 Opening Year

5.6.10 For the purpose of the traffic and economic assessment of the proposed scheme, an opening year of 2024 was assumed.

5.6.11 Although the 2017 traffic surveys provide detailed information to assist in the development of the Paramics Base model, further information was required to define future traffic demand after the 2017 Base Year.

5.6.12 The SEStran Regional Model (SRM12), which was developed separately by Transport Scotland and covers the South East Scotland area, was used to derive an estimate of future growth based on the traffic related effects of proposed changes in land use over both the local and the wider regional area.

5.6.13 The traffic data from SRM12 consisted of AM Peak Hour, Inter-Peak Hour and PM-Peak Hour traffic turning flows, expressed in Passenger Car Units (PCUs) and split by Cars, LGVs, HGVs and PSVs. This data was extracted from the SRM12 models for the 2012 Baseline Year and the 2024 Reference Case Year, and used to create trip matrices for the zoning system defined in Paramics.

5.6.14 The traffic data was then converted to a 4-Hour AM Period, 5-Hour Inter-Peak Period and 5-Hour PM Period using pre-defined factors and from PCUs to vehicles. Further factors derived from the observed demand profile were applied to convert the AM Period and PM Period to individual hourly periods to match the format of data required in the Paramics model.

5.6.15 To maintain the integrity of the detailed observed data collected during the May 2017 traffic surveys, the SRM12 data was only used to define the additional traffic for future years.

5.6.16 The estimated traffic growth from the 2017 Base Year to the proposed 2024 Scheme Opening Year was derived by comparing the 2012 and 2024 SRM12 matrices and adopting a linear growth profile over the 12 year period. Given that the Paramics 2017 Base model year is 5 years into the 12 year SRM12 forecast period, a proportion of 7/12ths of the derived increase in trips was added to the observed 2017 matrices to create the new 2024 trip matrices.

5.6.17 The derived trip matrices for each modelled period and for Light Vehicles and Heavy Vehicles were incorporated into the model to assess network performance.

5.6.18 Given the level of congestion predicted on the base network, it was necessary to run the simulation model multiple times with random seeds to achieve a reasonable level of confidence in the results.

5.6.19 A total of 30 simulations of the Paramics Base model were run with the derived 2024 trip matrices. To provide a reasonable basis for the assessment of the proposed scheme, 15 runs, i.e. half of the available runs, which provide the most consistent results were identified and taken through the standard statistical analysis test.

5.6.20 The level of variation between modelled runs of the 2024 Base Paramics model indicates that a total of 12 of the 15 runs would be required to achieve a 95% confidence level that the journey times were within 5% of the average of all runs on the A720, and within 10% of the average of all runs on the A7 and A6106 during each of the three modelled time periods.

5.6.21 Based on these results, it was concluded that the results for the 15 runs provide a reasonable basis for the assessment of the proposed scheme.

Growth Beyond 2024 Opening Year to 2039 Design Year

5.6.22 To assess the effects of traffic growth beyond the assumed 2024 opening year, the following growth rates were extracted from TMfS14:

- 2022 to 2027 – 1.32% p.a.;
- 2027 to 2032 – 1.22% p.a.;
- 2032 to 2037 – 0.95% p.a.; and
- 2037 to 2039 – 0.69% p.a. (extrapolated).

5.6.23 These TMfS14 growth rates were used to derive an overall growth factor of 17.5% between 2024 and 2039, which was applied to the SRM12 Reference Case model to develop a new SRM12 2039 Design Year model.

5.6.24 The resulting trip matrices for the scheme area derived from the SRM12 2039 model were then compared with the equivalent matrices derived from the SRM12 2024 model to estimate the traffic growth for each zone to zone movement on the network. A linear growth profile for the 15 years of traffic growth between 2024 and 2039 was adopted. The additional traffic was added to the 2024 Paramics matrices in yearly increments to establish the level of growth that the Paramics model network could accommodate.

5.6.25 Given the level of congestion predicted on the network, it was necessary to run the simulation model multiple times with random seeds to achieve a reasonable level of confidence in the results.

5.6.26 The traffic demand was increased annually from the assumed 2024 Opening Year to examine traffic conditions in 2025, 2026 and 2027.

5.6.27 A total of 30 simulations of the Paramics Base model were run with the derived 2027 trip matrices. To provide a reasonable basis for the assessment of the proposed scheme, 15 runs, i.e. half of the available 30 runs, which provide the most consistent results were identified and taken through the standard statistical analysis test.

5.6.28 The level of variation between modelled runs of the 2027 Paramics Base model indicates that a total of 14 of the 15 runs would be required to achieve a 95% confidence level that the journey times were within 5% of the average of all runs on the A720, and within 10% of the average of all runs on the A7 and A6106 during each of the three modelled time periods.

5.6.29 A total of 30 simulations of the Paramics Base model were run with the derived 2028 trip matrices. The level of variation between modelled runs of the 2028 Paramics Base model indicated that the desired confidence level in the journey time consistency could not be achieved. This indicated that the base network was unable to accommodate the traffic demand in 2028.

5.6.30 Following an assessment of network performance based on incremental loading of predicted annual growth, it was concluded that the Base Paramics model could accommodate traffic up to the estimated 2027 demand level.

Traffic Growth – Design Network

5.6.31 To provide a consistent basis for assessing the effects of the proposed scheme, the 2024 trip matrices derived for the Paramics Base model were incorporated into the Paramics Design model.

Additional Traffic due to Grade-Separation

5.6.32 The Design model was also developed to incorporate additional trips that the SRM12 model predicted could be attracted to the Sheriffhall Roundabout following grade-separation due to the provision of increased capacity at this location.

5.6.33 The additional trips estimated by SRM12 were derived by comparing the SRM12 2024 Reference Case matrices and the SRM12 2024 Test Case scenario with the inclusion of the proposed grade-separated junction at Sheriffhall Roundabout. This additional traffic was added to the Base 2024 Paramics model matrices to create 2024 Design model matrices which included additional trips due to increased capacity following grade-separation.

5.6.34 The results from the Paramics model indicated that the Design network could not accommodate 100% of the additional trips estimated by the SRM12 model with the proposed Sheriffhall improvement during the AM and PM Periods. Consequently, the Inter-Peak and Overnight traffic was increased by the full 100% of predicted additional demand whilst traffic demands in the AM and PM Periods were increased in increments of the predicted additional demand up to the operational capacity of the network.

5.6.35 A total of 30 simulations of the Paramics Design model were run with the derived 2024 trip matrices with 25% of the predicted additional demand during the AM and PM Periods. To provide a reasonable basis for the assessment of the proposed scheme, 15 runs, i.e. half of the available runs, which provide the most consistent results were and identified and taken through the standard statistical analysis test.

5.6.36 The level of variation between modelled runs of the 2024 Paramics Design model with 25% of the predicted additional demand during the AM and PM Periods indicated that a total of 11 of the 15 runs would be required to achieve a 95% confidence level that the journey times were within 5% of the average of all runs on the A720, and within 10% of the average of all runs on the A7 and A6106 during each of the three modelled time periods.

5.6.37 A total of 30 simulations of the Paramics Design model were run with the derived 2024 trip matrices with 30% of the predicted additional demand during the AM and PM Periods. The level of variation between modelled runs

of the 2024 Paramics Design model with 30% of the predicted additional demand during the AM and PM Periods indicated that the desired confidence level in the journey time consistency could not be achieved using the model runs available. This indicates that the network is unable to accommodate the traffic demand under this scenario.

5.6.38 It was therefore concluded that the trip matrices defined for the heavily congested AM and PM periods could accommodate an increase of 25% of the predicted additional demand defined by SRM12. The trip matrices defined for the more lightly trafficked Inter-Peak and Overnight Periods include the full 100% predicted additional demand defined by the SRM12 model with the proposed Sheriffhall improvement.

Growth in Traffic After Effects of Additional Traffic due to Grade-Separation

5.6.39 Because the highest traffic demand occurs during the AM and PM Periods, these periods were fixed to the derived 2024 demand level with 25% of the predicted additional demand during the AM and PM Periods, while traffic growth in the Inter-Peak and Overnight Periods was tested.

5.6.40 A total of 30 simulations of the Paramics Design model were run with the derived 2025 trip matrices (Inter-Peak and Overnight traffic growth only). To provide a reasonable basis for the assessment of the proposed scheme, 15 runs, i.e. half of the available runs, which provide the most consistent results were and identified and taken through the standard statistical analysis test.

5.6.41 The level of variation between modelled runs of the 2025 Paramics Design model (Inter-Peak and Overnight traffic growth only) indicates that the desired confidence level in the journey time consistency could not be achieved using the model runs available. This indicates that the network is unable to accommodate the traffic demand specified under this scenario.

5.6.42 Following an assessment of network performance based on incremental loading of additional traffic due to grade-separation during the AM and PM periods, it was concluded that the trip matrices defined for the heavily congested AM and PM periods could accommodate an increase of 25% of the predicted additional demand defined by SRM12. The trip matrices defined for the more lightly trafficked Inter-Peak and Overnight Periods include the full 100% predicted additional demand defined by the SRM12 model with the proposed Sheriffhall improvement in 2024.

5.7 Operational Assessment

Introduction

5.7.1 The principal operational benefits of the proposed scheme would be to improve the movement of traffic on the A720 between Gilmerton and Old Craighall by providing grade-separation of the A720 at the existing Sheriffhall Roundabout and reducing the conflict between strategic and local traffic.

5.7.2 For the purpose of the assessment of the proposed scheme, it has been assumed that the scheme would open in 2024.

5.7.3 The operational assessment is based on the examination of the results from the Paramics models for the assumed 2024 Opening Year.

5.7.4 Paramics includes the function to simulate the effects of the random variations in driver behaviour that occur naturally on the road network throughout the day, which can result in variability in the modelled results. Due to the variability between Paramics simulations, the assessment is based on the average of 15 separate model simulations to provide a reasonable basis to compare the operational effects of the proposed scheme relative to the Base model.

Traffic Volumes

5.7.5 The changes in traffic volumes through Sheriffhall junction are summarised in Table 5.5.

Table 5.5 Total Sheriffhall Junction Traffic Flows (14 Hour AAWDT)

Year / Traffic Movement	Base network	Design network +Grade-Sep traffic	Difference	% Difference
2017 Junction Flow	67,530	-	-	-
2017 A720 Through Traffic	-	-	-	-
2017 Total Sheriffhall Flow	67,530	-	-	-

Year / Traffic Movement	Base network	Design network +Grade-Sep traffic	Difference	% Difference
2024 Junction Flow	73,570	39,930 (52%)	33,640	-46%
2024 A720 Through Traffic	-	37,340 (48%)	37,340	-
2024 Total Sheriffhall Flow	73,570	77,270	3,700	+5%

Note: The above results are based on the averages of 15 simulation runs.

5.7.6 It is estimated that the annual average weekday traffic (AAWDT) flow through Sheriffhall Roundabout in 2017 was 67,530 vehicles.

5.7.7 It is predicted that the AAWDT flow could increase by 9% to 73,570 vehicles by 2024.

5.7.8 The provision of grade-separation at Sheriffhall Roundabout could increase traffic flows through the junction by a further 5% to 77,270 vehicles in 2024. However, the provision of the grade-separated junction would allow 48% of the traffic to pass through the new junction on an elevated structure and consequently reduce traffic flow on the roundabout by 46% overall.

5.7.9 The estimated 37,340 (48%) strategic trips that would flow freely on the A720 through the new junction on an average weekday would not incur junction delays and would be separated from the remaining 39,930 (52%) local trips which use the A7 or A6106 for part or all of their journey.

5.7.10 Eliminating the conflict between strategic and local traffic movements would result in significant operational benefits for road users on the A720, A7 and A6106.

Journey Times and Speeds

5.7.11 Savings in journey times typically represent one of the most significant benefits resulting from the provision of a new transport improvement scheme.

5.7.12 A comparison of the AM-peak hour, PM-peak hour and 14-hour journey speeds and times along the A720 for the Base and Design models in the proposed 2024 Opening Year is shown in Table 5.6.

Table 5.6 Comparison of 2024 Journey Speeds and Times on A720

Time Period	Direction	Base 2024 Speed (mph)	Design 2024GS Speed (mph)	Speed Diff. (mph)	Base 2024 Time (mins)	Design 2024GS Time (mins)	Time Diff. (mins)	Time Diff. (%)
AM (07:15 - 08:15)	E/b	49	52	+3	7.8	7.3	-0.5	-6%
AM (07:15 - 08:15)	W/b	15	17	+2	25.7	21.8	-3.9	-15%
PM (16:00 - 17:00)	E/b	20	51	+31	19.1	7.4	-11.7	-61%
PM (16:00 - 17:00)	W/b	13	21	+8	28.6	18.3	-10.3	-36%
Total (14-Hour)	E/b	34	52	+18	11.2	7.3	-3.9	-35%
Total (14-Hour)	W/b	26	35	+9	14.8	10.9	-3.9	-26%

Note: The above results are based on the averages of 15 simulation runs over a 10km section of the A720.

5.7.13 The above results indicate that average journey times on the A720 during the AM peak hour would decrease by 6% (0.5mins) and 15% (3.9mins) in the eastbound and westbound directions respectively. During the PM peak hour, the corresponding average journey times would decrease by 61% (11.7mins) and 36% (10.3mins). During the 14-Hour average weekday, average journey times would decrease by 35% (3.9mins) and 26% (3.9mins) in the eastbound and westbound directions respectively.

5.7.14 Overall, the proposed scheme would reduce journey times through the junction for A720 strategic traffic.

A comparison of the 14-hour journey speeds and times on the A7 and A6106 from the Base and Design models in the assumed 2024 Opening Year is shown in Table 5.7.

Table 5.7 Comparison of 2024 Journey Speeds and Times on the A7 and A6106

Time Period	Route / Direction	Base 2024 Speed (mph)	Design 2024GS Speed (mph)	Speed Diff. (mph)	Base 2024 Time (mins)	Design 2024GS ime (mins)	Time Diff. (mins)	Time Diff. (%)
Total (14-Hour)	A7 N/b	16	23	+7	8.9	6.2	-2.7	-30%
Total (14-Hour)	A7 S/b	20	26	+6	7.3	5.6	-1.7	-23%
Total (14-Hour)	A6106 N/b	26	28	+2	2.8	2.6	-0.2	-8%
Total (14-Hour)	A6106 S/b	7	26	+19	9.7	2.7	-7.0	-72%

Note: The above results are based on the averages of 15 simulation runs over 4km and 2km sections of the A7 and A6106.

5.7.15 The above results indicate that average journey times on the A7 during the 14-Hour average weekday period would decrease by 30% (2.7mins) and 23% (1.7mins) in the northbound and southbound directions respectively.

5.7.16 The average journey times on the A6106 during the 14-Hour average weekday period would decrease by 8% (0.2mins) and 72% (7.0mins) in the northbound and southbound directions respectively.

5.7.17 Overall, the proposed scheme would reduce journey times through the junction for A7 and A6106 local traffic.

Road Safety

5.7.18 To examine the road safety benefits of the proposed scheme, the estimated changes in the number of road traffic accidents for both the Base and Design models was assessed using the computer model NESA (Network Evaluations from Surveys and Assignment).

5.7.19 The NESA accident only models were based on traffic data extracted from the Paramics models and considered the effects of the proposed grade-separation of Sheriffhall Roundabout over a 60-year assessment period.

5.7.20 The total number of accidents in the NESA Base and Design models and the corresponding accident benefits based on the application of default accident rates are shown in Table 5.8.

Table 5.8 Number of NESA Accidents (2024 Base Weekday Traffic) – Default Accidents

Option	Total Link Accidents	Total Junction Accidents	Total Link & Junction Accidents
Base	2485.0	1188.7	3673.7
Design (+GS Traffic)	2549.3	997.6	3546.9
Benefits	-64.3	191.1	126.8

5.7.21 The results from the NESA accident model indicate that the proposed scheme would reduce the number of personal injury accidents on the modelled network by 127 accidents over the 60-year assessment using standard default accident rates.

5.8 Economics

Scheme Cost Estimate

5.8.1 The total scheme cost, including risk, optimism bias, preparation and supervision costs, is shown in Section 3.5 of this report.

5.8.2 In accordance with WebTAG guidelines regarding real cost changes over time, construction cost increases above inflation as measured by the Gross Domestic Product (GDP) deflator have been considered. Transport Scotland has confirmed that inflation through to construction is at a rate of 3.8% per annum for FY19/20 and FY20/21, and 3.5% per annum from FY21/22 onwards. For the purpose of the economic assessment, the base scheme cost was increased to incorporate the real cost adjustments due to forecast increases in construction

costs above general inflation as measured by GDP which is estimated to be approximately 2.0% per annum over the same period.

5.8.3 The adjustments for construction price inflation above general GDP inflation result in an estimated scheme cost of £125.222m, including real cost adjustments through to construction. The scheme costs which have been used in the economic assessment are shown below in Table 5.9.

Table 5.9 Scheme Cost Estimate Summary, Including Risk, Optimism Bias and Real Cost Adjustments

Cost Element	Scheme Cost (£m)
Total Construction Cost (including 15% OB, 23% OB Structures)	109.067
Total Land Cost (including 15% OB)	3.745
Preparation (6% of Total Construction and Land Cost)	6.769
Supervision (5% of Total Construction and Land Cost)	5.641
Total Scheme Cost	125.222

Note: All costs are in Q4, 2018 prices, including real cost adjustments through to construction, and exclude VAT.

TUBA Economic Appraisal

5.8.4 The economic results from the TUBA model for the proposed scheme, based on a 60-year assessment period, are summarised in Table 5.10.

Table 5.10 TUBA Appraisal Summary

Item	Proposed Scheme Including Construction Price Inflation
Present Value of Benefits (PVB) (£m)	502.764
Present Value of Costs (PVC) (£m)	84.965
Net Present Value (NPV) (£m)	417.799
Benefit to Cost Ratio (BCR)	5.917

Note: All monetary values are in 2010 market prices, discounted to 2010.

5.8.5 Including the effects of Construction Price Inflation, the results of the TUBA assessment indicate that the provision of the proposed scheme would generate a Net Present Value of £417.799m and a Benefit to Cost Ratio of 5.917 over the 60-year assessment period.

5.8.6 In accordance with Value for Money Guidance, schemes which generate a BCR greater than 4.00 are considered to represent very high value for money.

NESA Economic Appraisal

5.8.7 A NESA accident model was developed to assess the accident benefits associated with the proposed scheme.

5.8.8 The accident benefits derived from the NESA accident only Base and Design models, based on the 60-year assessment period and adopting default accidents, are shown below in Table 5.11.

Table 5.11 NESA Accident Benefits – Default Accidents

Option	Link Cost (£m)	Junction Cost (£m)	Total Link & Junction Cost (£m)
Base	147.504	42.662	190.166
Design (+GS Traffic)	151.807	36.668	188.475
Benefits	-4.303	5.994	1.691

Note: All monetary values are in 2010 market prices, discounted to 2010.

5.8.9 The results of the NESA accident assessment based on the application of default accidents indicate that the provision of the proposed scheme would generate a £1.691m accident benefit over the 60-year assessment period.

Combined Economic Appraisal

5.8.10 The economic results from the combined TUBA and NESA models for the proposed scheme, based on a 60-year assessment period, are summarised in Table 5.12.

Table 5.12 Combined Appraisal Summary

Item	Proposed Scheme Including Construction Price Inflation
Present Value of Benefits (PVB) (£m)	504.455
Present Value of Costs (PVC) (£m)	84.965
Net Present Value (NPV) (£m)	419.490
Benefit to Cost Ratio (BCR)	5.937

Note: All monetary values are in 2010 market prices, discounted to 2010.

5.8.11 Including the effects of Construction Price Inflation, the results of the combined assessment indicate that the provision of the proposed scheme would generate a Net Present Value of £419.490m and a Benefit to Cost Ratio of 5.937 over the 60-year assessment period.

5.8.12 In accordance with Value for Money Guidance, schemes which generate a BCR greater than 4.00 are considered to represent very high value for money.

Sensitivity Tests

5.8.13 A series of sensitivity tests was also undertaken to examine the effects of changes in the traffic growth forecasts considered in the TUBA economic assessments and NESA accident assessments.

5.8.14 The TUBA sensitivity tests were undertaken for the following traffic growth scenarios:

- Base 2017 / Design 2017 based on a fixed trip matrix assessment; and
- Base 2024 / Design 2024 based on a fixed trip matrix assessment.

5.8.15 The Base 2017 / Design 2017 sensitivity test examined the economic performance of the proposed scheme assuming no growth in traffic from the traffic levels observed in 2017 and that no additional traffic would be attracted to the junction due to the effects of grade-separation.

5.8.16 The Base 2024 / Design 2024 sensitivity test examined the economic performance of the proposed scheme assuming only growth in traffic between 2017 and 2024 and that no additional traffic would be attracted to the junction due to the effects of grade-separation.

5.8.17 The results of the TUBA sensitivity tests, which include the effects of the Cost Price Inflation, are summarised in Table 5.13.

Table 5.13 TUBA Appraisal Summary Sensitivity Tests

Item	Base 2017 / Design 2017	Base 2024 / Design 2024
Present Value of Benefits (PVB) (£m)	106.396	492.811
Present Value of Costs (PVC) (£m)	84.965	84.965
Net Present Value (NPV) (£m)	21.431	407.846
Benefit to Cost Ratio (BCR)	1.252	5.800

Note: All monetary values are in 2010 market prices, discounted to 2010.

5.8.18 The results of the TUBA sensitivity tests indicate that the proposed scheme would generate a BCR of 1.252 even with zero growth in traffic after 2017 and a BCR of 5.800 in the 2024 fixed matrix assessment which excludes the effects of additional traffic due to grade-separation.

5.8.19 A NESA sensitivity test was undertaken to examine the effect of adopting local accident data over the 5 year period between 2012 and 2016 inclusive. The results of the NESA sensitivity tests are summarised in Table 5.14.

Table 5.14 NESA Accident Benefits – Local Accidents

Option	Link Cost (£m)	Junction Cost (£m)	otal Link & Junction Cost (£m)
Base	102.420	29.53	131.950
Design (+GS Traffic)	103.828	21.952	125.780
Benefits	-1.408	7.578	6.170

Note: All monetary values are in 2010 market prices, discounted to 2010.

5.8.20 The results of the NESA accident sensitivity test based on the application of local accident data indicate that the provision of the proposed scheme would generate a £6.170m accident benefit over the 60-year assessment period.

5.8.21 The results of the above TUBA and NESA sensitivity tests indicate that proposed scheme would generate significant economic benefits over the 60-year assessment period. In accordance with Value for Money Guidance, schemes which generate a BCR greater than 4.00 are considered to represent very high value for money.

5.8.22 Even if there were no traffic growth from the observed 2017 baseline conditions, the economic benefits of the scheme would exceed the cost of the scheme

6 Conclusions

6.1 Introduction

6.1.1 This section gives a summary of the engineering, traffic and economic findings of the DMRB Stage 3 assessment for the scheme as detailed in this report. A summary of the scheme objectives is also included in this section.

6.2 Engineering Considerations

6.2.2 The scheme has been designed in accordance with the DMRB and comprises of a grade separated roundabout at Sheriffhall, requiring vertical and horizontal realignment of the A720 over an approximate length of 1600m. The A720 will be carried across the Sheriffhall Roundabout by two new bridges. The existing Borders Railway bridge will also be extended to accommodate the increased width of the A720 and the slip roads. The roundabout will be enlarged and become an 8 arm roundabout retained at its existing location and the circulatory carriageway reduced to three lanes. Side roads will also be realigned to tie into the enlarged roundabout and the existing local road network.

6.2.3 The scheme provides a Departure-free design for the A720 mainline and slip roads. Two Departures from Standard have been submitted and approved for the cross section of the realigned section of the A6106 South (Old Dalkeith Road) for the non-provision of hard strips.

6.2.4 The scheme includes Non-Motorised Users (NMU) facilities which provides low-level grade-separated NMU links across the Sheriffhall Roundabout with five subways connecting to off-carriageway, shared pedestrian/cycle routes on the local roads.

6.2.5 The proposed drainage for the scheme has been designed in accordance with the DMRB, the SuDS Manual and relevant best practice. The carriageway runoff will be treated and attenuated by SuDS and provide a minimum of two levels of treatment prior to discharge to watercourses.

6.2.6 Public utilities are present which serve adjacent residential, commercial and industrial developments. Preliminary proposals for required diversions and budget costs have also been obtained.

6.2.7 The A720 mainline will remain unlit, but the merge and diverge slip roads will be partially illuminated on their approach to the roundabout. In terms of lighting design requirements, Sheriffhall Roundabout is classified as a conflict area and will be lit across the full extents. Road lighting will also be provided on the side road approaches to the roundabout.

6.2.8 Intelligent Transport Systems including traffic detection systems and CCTV will be provided throughout the scheme to support operations and improve users' experience.

6.2.9 A potential construction sequence which considers how the scheme could be constructed whilst maintaining traffic flows on all roads, has been identified for assessment purposes. To minimise disruption and delay on the network, comprehensively planned traffic management would be anticipated to be required during some phases, including diversions during the overnight partial closure of the roundabout during construction of the new A720 bridges.

6.3 Traffic and Economic Assessment

6.3.1 The principal operational benefits of the scheme would be to improve the movement of traffic on the A720 between Gilmerton and Old Craighall by providing grade-separation of the A720 at the existing Sheriffhall Roundabout and reducing the conflict between strategic and local traffic.

6.3.2 The operational assessment indicates that average journey times on the A720 during the AM peak hour would decrease by 6% (0.5mins) and 15% (3.9mins) in the eastbound and westbound directions respectively. During the PM peak hour, the corresponding average journey times would decrease by 61% (11.7mins) and 36% (10.3mins). During the 14-Hour average weekday, average journey times would decrease by 35% (3.9mins) and 26% (3.9mins) in the eastbound and westbound directions respectively. Overall, the proposed scheme would reduce journey times through the junction for A720 strategic traffic.

6.3.3 The operational assessment also indicates that average journey times on the A7 during the 14-Hour average weekday period would decrease by 30% (2.7mins) and 23% (1.7mins) in the northbound and southbound directions respectively. The average journey times on the A6106 during the 14-Hour average weekday period would decrease by 8% (0.2mins) and 72% (7.0mins) in the northbound and southbound directions respectively. Overall, the proposed scheme would reduce journey times through the junction for A7 and A6106 local traffic.

6.3.4 The total scheme cost including risk, optimism bias, an adjustment for construction price inflation, preparation and supervision costs is estimated to be £125.222m in Q4 2018 prices, including real cost adjustments through to construction.

6.3.5 The results of the TUBA assessment indicate that the scheme would generate a Net Present Value of £417.799m with a Benefit to Cost Ratio of 5.917 over the 60-year assessment period. In accordance with Value for Money Guidance, schemes which generate a BCR greater than 4.00 are considered to represent very high value for money.

6.3.6 The results of the NESA accident assessment based on the application of default accidents indicate that the provision of the proposed scheme would generate a £1.691m accident benefit over the 60-year assessment period.

6.3.7 The results of the combined assessment indicate that the scheme would generate a Net Present Value of £419.490m with a Benefit to Cost Ratio of 5.937 over the 60-year assessment period.

6.3.8 A series of sensitivity tests was undertaken to examine the effects of changes in the traffic growth forecasts considered in the TUBA economic assessments and NESA accident assessments. Including the effects of Construction Price Inflation, the results of the TUBA sensitivity tests indicate that the proposed scheme would generate a BCR of 1.252 even with zero growth in traffic after 2017 and a BCR of 5.800 in the 2024 fixed matrix assessment which excludes the effects of additional traffic due to grade-separation. The results of the NESA accident sensitivity test based on the application of local accident data indicate that the provision of the proposed scheme would generate a £6.170m accident benefit over the 60-year assessment period.

6.4 Satisfying the Scheme Objectives

6.4.1 The scheme has been developed to meet the scheme objectives detailed in Section 1.2. The following paragraphs detail how the scheme meets and satisfies each objective.

A. Improve the movement of traffic on the A720 between Gilmerton and Old Craighall by providing grade separation of the A720 at the existing Sheriffhall Roundabout

6.4.2 The operational traffic assessment has found that the provision of grade separation at Sheriffhall would significantly improve traffic conditions at Sheriffhall Roundabout and reduce overall journey times on the A720. The traffic assessment indicates that during peak periods journey times will typically reduce by approximately 0.5 minutes eastbound and 3.9 minutes westbound in the morning, and 11.7 minutes eastbound and 10.3 minutes westbound in the evening in 2024.

B. Reduce the conflict between strategic and local traffic.

6.4.3 The scheme will reduce the conflict between strategic and local traffic by removing the at-grade junction and providing grade separation. The existing junction arrangement requires traffic on the A7 and A6106 local roads to cross the A720 trunk road at-grade. The proposed scheme provides grade separation which will remove this conflict. A comprehensive traffic survey was undertaken in 2017, the results of which indicate that approximately 75% of A720 traffic passes through Sheriffhall Roundabout and continues on the A720. Similarly, around 50% of local traffic passes through the roundabout without joining the A720. The removal of approximately 75% of strategic traffic from the roundabout will significantly reduce the conflict between strategic and local traffic. Approximately 69,000 vehicles were recorded passing through the Sheriffhall junction in 2017 during the 14-hour period between 6:00am and 8:00pm. Almost 11,400 vehicles crossed the Sheriffhall Roundabout without joining the A720. Post scheme-opening, these movements will have reduced journey times across the A720 due to the removal of conflicting movements.

C. Minimise traffic impact of local proposed developments in Midlothian, East Lothian and City of Edinburgh on the A720 between Gilmerton Junction and Old Craighall Junction and approach roads.

6.4.4 Traffic modelling has been undertaken to determine the impact of local proposed developments. Considering the predicted traffic growth derived from regional models, including additional trips generated by proposed developments, the results from the traffic models indicate that the existing Sheriffhall Roundabout and local road network will experience significant operational stress during peak periods by the year 2024, with demand exceeding capacity. The scheme will address the bottleneck on the strategic road network by improving operating conditions at Sheriffhall and help to reduce the traffic impact of proposed developments in the area. The grade separation at Sheriffhall will also help facilitate future development in the surrounding area, such as the proposals contained in The Midlothian Local Development Plan (2017).

D. Improve road safety for all users on the A720 and approach roads between Gilmerton Junction and Dalkeith Northern Bypass.

6.4.5 The removal of the at-grade Sheriffhall roundabout will reduce conflict points between strategic and local traffic and hence improve road safety. Examination of accident records at this location over the last ten years indicates there has been a concentration of predominantly slight personal injury accidents and a limited number of serious personal injury accidents on the approaches to Sheriffhall roundabout and on the circulatory carriageway. The results from the NESA accident model indicate that the proposed scheme would reduce the number of personal injury accidents on the modelled network by 127 accidents over the 60-year assessment using standard default accident rates. The junction layout also provides separate dedicated NMU facilities incorporating links and underpasses, which will improve safety for NMU users through improved separation from motorised users.

E. Minimise intrusion of the new works on the natural environment, cultural heritage and people whilst enhancing the local environment where opportunities arise.

6.4.6 The Environmental Statement reports the findings of the Environmental Impact Assessment (EIA) for the scheme. As a result of the EIA, a range of measures has been incorporated into the design of the scheme to prevent, reduce or offset significant adverse environmental effects. The Environmental Impact Assessment has found that the proposed mitigation measures reduced the impact of the scheme leading to no significant residual adverse impacts on cultural heritage assets, road drainage and the water environment, regional and local air quality and climate change (i.e. Greenhouse Gas Emissions) during operation of the scheme. Particularly, with respect to air quality, there would be no receptors that experience an exceedance of any national objectives explicitly because of the scheme. Overall the impact on local air quality is imperceptible. Large adverse effects are predicted on one property in relation to visual impact after establishment of landscape mitigation planting and resulting from land take required for the scheme. There will be significant residual beneficial impacts on the amenity of the NMU routes, the views from the A720 and the driver stress on the A720. The development of the drainage design and the requirement for provision of flood compensation storage has provided an opportunity to create enhanced ecological habitats. The design was developed to ensure that the Sustainable Drainage Systems (SuDS) ponds to the south of the A720 could create functionally linked ecological areas and the use of native seed mixes and planting native trees and shrubs will provide further gains in floristic diversity, much enhanced beyond the existing more species-poor grassland habitats.

F. Facilitate integration for different modes of transport along and across the A720 corridor between Gilmerton Junction and the Dalkeith Northern Bypass.

6.4.7 The scheme will assist with the integration of public transport and adjacent Shawfair Park and Ride site by removing the barrier created by the congested at-grade roundabout. SESplan recognises that Sheriffhall roundabout currently acts as a major barrier to active travel between Midlothian and southern Edinburgh. SEStran identified Sheriffhall as one of the missing links to the Strategic Cycle Network and also highlighted issues for consideration, including improving the efficiency of bus links to the Shawfair Park and Ride and segregated cycle links across the bypass. Due to traffic delays experienced on the approaches to Sheriffhall roundabout, bus services allow more time on route timetables for services crossing the A720 at Sheriffhall. Lothian Buses have indicated that the junction improvements and associated reduction in traffic delays should reduce journey times for its services that operate between the A7 North and A6106 South. The scheme also provides enhanced NMU provision to encourage increased modal shift. Traffic counts show that the current numbers of NMU users crossing the junction are less than 20 per day. NMU proposals have been developed extensively in conjunction with local NMU stakeholders to provide an exemplar scheme which is considered will encourage a much greater NMU usage.

G. Reduce severance by improving accessibility across the A720 for all users.

6.4.8 During consultation work undertaken during scheme development, stakeholders highlighted that the existing A720 at Sheriffhall acts as a barrier; the scheme to grade separate Sheriffhall will remove this barrier and improve accessibility across the A720 for all users. As noted for Objective B, in 2017 approximately 75% of A720 traffic was observed to pass through Sheriffhall Roundabout and continue on the A720. Similarly, nearly 50% of local traffic passed through the roundabout without joining the A720. The removal of 75% of strategic traffic from the roundabout will greatly reduce the barrier created by the presence of the at-grade A720 which has also been highlighted by relevant stakeholders as a major barrier to active travel. The fully grade separated NMU facilities will remove the current severance to cyclists and pedestrians. This has been found to result in a large beneficial impact on the NMU routes within the area. In addition, key desire lines between the A7 South and A7 North, and A6106 Old Dalkeith Road and A7 North will be reduced in length.