Department for Infrastructure

STAGE 2 SCHEME ASSESSMENT REPORT - PREFERRED OPTIONS REPORT

A29 Cookstown Bypass

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PUBLIC

Department for Infrastructure

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ABOUT THE DEPARTMENT FOR INFRASTRUCTURE

The Department for Infrastructure (DfI) (formerly TransportNI and Roads Service) plays a significant role in facilitating the safe and convenient movement of people and goods throughout the province and the safety of road users, through the delivery of road maintenance services and the management and development of the transport network. It also informs the Department's policy development process to ensure that measures to encourage safe and sustainable travel are practical and can be delivered.

DfI's purpose statement is: 'Every day connecting people safely, supporting opportunities and creating sustainable living places.'

DfI is responsible for the maintenance of over 25,000km of public roads together with about 9,700km of footways, 5,800 bridges, 271,000 street lights and 51 Park & Ride/Park & Share (P&R/P&S) public car parks. It also has responsibility for the development of the transport network and a range of transport projects designed to improve network safety, sustainability and efficiency.

The key objectives of DfI are to:

- manage, maintain and improve the transport network to keep it safe, efficient, reliable and sustainable
- promote increased customer satisfaction with the services delivered by DfI
- work constructively with DfI's key stakeholders to support the delivery of high quality services
- develop DfI's capacity and capability to meet objectives
- ensure effective management of DfI's budget, assets and corporate governance arrangements
- improve DfI's resilience in responding to emergencies.

For the purposes of this report, references to DfI shall be read as references to its former TransportNI or Roads Service brand.

Further information about DfI is available on the website, please visit: https://www.infrastructure-ni.gov.uk/

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1. INTRODUCTION

Cookstown is located approximately 40km west of Belfast in County Tyrone. The existing A29 runs north to south through the centre of Cookstown, connecting Coleraine on the north coast to Cookstown, Dungannon and onwards to Armagh City as shown in Figure 1-1 and Figure 1-2 below in context with the existing road network.

The Department for Infrastructure's (DfI's) main objective for the scheme is to relieve congestion in the town centre of Cookstown. The A29 Cookstown Bypass proposal is to provide a direct strategic link between the A29 Moneymore Road to the north of Cookstown and Loughry Roundabout to the south of the town. The scheme includes improvements to the existing link between A505 Drum Road and Loughry Roundabout (hereafter referred to as Sandholes Link Road).

The A29 through Cookstown acts as a main distributor road with minor lateral roads radiating from it, serving both strategic (through) traffic and local traffic. These conflicting trips contribute to congestion, causing delays and driver frustration. The needs of public transport and non-motorised users such as cyclists and pedestrians add to the congestion.

The removal of through traffic from the town centre would reduce conflict between strategic and local traffic, reduce congestion and improve road safety for all users. The current adverse effects of severance, noise, air quality and the impact on townscape are also likely to be reduced. It is expected to improve the quality of life for residents and make the town more attractive to visitors and shoppers.

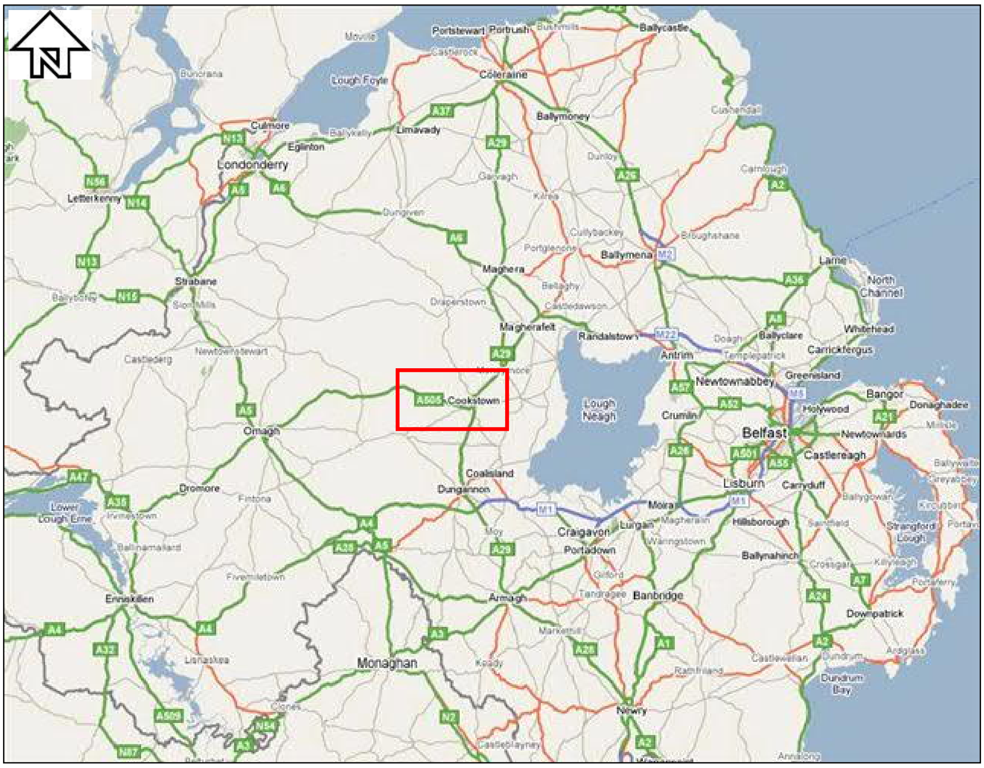

Figure 1-1 - Cookstown Location Plan (in red) – Northern Ireland Context

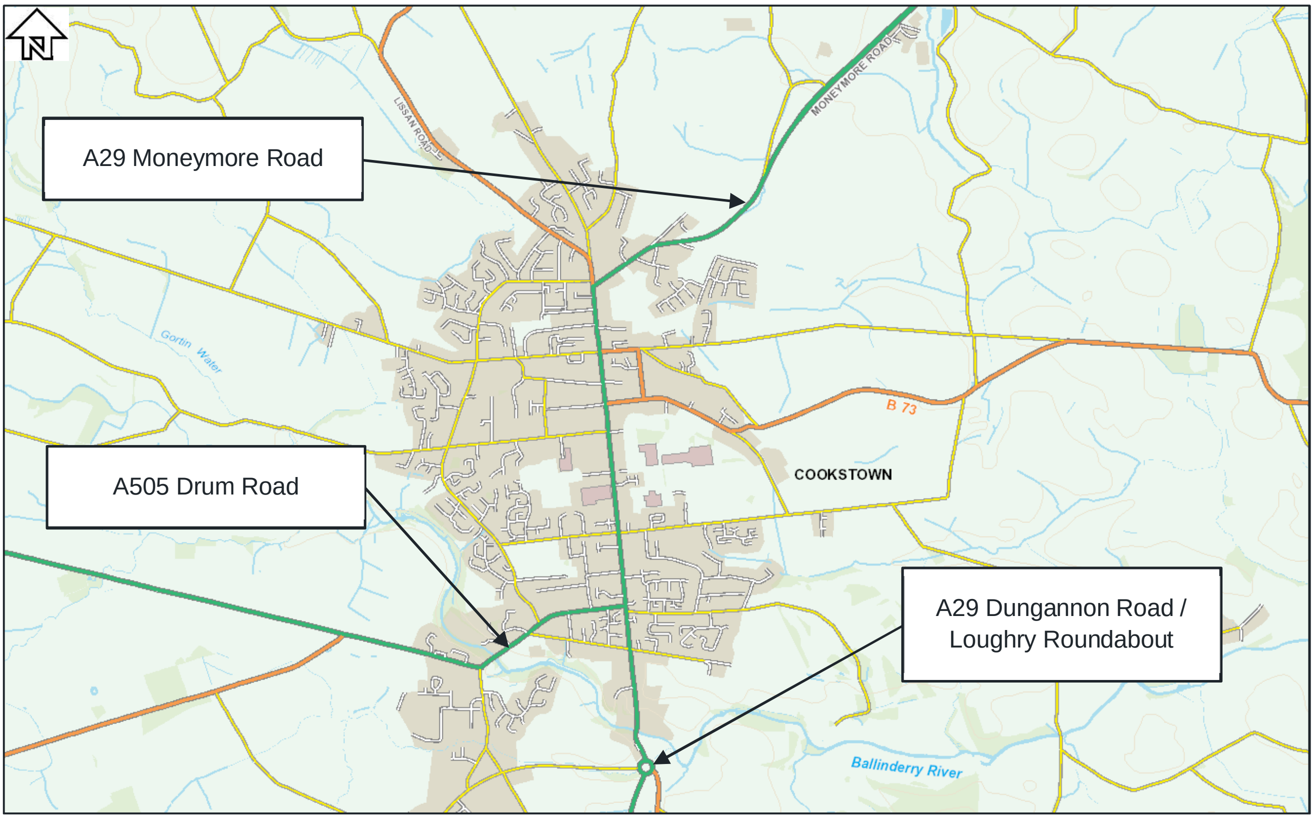

Figure 1-2 - Cookstown Location Plan – Existing Major Road Network

1.1. THE REGIONAL STRATEGIC TRANSPORT NETWORK

The Regional Development Strategy for Northern Ireland 2035 (RDS) guides the future development of Northern Ireland. The RDS recognises the key role that the Regional Strategic Transport Network (RSTN) has to play in achieving the social, economic and development goals in Northern Ireland.

The Regional Transportation Strategy for Northern Ireland 2002-2012 (RTS); identifies strategic transport investment priorities, potential funding sources and affordability of planned initiatives. A revised strategy document, 'Ensuring a Sustainable Transport Future - A New Approach to Regional Transportation', was published in 2012. One of its main Strategic Objectives is to "*improve connectivity within the region*" by completing the work identified in the current Regional Strategic Transport Network Transport Plan (RSTN TP) and Strategic Road Improvement (SRI) Programme.

The RTS supports and complements the RDS 2035 and aims to achieve its vision for transportation, "*to have a modern, sustainable, safe transportation system which benefits society, the economy, and the environment and which actively contributes to social inclusion and everyone's quality of life*."

The RSTN TP 2015 is based on guidance in the RDS and RTS. The plan presents a range of multimodal transport initiatives to manage, maintain and develop Northern Ireland's Strategic Transport Network and proposes SRIs to: "*Remove bottlenecks on the key road network where lack of capacity is causing congestion; and improve the environment by providing town bypasses, relieving the effects of heavy through traffic*."

The RSTN comprises the complete rail network, five Key Transport Corridors (KTCs), four Link Corridors, the Belfast Metropolitan Transport Corridors and the remainder of the trunk road network. The A29 is a trunk road (T15) and been classified as one of the four Link Corridors in the RSTN.

The A29 through Cookstown acts as a main distributor road with minor lateral roads radiating from it, serving both strategic (through) traffic and local traffic. These conflicting trips contribute to congestion, causing delays and driver frustration.

Improvements to the network aim to improve journey time and reliability for road users travelling within and through Cookstown, improve road safety, relieve traffic congestion, enhance connectivity and unlock the economic potential of the region.

1.2. INVESTMENT STRATEGIES AND DELIVERY PLAN

In 2008, the Strategic Investment Board announced the updated Investment Strategy for Northern Ireland (ISNI) 2008-2018 which outlined the Government's chief objectives for infrastructure investment. The strategy envisaged an investment of £2.5 billion in SRIs up to 2018.

Due to the envisaged additional investment, DfI produced an associated document listing additional projects to define an Expanded SRI programme to further improve the motorway and trunk road network, known as 'Expanding the Strategic Road Improvement Programme 2015'. Together with the Investment Delivery Plan (IDP) 2008, these documents show how the Investment Strategy for Northern Ireland would be implemented.

An improvement to the A29 trunk road was included in the Investment Delivery Plan (IDP) as a strategic road improvement in the forward planning schedule. This consists of major highway schemes which could be started in the next 10 years, subject to clearing the statutory procedures, satisfactory economic appraisal and the availability of funds.

1.3. SCHEME OBJECTIVES

The following four criteria, as set out in the Transport Analysis Guidance, are the overarching main objectives for transport:

- Economy - to support sustainable economic activity and get good value for money
- Environment - to protect the built and natural environment
- Social - to improve safety, accessibility and integration
- Public Accounts - to consider the cost to the broad transport budget.

The Project Specific scheme objectives aim to achieve the following:

- To relieve traffic congestion within Cookstown.
- To reduce journey travel times along the A29 corridor.
- To improve the road network between the north and south of the Province.
- To improve road safety
- To improve the quality of life for the majority of residents.
- To improve the town centre environment.
- To minimise the impact on the natural and built environment.
- To enhance the economic growth of the area
- To achieve value for money as demonstrated through a net positive return on investment.

1.4. PURPOSE OF THE REPORT

This report has been compiled in line with recommendations contained in the Design Manual for Roads and Bridges (DMRB) document TD37/93 – Scheme Assessment Reporting. It is noted that TD37/93 has been withdrawn from DMRB (October 2019) however the publication of DfI Director of

Engineering Memorandum in September 2020 (DEM) 182/20 intends to retain its use in lieu of other standards for Scheme Assessment Reporting.

The overarching aims of assessment reporting are to "*permit consideration of the likely environmental, economic and traffic effects of alternative proposals, and to allow the public and statutory bodies to comment on proposals taking account of their environmental, economic and traffic implication*".

Stage 2 reporting specifically aims to "*identify the factors 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 routes or schemes*".

This report will provide a non-technical summary of the Stage 2 assessment and make recommendations on a Preferred Scheme to be brought forward to the next stage.

2. SCHEME BACKGROUND

2.1. OVERVIEW

In June 2007, Roads Service - now DfI commissioned Mouchel Parkman, now WSP, to assist in the development of an A29 Cookstown Bypass and completion of statutory procedures.

The Stage 1 Scheme Assessment Report (SAR1) was undertaken and published in November 2008, recommending development of Route Options to the east of Cookstown. The SAR2 was completed in March 2010 and in June 2010 the Emerging Preferred Route was announced and presented via a Public Information day.

Further development of the Preferred Route ceased in 2011 due to lack of funding until October 2016, when the then Minister for Infrastructure announced funding would be made available to bring forward the development of a number of capital works schemes which included the A29 Cookstown Bypass. The A29 Cookstown Bypass scheme consists of the town bypass and improvements to Sandholes Link Road.

2.2. SUMMARY OF PREVIOUS REPORTS INCLUDING STAGE 1 SCHEME ASSESSMENT REPORT

An eastern distributor route to relieve the town centre was identified in the East Tyrone Area Plan 1974-1994 (published 1978). Part of this route, between the A29 Moneymore Road and Old Coagh Road, named the East Circular Road, has been constructed. In September 2004, Atkins issued a Scheme Appraisal for Cookstown Eastern Distributor Road. This report developed the findings of a JMP Consultants Cookstown Transportation Study, prepared in March 1999, and detailed a proposed route for strategic traffic, the Eastern Distributor Road, including horizontal and vertical alignments, and an Appraisal Summary Table (AST) using the New Approach to Appraisal for Highways projects. A proposal for a Sandholes Link Road was also included as a means of further reducing through traffic in the town centre by making the proposed eastern distributor more attractive for traffic travelling to / from Omagh, via the A505 Drum Road.

The Eastern Distributor Road and Sandholes Link Road were included in The Cookstown Area Plan 2010 (Adopted Plan), and the A29 Cookstown Eastern Distributor was listed within the Regional Strategic Transport Network Transport Plan (RSTN TP) 2015 and the Investment Delivery Plan (IDP) as a strategic road improvement in the forward planning schedule. This consists of major highway schemes which could be started in the next 10 years, subject to clearing the statutory procedures, satisfactory economic appraisal and the availability of funds.

Following publication of the Cookstown Area Plan 2010 in June 2004, a Cookstown Local Transport Study was prepared by Jacobs Babtie (dated September 2005). This study focused on the needs of local traffic, but also listed an Eastern Distributor Road, Sandholes Link, and an eastern bypass as possible means of reducing problems in the town centre.

After a review of the previous reports and studies, it was agreed that alternatives to the Eastern Distributor Road should be considered. A Stage 1 Scheme Assessment in accordance with DMRB TD37/93, Scheme Assessment Reporting was undertaken to assess the environmental, engineering, economic and traffic benefits, dis-benefits and constraints of broadly defined improvement corridors to the east and west of Cookstown (drawing reference 718314-WSP-B-D-0800-0164 in Appendix A shows the extent of these corridors). The findings of this assessment were published in November 2008 in the A29 Cookstown Bypass Stage 1 Scheme Assessment Report - Constraints Report (SAR1).

The SAR1 concluded that the Eastern Corridor offered the best options for a bypass close to the town and for alternatives that extend out beyond the existing and future development and industry identified in the Area Plan. The Eastern Corridor also includes the option of improving the existing road network between the Sandholes Road and the A505 Drum Road.

Bypass options within the Western Corridor were found to be considerably longer than those to the east due to existing development and the alignment of the existing A29 to the north east of the town centre. The assessment also highlighted the particular significance of the Upper Ballinderry River Special Area of Conservation (SAC) and Area of Special Scientific Interest (ASSI). There are also more significant flood plains and low-lying areas within the Western Corridor.

Improvements to the existing A29 through the town centre were considered and discounted early in the feasibility stage. Improvement options would be significantly constrained by existing development and the local road network, and the current adverse effects of severance, noise, air quality and the impact on townscape would remain, or are likely to deteriorate further.

The SAR1 recommended that alternative bypass route options within the Eastern Corridor including improvements to the Sandholes Link Road were developed, and that a Stage 2 scheme assessment in accordance with TD37/93, is undertaken to assess the engineering, environmental, economic and traffic benefits, dis-benefits and constraints associated with these route options, with a recommendation for a Preferred Route to be developed at Stage 3.

Roads Service Board (now Roads and Rivers Management Group) approval for the scheme to move into the Preparation Pool was granted in December 2008. This is a list of high priority major highway schemes which could be started in the next 5 years, subject to clearing the statutory procedures, satisfactory economic appraisal and the availability of funds.

Subsequent to receiving Gateway Approval, a Stage 2 scheme assessment was undertaken in accordance with TD37/93 and Roads Service Policy and Procedure Guide RSPPG_E030, Major Road Improvement Schemes: Inception to Construction. The SAR2 identified a preferred route for the bypass which was announced in June 2010.

Due to lack of funding limited development on the Preferred Route design was undertaken post 2010.

2.3. SCOPE OF THIS REPORT

Due to the intervening timeframe between initial selection of the Preferred Route in 2010 and recommencement of the scheme in 2018, the decision to prepare a new Stage 2 assessment was agreed with DfI (previously Roads Service).

2.4. SCHEME TIMEFRAMES

For the development purposes of this document, a construction timeframe has been assumed of approximately eighteen months commencing on site in the Autumn of 2023. This is subject to statutory procedures and funding availability. The schemes opening year is therefore 2025 with a design year of 2040. Refer to section 7.2.1 for timeframe dates and assumptions.

3. EXISTING CONDITIONS

3.1. INTRODUCTION

Cookstown has an estimated population of 11,600[1]. Retail, commercial and leisure facilities are largely focused along the existing A29 and residential areas surround the town centre. The main areas of industry are located to the south-west and north-east of the town.

The A29 runs north to south through the centre of Cookstown, serving both strategic and local traffic. There are four principal ('A' or 'B' class) roads which join the A29 in Cookstown including:

- A505 Drum Road from Omagh
- B520 Tullywiggan Road from Stewartstown
- B73 Coagh Road from Coagh
- B162 Lissan Road from Draperstown

Further details are shown on drawing reference 718314-WSP-B-D-0000-0038 in Appendix A.

3.2. EXISTING ENGINEERING CONDITIONS

3.2.1. GENERAL (A29)

The existing road network is shown on drawing 718314-WSP-B-D-0000-0038 in Appendix A and the existing A29 has been described from south to north.

To the south-west of Cookstown, A29 Dungannon Road has links with Sandholes Road, serving predominantly industry, and B520 Tullywiggan Road via Loughry Roundabout. The traffic speed at the roundabout is National Speed Limit (60mph). North of the roundabout, a 30mph speed limit applies south of Kings Bridge carrying the A29 over the Ballinderry River. Retail outlets, commercial and residential properties border the A29 between the roundabout and the junction with Sweep Road and Castle Road. This section of the A29 consists of single carriageway, approximately 8m wide with 2m wide footways on both sides of the road, and ghost island junctions at the accesses of several of the retail and commercial properties.

From the signalised junction at Sweep Road / Castle Road to the ghost island junction with Fairhill Road, the A29 consists of approximately 12m wide single carriageway with a hatched central area, with provision for on street parking parallel to the kerb on both sides of the road. There are wide footways on both sides of the road, and pedestrian refuges opposite footway buildouts. Segregated off-road cycle routes are provided on both sides of the carriageway, from the junction of Loy Street / Fairhill Road south to outside Holy Trinity College on the west side of the carriageway, and junction of Fountain Road on the east side of the road. Segregation with a solid white line (delineated) and corduroy paving is used to inform cyclists and pedestrians of the layout of the facility. The majority of land use along this section of road is residential with some retail premises scattered throughout.

Approximately 40m north of the junction with Fairhill Road, the A29 widens into two 8.5m wide carriageways, each with two traffic lanes, separated by a 1.5m hatched central area. This develops

[1] Sourced from 2011 Census: Census Office for Northern Ireland. July 2015. Usual Resident Population: KS101NI (Settlement 2015). [Online]. [10 September 2020]. Available from: https://www.ninis2.nisra.gov.uk/public/PivotGrid.aspx?ds=6609&lh=74&yn=2011&sk=136&sn=Census%202011&yearfilter=

into a kerbed central reserve north of the signalised junction with Molesworth Road. There is an additional 5m width of (echelon) parking bays orientated at a skew angle to the flow of traffic and 3.5m wide footways on both sides of the road. This section of the A29 passes through the town centre, it has several official names including Oldtown Road, William Street, Loy Street and Church Street, however, is known locally as Main Street. Retail and commercial properties are located along both sides of the road.

From the signalised junction with Orritor Street / Coagh Street, the A29 continues north towards a double mini-roundabout junction with Morgans Hill Road / Lissan Road. The carriageway cross section reduces to approximately 12m wide single carriageway 100m north of the junction of Orritor Street and Coagh Street with on street (parallel) parking, and 4m wide footways on both sides of the road. The land use on either side of the A29 changes from commercial and retail premises in the town centre, to residential housing with direct private driveway access onto the A29.

Beyond the junction of Morgans Hill Road and Lissan Road, the A29 Moneymore Road continues north east through a predominantly residential area. The speed limit increases to 40mph in advance of a T-junction with East Circular Road. The A29 continues in a north easterly direction with the speed derestricted to the north east of a lay-by on the southbound carriageway. Beyond this, the A29 becomes a 3.5km section of rural dual carriageway with hard shoulders and central reservation towards Moneymore.

3.2.2. ALIGNMENT OVERVIEW (A29)

The horizontal alignment of the A29 is virtually straight through Cookstown whilst the vertical alignment is undulating, with an overall rise of 31.5m from approximately 45.8m above ordnance datum (AOD) at Loughry Roundabout to 77.3m AOD at the junction with Morgans Hill Road and Lissan Road. Crests are located directly north of the junction with the A505 Drum Road, at the junctions with Convent Road and Fairhill Road and between the junctions with Orritor Street and Coagh Street and Morgans Hill Road and Lissan Road. North-east of the junction with Morgans Hill Road and Lissan Road, the A29 falls to approximately 56.6m AOD at the start of the dual carriageway.

3.2.3. MINOR ROAD JUNCTIONS (A29)

Junctions along the existing A29 are mixed depending on the traffic volumes and demands of the minor roads.

There are four independently operating traffic signal controlled junctions on the A29 through Cookstown, located at the junctions of the A29 with Sweep Road / Castle Road; Cemetery Road / Fountain Road; Molesworth Street and Coagh Street / Orritor Street. DfI have advised that the operation of the signals is regularly monitored and reviewed in order to optimise the timings.

To the north Morgans Hill Road and Lissan Road join the A29 by means of a double mini roundabout and there are numerous major / minor priority junctions utilising ghost island layouts as well as simple T-junctions.

There are numerous private accesses and driveways with direct access on to the A29.

3.2.4. ROAD LIGHTING (A29)

The A29 is illuminated along its length through the town centre from Loughry (A29 Dungannon Road) Roundabout to the south east extent of the lay-by on Moneymore Road.

3.2.5. NON-MOTORISED USER FACILITIES (A29)

The A29 through Cookstown is used by public transport with bus stops in the town centre located at footway buildouts and bays marked out within the nearside traffic lane.

Footway provision along the A29 has been outlined in section 3.2.1. There are two formal pedestrian crossing points, a signal-controlled crossing north of Convent Road and an uncontrolled (zebra) crossing north of Burn Street. Beyond the town centre pedestrian facilities typically terminate at the outermost housing developments, with widths varying between 1 – 2m.

The National Cycle Route Sustrans 95 passes through the study area via Cookstown town centre using Clare Lane / Cloghog Road / Fountain Road in the east to Fairhill Road / Tullagh Road in the west via Cookstown Leisure Centre and Loy Street. A second cycle route uses part of the existing A29 from the junction of Fairhill Road / Tullagh Road to Coolreaghs Road in the north, known as the Lough Fea Cycle Route, part of “The Sperrins Cycle Routes”.

3.2.6. GENERAL (SANDHOLES LINK)

Sandholes Road extends east of Loughry Roundabout as a two-lane single carriageway with an approximate 3m wide shared footway / cycleway on the eastbound carriageway. National Speed Limit applies (60mph). A minor road, also known as Sandholes Road, links this east-west Sandholes Road to the A505 Drum Road, in a north-south direction. This report refers to the north-south minor road as Sandholes Link Road.

Sandholes Link Road has a concentration of industrial units on the west side and a mixture of industry and residential on the east. It is illuminated and consists of single carriageway (approximately 6.0m width) with a 2-3m shared footway / cycleway on the west side of the carriageway over its full length (i.e. southbound direction of travel). A footway of approximately 1-2m width is provided between the residential properties of Old Rectory Park and A505 Drum Road on the east side of the carriageway (i.e. northbound direction of travel). There are numerous existing single accesses along its length for commercial premises and residentials properties.

Sandholes Link Road connects to A505 Drum Road via a major-minor priority junction, with a segregated turning lane for northbound traffic wishing to travel west along Drum Road, also facilitating turning movements from Drum Road onto Sandholes Link Road. The speed limit is 30mph from A505 Drum Road to just south of the left-right staggered junctions with Derrylornan Industrial Estate and Old Rectory Park, after which National Speed Limits apply (60mph).

Sandholes Link Road connects to the east-west Sandholes Road through a simple major-minor junction approximately 320m south of the junction with Strifehill Road. Strifehill Road, an unlit and un-lined narrow road, connects to both Sandholes Road and Sandholes Link Road with major / minor priority junctions.

3.2.7. ALIGNMENT OVERVIEW (SANDHOLES LINK)

Sandholes Link Road has a predominantly straight horizontal alignment from the A505 Drum Road to its junction with Strifehill Road south of the Fairy Burn watercourse, where it changes direction to join with Sandholes Road, in a south-westerly direction.

Its vertical alignment undulates along its length with an approximate level of 59.97.5m AOD at the junction with Sandholes Road. The level reduces to 53.3m AOD forming a sag curve where the road crosses the Fairy Burn. The road rises again to a crest of 62.7m AOD before falling back to a level of 54.4m AOD at the junction with the A505 Drum Road.

3.2.8. STRUCTURES

The structures identified within the study area from DfI's structures inventory plan include corrugated steel pipe culverts as well as single and multi-span masonry arch bridges. Derrylornan Bridge has two spans with Kings Bridge and Kidd's Bridge (where B73 Coagh Road crosses a disused railway) both have three spans. Kidd's Bridge is listed as an Historic Building (ref: HB09/13/037) within the Northern Ireland Buildings Database.

Existing structures are illustrated on drawing reference 718314-WSP-B-D-0800-0165 in Appendix A.

3.2.9. HYDROLOGY

The principal watercourse in the area, the Ballinderry River, flows in a north-west to south-east direction south of Cookstown, with its corresponding flood plain constrained between drumlins. Approximate levels of the Ballinderry River downstream of Derrylornan Bridge (on A505 Drum Road) is 44.5m AOD and downstream of the Ballinderry Bridge (on A29 Dungannon Road) is 40.2m AOD. The Ballinderry River flows into Lough Neagh on its west shore between the villages of Ballyronan and Ardboe.

One of the main tributaries of the Ballinderry River is the Fairy Burn which is in the west of the study area flowing west to east beneath Sandholes Link Road connecting with the Ballinderry River to the north-east of Loughry Roundabout.

There are also a number of other designated and undesignated watercourses flowing through the study area including Fountain Road Stormwater Drain and Molesworth Road Stormwater Drain in the vicinity of Killymoon Road. The predominant flow direction is west to east.

Drawing references 718314-WSP-B-D-0500-0014 to 0017 and 0031 in Appendix A show the location of these watercourses.

3.2.10. TOPOGRAPHY

The character of the Cookstown area is dominated by drumlins with an approximate maximum elevation of 20m above the surrounding landscape. Ground levels vary between 55 and 85m AOD north of Castle Road and between 35 and 50m AOD south of Castle Road. Drumlin side slopes vary greatly within the range 1(v):10(h) to 1(v):15(h) on the elongated slopes and 1(v):4(h) to 1(v):6(h) on the steep sides. The steepest slopes east of the town in the proximity of the proposed Route Options are found on the banks of the Ballinderry River just south of the Waste Water Treatment Works.

Flat, boggy ground is associated with the inter-drumlin hollows and valleys of the Ballinderry River in the south west of the study area, and Lissan Water to the north east (just outside the study area). Streams within the area are steeply incised through the Glacial Till and wind their way through the drumlin topography. Undulating areas away from the floodplains are characteristic of glacial sand and gravel deposits

The existing minor road network is predominantly at grade following the contours of the ground with the exception of Loughry Roundabout to the south of Cookstown which is on embankment, and A29 Dungannon Road leading to this junction in cutting.

3.2.11. GEOLOGY

Drift deposits in the study area predominantly comprise Glacial Till, with other deposits presently locally and/or overlying the Glacial Till, as presented in drawing reference 718314-WSP-B-D-0600-0006 in Appendix A, Drift Geology.

It should be noted that some of the more isolated deposits, encountered locally by the GI carried out to date, are not shown on the aforementioned drawings given the scale of the drawings. However, they are included in the undernoted generalised sequence of strata across the study area.

Table 3-1 - Description Summary of Existing Geology

Geological Unit	Typical Description	Depth Encountered from (m bgl)	Typical Thickness (m)	Anticipated Location
Topsoil	Soft to firm, dark brown, slightly sandy, slightly gravelly CLAY with rootlets.	0.0	0.2 - 0.5	Across Study Area
Made Ground	Firm, brown, slightly sandy, gravelly CLAY, with high cobble content. Some locations with concrete, brick, tile and rubble fragments.	0.0 -0.1	2.0-3.0	Isolated areas including infilled railway cuttings, roads
Peat	Soft, black, fibrous PEAT.	0.3 – 0.6	0.2- 0.9	Isolated areas, including near Loughry Roundabout, and Kidds Bridge
Alluvium	Very loose to loose, light brown to reddish brown, slightly silty, slightly clayey, slightly gravelly, fine to coarse SAND. Firm, reddish brown, slightly sandy, slightly gravelly CLAY.	0.3 – 0.4	3.0 – 7.5	Generally localised around waterbodies
River Terrace Deposits	Stiff to very stiff, reddish brown, slightly sandy, slightly gravelly CLAY with low to medium cobble content	3.0	13.5	Ballinderry River, Lissan Water
Glaciofluvial Deposits	Soft to very stiff, reddish brown, slightly sandy, slightly gravelly CLAY with low to medium cobble content. Loose to very dense, greyish brown, clayey, sandy, GRAVEL with medium cobble content.	0.1	9.40+	Northern extent of Study Area near Moneymore Road, and southern extent of Sandholes Road and
Glacial Till	Firm to stiff, red brown, silty, slightly gravelly, sandy CLAY with low to medium cobble content. Firm to very stiff, light brown to orange brown, sandy, gravelly SILT with frequent cobbles and boulders. Medium dense, reddish brown, gravelly, fine to coarse SAND with low cobble content	0.4 – 3.0	20+	Predominant lithology throughout the Study Area

Geological Unit	Typical Description	Depth Encountered from (m bgl)	Typical Thickness (m)	Anticipated Location
Mudstone	Slightly to moderately weathered, weak to very weak, reddish brown MUDSTONE	11.0 – 16.5	Not proven	Ballinderry River Crossing
Sandstone	Moderately strong to weak, weathered, orange brown SANDSTONE Unweathered, grey brown to red brown SANDSTONE	0.4 - 7.1	Not proven	Bedrock underlying much of the Bypass
Limestone	Completely weathered, brown, MARL. Sandy LIMESTONE	3.5 – 5.2	Not proven	Ballinderry River Crossing

The above table also summarises the solid geology encountered below the superficial deposits. This comprises four main stratigraphic units; the Rossmore Mudstone Formation, the Derryloran and Rockdale Formations of the Tyrone Group and the Sherwood Sandstone Group as presented in drawing reference 718314-WSP-B-D-0600-0007 in Appendix A Solid Geology.

- The Rossmore Mudstone formation is located south of the Derryloran Fault, in the south of the study area. This formation consists of dark grey Mudstone, thin Siltstone and fine-grained Sandstone.
- The Derryloran Formation is shown in the south west of the study area and consists of a series of fine-grained conglomerates, and sandstones. This formation includes 3m diameter dolomitized sandy limestone and dolomitic nodules in some of the sandstones.
- The Rockdale Limestone Formation is recorded in the central section of the study area. This lithology consists predominantly of shelly Limestone, as well as thin beds of Mudstone and Sandstone. Bedding within these formations is shown to dip shallowly in a predominantly easterly direction.
- The Sherwood Sandstone Group is shown in the north and east of the study area, with limited exposures around the railway cutting in the east (which is now infilled). It has two formations within the study area consisting of Breccia, which contains Granite, Schist, Quartz and Sandstone within a sandy matrix; and Sandstone.

Three faults are indicated to cross the proposed routes, as presented on the Solid Geology Map in Appendix A. The Derryloran Fault trends roughly west to east, south of Castle Road near the Ballinderry River. The Sandholes Link Road also traverses the Derryloran Fault.

The Killymoon Fault trends roughly north to south to the east of the study area bringing several different solid lithologies into juxtaposition.

3.2.12. HYDROGEOLOGY

Groundwater Vulnerability is a term used to represent the natural ground characteristics that determine the ease with which groundwater may be contaminated by human activities.

The Groundwater Vulnerability Map of Northern Ireland indicates that in the south of the study area, predominantly near the Fairy Burn and Ballinderry River, the site is underlain by a highly permeable geological aquifer with soils of moderate to high vulnerability. Within the central section of the study area, between Castle Road and B73 Coagh Road, the underlying aquifer has a low to moderate potential, while the northern section between the B73 Coagh Road and Moneymore Road is generally of moderate vulnerability with localised areas of moderate to high vulnerability. Groundwater was generally struck at relatively shallow depths within previous phases of ground investigation works.

3.3. EXISTING TRAFFIC CONDITIONS

3.3.1. A29 AND THE TOWN CENTRE

The A29 runs through the core retail area within the town centre. The different uses of the network conflict in the town centre where shopping, personal business and employment trips wishing to access the centre demand the same roadspace that is required for strategic or through traffic. This conflict is further compounded by the needs of the network to accommodate the demands of other road users, notably pedestrians, cyclists and public transport.

South of the town centre, between the junction of the A29 Killymoon Street / Sweep Road / Castle Road and the junction of the A29 William Street / A29 James Street / Molesworth Street (see drawing reference 718314-WSP-B-D-0800-0164 in Appendix A for location), the A29 is a wide single carriageway with a hatched central area. This acts as a traffic calming measure to through traffic by reducing lane width as well as providing width for right turn ghost islands / lanes for safe turning areas to reduce congestion. The central area has also been utilised to provide localised sheltered island areas for pedestrian crossing locations. The road frontage for this section is predominantly residential and parallel on-street parking is provided on both sides of the road.

During the traffic survey period (March 2019), the average 24-hr weekday two-way flow recorded on Chapel Street was approximately 15,500 vehicles.

The town centre may be defined by the junction of the A29 William Street / A29 James Street / Molesworth Street and the junction of Orritor Street / Coagh Street / A29 William Street. The road standard for this section changes to an urban 2-lane dual carriageway. This section supports the core retail and business area of the town. On street parking is provided on both sides of the dual carriageway, with parking being limited to short-stay, Monday to Saturday between 9:00am and 6:00pm to encourage turnover of spaces. There are 128 echelon (angled) parking bays currently over this length to include 10 disabled bays. Due to the angle of these parking bays, drivers are required to reverse into the nearside traffic lane when exiting the parking bay. Observations have shown occasional unauthorised short-term waiting / parking in the nearside lane. Both these issues impact the operation of this section of the network, with drivers predominantly using the offside lane to avoid parking and manoeuvring vehicles.

The observed average 24-hr weekday two-way traffic flow on this section, during the survey period, was approximately equal to 15,565 vehicles

North of the town centre, between the junction of Orritor Street / Coagh Street / A29 William Street and the junction of the A29 / Lissan Road / Morgans Hill Road, the A29 is a wide single carriageway with a mixture of parallel on-street parking provision and echelon parking bays on both sides of the road. The frontage development is predominantly residential.

The observed average 24-hr weekday two-way traffic flow on this section, during the survey period, was approximately equal to 15,785 vehicles.

3.3.2. LOCAL ROAD NETWORK

In general the local distributor road network serving Cookstown runs east - west, providing direct connections with the A29. It is the connection of these local distributor roads with the A29 that forms the majority of the key junctions in the town.

During the morning (AM) peak and weekday afternoons, the effect of pupils arriving and leaving schools has an impact on the operation of the A29 causing delays. Based on anecdotal evidence, the pedestrian activity associated with pupils requires assistance of traffic wardens and school crossing patrols which also interrupt the flow of traffic. There are also several regular bus services stopping along the A29 to collect / drop off their passengers.

Westland Road may be classed as a local distributor within the road hierarchy, and is a direct link between the north (Morgans Hill/ Lissan Road Junction) and the south (A505 Drum Road) of the town. It attracts through traffic bypassing the High Street, and is used by heavy goods and other commercial vehicles. During the survey period an average 24-hour weekday two-way flow of approximately 14,845 vehicles was recorded. This route is also connected to the main industrial sites in Cookstown via the A505 Drum Road, to the south and west of the town at the Ballyreagh Business Park and Derryloran Industrial Estate on Sandholes Road.

3.3.3. JOURNEY TIMES

Analysis of the journey time survey data indicates travel times between Loughry Roundabout and East Circular Road are relatively similar for the AM peak, inter-peak and off-peak periods for both directions of travel. The average journey time for these periods is approximately equal to 7 minutes and is primarily dictated by the presence of signalised junctions within the town centre.

The journey times recorded for the PM peak period were found to be considerably higher with vehicles travelling for over 10 minutes in the northbound direction and approximately equal to 7 minutes in the southbound direction. This was confirmed during site visits where it was observed that extensive queuing occurred at signalised intersections and especially at the junction of the A29 Dungannon Road with Sweep Road / Castle Road. It was observed that the queue for vehicles travelling northbound at times stretched almost the full length of the A29 through Cookstown.

3.3.4. COLLISION DATA

Six years of accident data was obtained for the Cookstown area between 17th April 2013 and 27th March 2019. This data has been used in the preparation of the economic assessment (reported in Section 7.4).

Analysis of the information revealed a number of fatalities occurred on the radial routes leading to and from Cookstown. None of the fatal accidents were found to have occurred within the settlement limits of the town.

3.4. EXISTING ENVIRONMENTAL CONDITIONS

Cookstown developed from its early 17th century origins as an agricultural market town to become an industrial base for the linen mills once prevalent along the Ballinderry River. The arrival of the railways in the 19th century brought further economic development into the area. Although activity associated with the mills and railways ceased in the 20th century, Cookstown still plays an important role as an economic and employment centre, with retail and commercial interests predominantly focused along the A29 corridor.

Settlement is concentrated around the A29 corridor in the town, with the spread of the built-up area greater to the west of the A29, however there are many farmsteads and individual dwellings scattered throughout the surrounding countryside.

Urban land uses include commercial interests along the A29, dense urban and suburban residential development, industrial estates, and occasional community open space. Footway facilities associated with urbanised areas typically terminate at the outermost housing developments.

The Cookstown Area Plan 2010 has designated several areas of land for industry and mixed business use on the east and south west periphery of the town and areas to the north, west, south and east have been designated for housing.

East of the Cookstown settlement boundary, agriculture forms the dominant land use, interspersed by farmsteads, hedgerows, watercourses, and woodland, the latter principally associated with the Killymoon Estate and Killymoon Golf Course. Green Belt designated land is also located to the east of Cookstown.

Ancient woodland has been identified east and north of Sandholes Road adjacent to the Ballinderry River (approximately 100 m east and 200 m north); also within the Ballinderry River valley within Cabin Wood (approximately 200 m east of all route options); and within the Killymoon Castle Historic Park, Garden and Demesne (approximately 300 m east of all route options). There is also one area Tree Preservation Order (TPO) adjacent to the Sandholes Link Road northern roundabout connection.

Cultural heritage interests of national significance include the statutorily protected Court Tomb (Scheduled Monument), Killymoon Estate (Historic Park, Garden and Demense), and Derryloran Church (under State Care). A number of local and regionally important unscheduled monuments are also recorded.

There is a complex network of watercourses associated with the Ballinderry River and its tributaries, which is particularly dense to the west of the town. The upper stretches of this river harbour habitats and species of European importance. Important ecological and wildlife habitats associated with the Ballinderry River and Killymoon Estate are ascribed national and local protection through Special Area of Conservation (SAC), Area of Special Scientific Interest (ASSI) and Site of Local Nature Conservation Importance (SLNCI) designation.

Cookstown is set within a wider landscape dominated by drumlins. The drumlins display a consistent, rolling character. The summit of Slieve Gallion, a prominent peak on the far eastern fringe of the Sperrins to the north, features prominently in many views. The nationally recognised Sperrin Area of Outstanding Natural Beauty (AONB), stretching from the Strule Valley in the west to the Lough Neagh lowlands perimeter in the east, is approximately 5km north west of Cookstown.

There is one National Cycle Route (95), which is an on-road cycle route using Clare Lane / Cloghog Road. There is also a shared-use off-road cycle route, located on the western side of Sandholes Road, extending from the junction with Drum Road in the north to the junction with Sandholes Road in the south.

More detailed information on the existing baseline conditions are described in section 6 of this report:

4. DESCRIPTION OF SCHEME OPTIONS

4.1. DEVELOPMENT OF ROUTE OPTIONS

4.1.1. STAGE 1 SCHEME ASSESSMENT REPORT (2008)

During Stage 1 of the assessment process, the environmental, engineering, economic and traffic advantages, disadvantages and constraints of broadly defined improvement corridors to the east and west of Cookstown were identified and assessed. This process included formal consultation with a range of Statutory and Non-Statutory Organisations. The findings of the assessment were published in November 2008 in the Stage 1 Scheme Assessment Report - Constraints Report and has not been subject to reassessment.

The Stage 1 assessment concluded that the Eastern Corridor offered the best options for a bypass of Cookstown. The Eastern Corridor also included the option of improving the existing road network between Sandholes Road and A505 Drum Road. It recommended that bypass route options within the Eastern Corridor, and Sandholes Link Road, are developed for assessment at Stage 2.

4.2. GENERAL DESCRIPTION OF ROUTE OPTIONS

Where depths of cuttings and heights of embankments are stated, they are measured relative to existing ground level (egl) at the carriageway centreline. Existing ground level is taken from the Ordnance Survey of Northern Ireland (OSNI) Enhanced Digital Terrain Model (EDTM) and expressed as meters Above Ordnance Datum (AOD).

The proposed upgrade to the existing Sandholes Link Road is intended to improve the link between a proposed bypass and the A505 Drum Road for traffic travelling to and from the direction of Omagh, reducing the need for travel through the town centre or minor road network to the west of Cookstown. It is not intended to be a 'standalone' scheme, and as such the overall scheme has been assessed with Sandholes Link Road as part of the final proposal for each bypass route option.

4.2.1. RED ROUTE OPTION

The Red Route Option (drawing reference 718314-WSP-B-D-0800-0099 to 718314-WSP-B-D-0800-0103, Appendix A) commences at the Loughry Roundabout (76m Inscribed Circle Diameter (ICD) – a measure of the roundabout size), on the A29 Dungannon Road south of Cookstown, creating a fifth arm between the A29 Dungannon Road and Tullywiggan Road. The existing culvert for the Fairy Burn (currently aligned beneath the existing roundabout) is proposed to be rerouted and an associated watercourse diversion to the east of the bypass is proposed.

The route extends in a north easterly direction on embankment with a maximum approximate height of 7.9m where the route option, crosses the Ballinderry River.

The route continues north east in a large asymmetric cutting (with the greater cut slope adjacent to the northbound carriageway and a maximum approximate depth 6.4m) passing between the river and a Wastewater Treatment Works (WwTW) on a 1020m horizontal radius. Retaining walls on both sides of the route (maximum approximate retained height of 3.5m on the northbound carriageway and 4.5m on the southbound carriageway) are proposed at this location to minimise impacts on the WwTW and the river, respectively. Provision has been made for pedestrian access to the WwTW outfalls by means of steps on both sides of the carriageway down to an accommodation underpass beneath the mainline.

A climbing lane is introduced at approximate Ch500m in the northbound direction for approximately 450m to enable overtaking of slower moving vehicles on a maximum gradient of 5.7% returning to a two-lane carriageway south of Killymoon Road.

The route option forms an at-grade junction with Castle Road (drawing reference 718314-WSP-B-D-0800-0104, Appendix A). This takes the form of a Left-In, Left-Out (LILO) junction, permitting turning movements onto Castle Road from the bypass by southbound traffic only, and from Castle Road onto the bypass in the southbound direction only. The west side (townside) of Castle Road is stopped up with no direct access to the bypass. This junction has been designed to provide access for the existing residential and commercial premises on Castle Road as the existing road is a no through road to the east of the Red Route. The approximate diversion length for vehicles using Castle Road LILO to access Cookstown town centre is 1.5km, with a return journey diversion length of 2.5km.

The alignment continues in a north east direction through a drumlin, creating a large cutting (maximum approximate depth of 16.0m), before encountering Killymoon Road. This junction is treated similar to Castle Road, with a LILO junction being provided for access to Killymoon Road from the southbound carriageway, and access from Killymoon Road to the southbound carriageway of the bypass only. The existing road on the west side (townside) is proposed to be stopped up (drawing reference 718314-WSP-B-D-0800-0105, Appendix A). This junction has been designed to maintain access to and from Killymoon Golf Course and Killymoon Castle. The approximate diversion length for vehicles using Killymoon Road LILO to access Cookstown town centre is 2.1km, with a return journey diversion length of 2.0km.

It is expected that the diversion route for those wishing to access the town centre from Castle Road or Killymoon Road will be: use of the LILO junction, travel to Loughrey Roundabout then along the existing A29 to their destination. Access to Castle Road and Killymoon Road will only be provided via Cloghog Road Roundabout, onto the bypass in the southbound direction, and utilise the LILO junctions as required.

The alignment continues north east across Killymoon Golf Course, passing east of housing at Golf View on a 900m horizontal radius and an embankment of maximum height of approximately 3.2m. Fountain Road Stormwater Drain will be culverted where the proposed bypass crosses the watercourse. The route continues north east on embankment, connecting to Cloghog Road via a proposed four arm roundabout (50m ICD), between properties at Festival Park and the existing junction with Cloghog Road, Fountain Road and Molesworth Road.

The southern section of Molesworth Road is to be realigned to the west of an existing veterinary practice to improve road safety by increasing the distance between the junction of Molesworth Road / Fountain Road and the proposed roundabout. The existing junction will be stopped up, and access will be provided via a simple T-junction onto the realigned Molesworth Road (drawing reference 718314-WSP-B-D-0800-0132, Appendix A). Provision will be made for improvement to the substandard bend on Clare Lane to improve accessibility for local traffic and access to the route from the east.

A length of overtaking opportunity known as a differential acceleration lane (DAL) in the northbound direction is provided from Cloghog Road Roundabout before returning to a WS2 cross section after approximately 250m in length. The route alignment continues north, passing directly east of an existing factory in cutting (maximum approximate depth 2.9m) before the route switches onto embankment and an underbridge (mainline over the side road) is provided at B73 Coagh Road. This will remain open with minimal change to the existing geometry to maintain connectivity for users (drawing reference 718314-WSP-B-D-0800-0106, Appendix A). It is noted this length will impact on the factory's private parking facilities.

The route, curving to the north west on a horizontal radius of 1020m, crosses Old Coagh Road on embankment (maximum approximate height of 11.2m). Old Coagh Road remains open via an underbridge (mainline over the side road) to maintain connectivity for users (drawing reference 718314-WSP-B-D-0800-0107, Appendix A). Continuing north from Old Coagh Road, the route passes between two drumlins on back to back horizontal radii of 1020m. The alignment cuts through the southern drumlin to a maximum depth of approximately 6.2m and the northern drumlin to a maximum approximate depth of 13.0m. Provision has been made for an accommodation works overbridge to provide access to severed agricultural land, outbuildings and dwellings at approximate Ch3200m.

The route then continues north on a low embankment (generally less than 2.0m height) and a 720m horizontal radius to tie into the A29 Moneymore Road at its existing (southern-most) junction with Tamlaghtmore Road, as a four-arm elongated roundabout (72m ICD elongated to facilitate the arm arrangement). A DAL is provided on the bypass in the southbound direction from the roundabout, and the existing dual carriageway on A29 Moneymore Road is proposed to be extended, within the existing road footprint, to the proposed roundabout (drawing reference 718314-WSP-B-D-0800-0108, Appendix A).

The Red Route alignment is 3.93km long. (3.58km of new carriageway construction and 0.35km of A29 Moneymore Road dual carriageway widening). Table 4-1 below summarises the key features described above in discrete lengths.

Table 4-1 - Description Summary of Red Route Option

Chainage (m)	Description
0-250	Commences at A29 Dungannon Road / Loughry Roundabout creating a fifth arm to the existing roundabout. The existing culvert for the Fairy Burn is proposed to be rerouted and a watercourse diversion to the east of the bypass is proposed. The route continues north-east on embankment to cross the Ballinderry River at an approximate height of 7.9m.
250-500	The route continues between the Ballinderry River and a drumlin creating an asymetric cutting of maximum depth of 6.4m. Retaining structures are provided to mitigate the impact on the Ballinderry River on the southbound carriageway.
500-750	The route passes east of the WwTW still in cut on the northbound carriageway, where retaining structures are proposed to mitigate the impact of earthworks on the WwTW and a pedestrian underpass is provided within the WwTW land. A climbing lane is introduced between Ch500-950m in the northbound direction.
750-1000	The bypass continues north-east rising towards Castle Road where a proposed LILO junction permits left turning movements into and out of Castle Road which is stopped up on the west of the bypass, which continues in a northerly direction, through a large drumlin creating a cut of maximum depth of 16.0m. 1No. Property is directly impacted by the works.
1000-1250	The proposed alignment continues straight, on a uphill gradient, to cross Killymoon Road at-grade where a LILO junction is provided, permitting left turning movements into and out of Killymoon Road which is stopped up on the west of the bypass. The route continues across the golf course to the rear of properties at Golf View.
1250-1500	Fountain Road Stormwater Drain is culverted beneath the bypass which continues on low embankment through this section

Chainage (m)	Description
1500-1750	The route continues north east on embankment, connecting to Cloghog Road via a proposed four arm roundabout, in the vicinity of Festival Park. Molesworth Road is to be realigned to the west of its current location.
1750-2000	The route alignment continues north, passing directly east of an existing factory in cutting (maximum depth 2.9m) impacting on the existing car park. A DAL is provided in the northbound direction from Cloghog Roundabout.
2000-2250	The earthworks change from a cutting to embankment at Ch2025m with a maximum height of 7.5m on the approach to B73 Coagh Road which remains open via an underbridge (mainline over the side road) to maintain connectivity for users.
2250-2500	The route remains on embankment through this section at a maximum height of 10.9m. A watercourse diversion (undesignated) is required to the west of the proposed alignment.
2500-2750	The route crosses Old Coagh Road on embankment (maximum height of 11.2m), remaining open via an underbridge (mainline over the side road) to maintain connectivity for users. The watercourse diversion (undesignated) continues to the west of the proposed alignment with a piped culvert required beneath B73 Old Coagh Road.
2750-3000	An existing undesignated watercourse is culverted beneath the proposed bypass at approximate Ch2790m. Continuing north the route passes through a drumlin creating a maximum depth of 6.2m
3000-3250	The route continues through a second drumlin with a maximum depth of 13.0m. Provision has been made for an accommodation works overbridge at approximate Ch3200m
3250-3500	Along this length, the route continues towards the A29 Moneymore Road on a low embankment (less than 2m height).
3500-3580	Bypass ties-in to A29 Moneymore Road via a four-arm elongated roundabout with a connection to Tamlaghtmore Road. The existing dual carriageway is proposed to be extended from its current termination point to the proposed roundabout with the bypass

4.2.2. PURPLE A ROUTE OPTION

The Purple A Route Option (drawing reference 718314-WSP-B-D-0800-0109 to 718314-WSP-B-D-0800-0114, Appendix A) commences from Loughry Roundabout (76m ICD) creating a fifth arm between the A29 Dungannon Road and Tullywiggan Road. The existing culvert for the Fairy Burn beneath the existing roundabout) is proposed to be rerouted and an associated watercourse diversion to the east of the bypass is proposed. Heading north-east on an embankment (maximum approximate height approximately 7.9m), the route crosses the Ballinderry River.

The route passes between the river and the WwTW on a horizontal radius of 510m, at a higher level than the Red Route Option, reducing the size of asymmetric cutting required (maximum depth of approximately 4.6m at the carriageway centreline). Retaining structures (maximum approximate height 5.0m on the northbound carriageway and 9.5m on the southbound carriageway) are used to minimise the impact of the route on the WwTW and Ballinderry River, respectively. Provision has been made for pedestrian access to the WwTW outfalls by means of steps to the west side of the carriageway down to an accommodation underpass which passes beneath the mainline.

A climbing lane is introduced in the vicinity of the WwTW in the northbound direction to enable overtaking on a maximum gradient of 6% returning to a two-lane carriageway south of Killymoon Road.

The route continues north, crossing Castle Road further west than the Red Route Option. A LILO junction with Castle Road is proposed permitting turning movements onto Castle Road from the bypass by southbound traffic only, and from Castle Road onto the bypass in the southbound direction only.). The west side of the existing road is stopped up with no direct access to the bypass (drawing reference 718314-WSP-B-D-0800-0115, Appendix A).

The route passes around the west side of a drumlin, following boundaries of properties at Golf View across Killymoon Golf Course on a 510m horizontal radius forming a large cutting (maximum approximate depth of 12.2m). Killymoon Road is proposed to remain open to traffic over the mainline alignment towards the north end of this cutting via an overbridge (drawing reference 718314-WSP-B-D-0800-0116, Appendix A).

The alignment continues on embankment (maximum approximate height of 2.7m). Fountain Road Stormwater Drain will be culverted where the proposed bypass crosses the watercourse. The route then curves to the east on a 720m horizontal radius, passing to the south and east of properties at Festival Park on a low embankment (maximum approximate height of 3.5m) and joining Cloghog Road with creation of a four-arm roundabout (60m ICD). A DAL is provided on the south arm of the roundabout in the southbound direction, as well as on the north arm in the northbound direction.

Heading north from Cloghog Road, the route passes through two drumlins resulting in deep cuttings (maximum approximate depth of 12.9m and 12.4m at the carriageway centreline) before continuing north on embankment over the existing B73 Coagh Road via a new underbridge (mainline over the side road) to maintain existing use. There is proposed to be minimal works undertaken to B73 Coagh Road at this location (drawing reference 718314-WSP-B-D-0800-0117, Appendix A). Provision will be made for improvement to the substandard bend on Clare Lane to improve accessibility for local traffic to the route from the east.

The alignment then skirts the side of another drumlin on a 1020m horizontal radius on embankment. Old Coagh Road is crossed on embankment of approximately 7.4m with an underbridge (mainline over the side road) to provide continued use of Old Coagh Road. Similar to B73 Coagh Road, minimal works are proposed to the existing carriageway (drawing reference 718314-WSP-B-D-0800-0118, Appendix A). The route continues north on a horizontal radius of 3000m crossing a disused railway on embankment (maximum approximate height of 16.6m) before curving to the north west on a 720m horizontal radius around a drumlin on embankment (maximum approximate height of 2.9m). Provision has been made for an accommodation works underpass to provide access to severed agricultural land at approximate Ch3200m, just north of the railway embankment. There are a number of watercourses converging to the south of the disused railway embankment which will be facilitated by a culvert and watercourse diversion to the east of the bypass.

The alignment continues north west in cutting (maximum depth 3.6m) to join the A29 Moneymore Road at the existing (southern-most) junction with Tamlaghtmore Road, as a four arm roundabout (60m ICD). A DAL is provided on the bypass from the roundabout in the southbound direction, and the existing dual carriageway on A29 Moneymore Road is to be extended west, to the proposed roundabout, within the existing road footprint (drawing reference 718314-WSP-B-D-0800-0119, Appendix A).

The Purple A route alignment is 4.3km long. (4.0km of new carriageway construction and 0.3km of Moneymore Road dual carriageway widening). Table 4-2 below summarises the key features described above in discrete lengths.

Table 4-2 - Description Summary of Purple A Route Option

Chainage (m)	Description
0-250	Commences at A29 Dungannon Road / Loughry Roundabout creating a fifth arm to the existing roundabout. The existing culvert for the Fairy Burn is proposed to be rerouted and a watercourse diversion to the east of the bypass is proposed. The route continues north-east on embankment to cross the Ballinderry River at an approximate height of 7.9m.
250-500	The route continues between the Ballinderry River and a drumlin creating an asymetric cutting of maximum depth of 4.6m. Retaining structures are provided to mitigate the impact on the Ballinderry River on the southbound carriageway.
500-750	The route passes east of the WwTW on embankment at a maximum height of 5.8m, on the northbound carriageway where retaining structures are proposed to mitigate the impact of earthworks on the WwTW and a pedestrian underpass is provided within the WwTW land. A climbing lane is introduced between Ch500-950m in the northbound direction.
750-1000	The bypass continues north-east rising towards Castle Road where a proposed LILO junction permits left turning movements into and out of Castle Road which is stopped up on the west of the bypass, which continues in a northerly direction, through a large drumlin creating a cutting of a maximum depth of 12.2m.
1000-1250	The proposed alignment continues in a cutting on a 510m radius with Killymoon Road kept open via an overbridge. The route continues across the golf course to the rear of properties at Golf View.
1250-1500	Switching to embankment, Fountain Road Stormwater Drain is culverted beneath the bypass.
1500-1750	The route continues north east on embankment (approximate height of 3.5m) to the south and east of Festival Park.
1750-2000	A connection to Cloghog Road via a four arm roundabout, is proposed to the east of Festival Park before the route alignment continues north. DALs are provided in the northbound and southbound directions from Cloghog Roundabout.
2000-2250	The route passes through two drumlins resulting in deep cuttings (maximum approximate depth of 12.9m and 12.4m at the carriageway centreline)
2250-2500	On the approach to B73 Coagh Road, the route switches from cutting to embankment due in part to the existing topography.
2500-2750	The route continues north on embankment over the existing B73 Coagh Road via a new underbridge (mainline over the side road) to maintain existing use (maximum height of 8.0m)
2750-3000	The route crosses Old Coagh Road on embankment (maximum height of 10.9m), remaining open via an underbridge (mainline over the side road) to maintain connectivity for users.
3000-3250	The route continues north on significant embankment of maximum height of 16.6m. A proposed culvert and watercourse diversion is required to the west of the alignment, south of the old railway embankment. An accommodation underpass is provided to the north of this. at approximate Ch3200m
3250-3500	The route continues around a second drumlin creating asymetrical earthworks as the route continues north, with a maximum height of 2.9m.
3500-3750	Along this length, the route continues towards the A29 Moneymore Road in slight cutting (maximum depth of 3.6m).

Chainage (m)	Description
3750-3980	Bypass ties-in to A29 Moneymore Road via a four-arm roundabout with connection to Tamlaghtmore Road. The existing dual carriageway is proposed to be extended from its current termination point to the proposed roundabout with the bypass.

4.2.3. PURPLE B ROUTE OPTION

The Purple B Route Option (drawing reference 718314-WSP-B-D-0800-0120 to 718314-WSP-B-D-0800-0128, Appendix A) follows the same alignment between the Loughry Roundabout (76m ICD) and the proposed roundabout at Cloghog Road (60m ICD) as the Purple A Route Option.

The alignment continues north passing through two drumlins resulting in deep cuttings (maximum approximate depth of 14.2m and 13.7m at the carriageway centreline) before continuing north on embankment over B73 Coagh Road on a new underbridge (mainline over the side road) to maintain its existing use. There is proposed to be minimal works undertaken to B73 Coagh Road at this location (drawing reference 718314-WSP-B-D-0800-0129, Appendix A). Provision will be made for improvement to the substandard bend on Clare Lane to improve accessibility for local traffic and access to the route from the east.

The alignment then skirts the side of a drumlin on a 1020m horizontal radius, forming a slightly asymmetric embankment (maximum approximate height of 7.6m), before crossing over the existing Old Coagh Road. Old Coagh Road is proposed to remain open via an underbridge (mainline over the side road) to maintain existing use (drawing reference 718314-WSP-B-D-0800-0130, Appendix A).

The route continues north east on a 1020m horizontal radius, crossing a disused railway on embankment (maximum approximate height 10.9m), before curving to the north east on a 1020m horizontal radius, broadly following land boundaries to the A29 Moneymore Road. Provision has been made for an accommodation works underpass to provide access to severed agricultural land south of the disused railway at approximate Ch3200m. There are a number of watercourses converging to the south of the disused railway embankment which will be facilitated by a culvert and watercourse diversion to the east of the bypass.

Between the disused railway and Moneymore Road, the alignment skirts a drumlin in cutting (maximum approximate depth of 2.9m) and continues on embankment (maximum approximate height of 8.0m) before passing through the middle of a drumlin, with a cutting of an approximate depth of 9.5m. The route then continues north on embankment (maximum approximate height of 5.4m) to create an offline four-arm roundabout (70m ICD) to the south of the existing carriageway in the vicinity of a car show room and industrial units. This roundabout is proposed to join the existing dual carriageway on A29 Moneymore Road with the bypass and provide a private access arm from the roundabout to replace an entrance now beneath the junction footprint. A DAL is provided on the bypass arm of the roundabout in the southbound direction. Where the bypass ties into the A29 Moneymore Road, it is proposed to maintain the dual carriageway towards Moneymore. It is the intention that the roundabout is used as an appropriate termination point for the dualling with the south-west arm towards Cookstown proposed as a single carriageway within the existing road footprint (drawing reference 718314-WSP-B-D-0800-0216, Appendix A).

The Purple B route alignment is 4.3km long (4.3km of new carriageway construction and 0.4km of reduction in width of Moneymore Road dual). Table 4-3 below summarises the key features described above in discrete lengths.

Table 4-3 - Description Summary of Purple B Route Option

Chainage (m)	Description
0-250	Commences at A29 Dungannon Road / Loughry Roundabout creating a fifth arm to the existing roundabout. The route continues north-east on embankment to cross the Ballinderry River at an approximate height of 7.9m.
250-500	The route continues between the Ballinderry River and a drumlin creating an asymetric cutting of maximum depth of 4.6m. Retaining structures are provided to mitigate the impact on the Ballinderry River on the southbound carriageway.
500-750	The route passes east of the WwTW on emabankment at a maximum height of 5.8m, on the northbound carriageway there retaining structures are proposed to mitigate the impact of earthworks on the WwTW and a pedestrian underpass is provided within the WwTW land. . A climbing lane is introduced between Ch500-950m in the northbound direction.
750-1000	The bypass continues north-east rising towards Castle Road where a proposed LILO junction permits left turning movements into and out of Castle Road which is stopped up on the west of the bypass, which continues in a northerly direction, through a large drumlin creating a cut of maximum depth of 12.2m.
1000-1250	The proposed alignment continues in cut on a 510m radius with Killymoon Road kept open via an overbridge. The route continues across the golf course to the rear of properties at Golf View.
1250-1500	Switching to embankment, Fountain Road Stormwater Drain is culverted beneath the bypass.
1500-1750	The route continues north east on embankment (approximate height of 3.5m) to the south and east of Festival Park.
1750-2000	A connection to Cloghog Road via a proposed four arm roundabout, is proposed in the vicinity of Festival Park before the route alignment continues north. DALs are provided in the northbound and southbound directions from Cloghog Roundabout.
2000-2250	The route passes through two drumlins resulting in deep cuttings (maximum approximate depth of 14.1m and 13.7m at the carriageway centreline)
2250-2500	On the approach to B73 Coagh Road, the route changes from cutting to embankment due in part to the existing topography.
2500-2750	The route continues north on embankment over the existing B73 Coagh Road on a new underbridge (mainline over the side road) to maintain the existing use (maximum height of 7.5m)
2750-3000	The route crosses Old Coagh Road on embankment (maximum height of 9.4m in this section), remaining open via an underbridge (mainline over the side road) to maintain connectivity for users.
3000-3250	The route continues north on significant embankment of maximum height of 10.8m. A proposed culvert and watercourse diversion is required to the west of the alignment to the south of the old railway embankment. An accommodation underpass is provided to the north of this. at approximate Ch3200m
3250-3500	The route continues around a second drumlin creating asymetrical earthworks as the route continues north-east, with a maximum height of 7.6m and depth of 2.8m.
3500-3750	Along this length, the route continues towards the A29 Moneymore Road on embankment before changing to a cut as it goes through another drumlin (maximum depth of 9.5m).
3750-4000	The route exits the drumlin and continues towards the A29 Moneymore Road on embankment (maximum depth of 5.4m).

Chainage (m)	Description
4000-4300	Bypass ties-in to A29 Moneymore Road via a four-arm offline roundabout. The existing dual carriageway towards Cookstown is proposed to be reduced to single carriageway from the proposed roundabout with the bypass. A private access arm is provided to replace an existing direct access due to the proposed location of the roundabout.

4.2.4. GREEN ROUTE OPTION

The Green Route Option (drawing reference 718314-WSP-B-D-0800-0191 to 718314-WSP-B-D-0800-0196, Appendix A) commences at Loughry Roundabout (75m ICD) creating a fifth arm. The proposed alignment positions the tie-in of the bypass further east than each of the other proposed route options, creating an oval shaped roundabout. This would require minor realignment of the existing Tullywiggan Road arm. The existing culvert for the Fairy Burn beneath the existing roundabout) is proposed to be rerouted and an associated watercourse diversion to the east of the bypass is proposed. Heading north on embankment (maximum approximate height approximately 11.3m), the route crosses the Ballinderry River.

The route passes between the river and the WwTW on two horizontal radii of 510m, at a lower level than the Red and Purple Route Options, reducing the size of asymmetric cutting required (maximum embankment height of approximately 0.3m at the carriageway centreline). Retaining structures (maximum approximate height 8.0m on the northbound carriageway and 8.5m on the southbound carriageway) are used to minimise the impact of the route on the WwTW and the river, respectively. Provision has been made for pedestrian access to the WwTW outfalls by means of steps down on both sides of the carriageway to an accommodation underpass which passes beneath the mainline, enabling pedestrian access under the carriageway to the WwTW outfalls. A Differential Acceleration Lane (DAL) has been introduced from Loughrey Roundabout providing overtaking opportunities in the northbound direction as there is no requirement for a climbing lane in this location.

The route continues north, crossing beneath the existing Castle Road further west than the Red Route Option, at a depth of approximately 8.4m. Castle Road is proposed to remain open to traffic over the proposed mainline via an overbridge, remaining on its existing alignment as far as practicable (drawing reference 718314-WSP-B-D-0800-0197, Appendix A).

The route passes through a drumlin, following the boundaries of properties at Golf View across Killymoon Golf Course on a 510m horizontal radius forming a significant cutting (maximum approximate depth of 22.7m). Killymoon Road is proposed to remain open to traffic over the mainline alignment towards the north end of this cutting via an overbridge with a minor realignment to the south of its existing location (drawing reference 718314-WSP-B-D-0800-0198, Appendix A).

The alignment continues in cutting on a 510m radius to switch to embankment in the vicinity of Golf View (maximum approximate height of 4.1m). Fountain Road Stormwater Drain will be culverted where the proposed bypass crosses the watercourse. The route then curves to the east on a 510m horizontal radius, passing to the south and east of properties at Festival Park on slight embankment (maximum approximate height of 1.6m) and joining Cloghog Road with creation of a four-arm roundabout (60m ICD). A DAL is provided on the south arm of the roundabout in the southbound direction, as well as on the north arm in the northbound direction.

Heading north from Cloghog Road, the route passes through two drumlins resulting in deep cuttings (maximum approximate depth of 12.5m and 13.2m at the carriageway centreline) before continuing north on embankment over the existing B73 Coagh Road via a new underbridge (mainline over the side road) to maintain its existing use. There is proposed to be minimal works undertaken to B73 Coagh Road at this location (drawing reference 718314-WSP-B-D-0800-0199, Appendix A). Provision will be made for improvement to the substandard bend on Clare Lane to improve accessibility for local traffic and access to the route from the east.

The alignment continues north cutting through another drumlin on a 900m horizontal radius on embankment. Old Coagh Road is crossed on embankment of approximately 8.5m with an underbridge (mainline over the side road) being provided for continued use of Old Coagh Road. Similar to B73 Coagh Road, minimal works are proposed to Old Coagh Road (drawing reference 718314-WSP-B-D-0800-0200, Appendix A).

The route continues north on a straight alignment crossing a disused railway on embankment (maximum approximate height of 24.5m) before curving to the north west on a 720m horizontal radius around a drumlin in cutting (maximum approximate depth of 5.9m). Provision has been made for an accommodation works underpass to provide access to severed agricultural land at approximately Ch3220m, just north of the railway embankment. There are a number of watercourses converging to the south of the disused railway embankment which will be facilitated by two culverts and watercourse diversion to the east of the bypass.

The alignment continues north west in cutting (maximum depth 6.3m) to join the A29 Moneymore Road at the existing (southern-most) junction with Tamlaghtmore Road, as a four-arm roundabout (60m ICD). A DAL is provided on the southern arm of the roundabout in the southbound direction, and the existing dual carriageway on Moneymore Road is to be extended west to the proposed roundabout within the existing road footprint (drawing reference 718314-WSP-B-D-0800-0201, Appendix A).

The Green route alignment is 4.3km long. (4.0km of new carriageway construction and 0.3km of Moneymore Road dual carriageway widening). Table 4-4 below summarises the key features described above in discrete lengths.

Table 4-4 - Description Summary Of Green Route Option

Chainage (m)	Description
0-250	Commences at A29 Dungannon Road / Loughry Roundabout creating a fifth arm to the existing roundabout. The existing culvert for the Fairy Burn is proposed to be rerouted and a watercourse diversion to the east of the bypass is proposed. A DAL is provided in the northbound direction. The route continues north-east on embankment to cross the Ballinderry River at an approximate height of 11.3m.
250-500	The route continues between the Ballinderry River and a drumlin creating an asymetric cutting of maximum depth of 7.8m. Retaining structures are provided to mitigate the impact on the Ballinderry River on the southbound carriageway.
500-750	The route passes east of the WwTW on embankment at a maximum height of 3.9m. On the northbound carriageway retaining structures are proposed to mitigate the impact of earthworks on the WwTW and a pedestrian underpass is provided within the WwTW land.
750-1000	The bypass continues north-east rising towards Castle Road which is kept open via an overbridge, through a large drumlin creating a cut of maximum depth of 22.7m.
1000-1250	The proposed alignment continues in cut on a 510m radius with Killymoon Road kept open via an overbridge. The route continues across the golf course to the rear of properties at Golf View.

Chainage (m)	Description
1250-1500	Switching to embankment, Fountain Road Stormwater Drain is culverted beneath the bypass.
1500-1750	The route continues north east on embankment (approximate height of 1.6m) to the south and east of Festival Park.
1750-2000	A connection to Cloghog Road via a proposed four arm roundabout, is proposed in the vicinity of Festival Park before the route alignment continues north. DALs are provided in the northbound and southbound directions from Cloghog Roundabout.
2000-2250	The route passes through two drumlins resulting in deep cuttings (maximum approximate depth of 12.5m and 13.2m at the carriageway centreline)
2250-2500	On the approach to B73 Coagh Road, the route changes from cutting to embankment in part due to the existing topography.
2500-2750	The route continues north on embankment over the existing B73 Coagh Road on a new underbridge (mainline over the side road) to maintain the existing use (maximum height of 11.3m) before cutting through a drumlin on the approach to Old Coagh Road (maximum approximate depth of 5.7m at the carriageway centreline)
2750-3000	The route crosses Old Coagh Road on embankment (maximum height of 21.6m in this section length), remaining open via an underbridge (mainline over the side road) to maintain connectivity for users.
3000-3250	The route continues north on significant embankment of maximum 24.5m. Proposed culverts and watercourse diversion is required to the west of the alignment to the south of the old railway embankment. An accommodation underpass is provided to the north of this. at approximate Ch3220m
3250-3500	The route continues through a drumlin to the north-east, with a maximum depth of 5.9m.
3500-3750	Along this length, the route continues towards the A29 Moneymore Road in cut (maximum depth of 6.3m).
3750-4000	The route continues towards the A29 Moneymore Road in cutting (maximum depth of 4.5m) where it connects with the A29 Moneymore Road via a four-arm roundabout. The existing dual carriageway is proposed to be extended from its current termination point to the proposed roundabout with the bypass.

4.2.5. SANDHOLES LINK ROAD

During the period between the announcement of the Preferred Route in June 2010 and the recommencement of the scheme, development of an existing private property has been granted planning approval and has subsequently been constructed within the protected area set aside for the scheme development. Based on this new development, a new online alignment has been proposed for the Sandholes Link Road. This new alignment no longer includes the upgrade of Strifehill Road.

The Sandholes Link Road (drawing reference 718314-WSP-B-D-0800-0131, Appendix A) is designed as a single urban carriageway (SU2) with kerbed footway on the southbound carriageway, and a kerbed shared footway / cycleway on the northbound carriageway. The design speed for the link road is 60kph (30mph).

The alignment commences with a new three arm roundabout (42m ICD) between Sandholes Road and A505 Drum Road. This junction is heavily constrained by residential and commercial properties, a public playground area and Derryloran Church (and church grounds), an archaeological site and Monument in State Care.

The route extends south following the existing horizontal and vertical alignment of Sandholes Road for approximately 550m. The cross section provides right turn lanes for access either side of the proposed widening, maintaining access to Derrylornan Industrial Estate and residential properties at Old Rectory Park. Provision has not been included at this stage for relocation of Old Rectory Park junction in line with the approved planning permission (approximately 50m to the north of its current location). This will be consulted upon further and confirmed during development of the Specimen Design.

The proposed alignment is raised higher than the existing alignment over the existing watercourse (Fairy Burn). A new culvert / bridge will be required to cross the Fairy Burn, with the old structure to be demolished. The alignment is approximately 2.5m above existing ground level and 2.6m above the watercourse in this location.

North of the watercourse, direct access is required for an existing commercial property on the southbound carriageway. No direct access with the existing Strifehill Road is proposed, and a turning head will be provided at the location of the current junction where Strifehill Road is stopped up.

Direct accesses to businesses and properties (at approximate Ch 500-600m) will be maintained.

The route creates a proposed three-arm roundabout (50m ICD) to the east of the existing junction with the east-west Sandholes Road. Direct access to residential and commercial properties, will be provided onto the link road.

The Sandholes Link Road is 0.69 km long. Table 4-5 below summarises the key features described above in discrete lengths.

Table 4-5 - Description Summary of Sandholes Link Road

Chainage (m)	Description
0-250	Commences at the junction of A505 Drum Road and Sandholes Road with a proposed three-arm roundabout. Provision has been made for relocation of the entrance to Old Rectory Park and the junction to Derrylornan Industrial Estate is to be maintained. Carriageway is designed as an urban single carriageway with right turn lanes as required.
250-500	Direct access is required from the link road to industrial units at approximate Ch 400m. A new structure over the Fairy Burn watercourse will be provided. The alignment continues online with Strifehill Road being stopped up.
500-690	Direct access for both residential and commercial properties will be provided. Proposed tie-in to the existing road netword via a four-arm roundabout in the vicinity of the existing junction between Strifehill Road and Sandhles Road.

4.2.6. SUMMARY OF CROSSINGS / JUNCTIONS

The following tables (Table 4-6 and Table 4-7 below) provide a summary of the key connections and crossings between the proposed route options and the existing road network and how each are being integrated. The descriptions given are based on the location of the side road in relation to the bypass, e.g. where the term overbridge is used, this refers to the side road being bridged over the bypass.

Table 4-6 - Summary of Key Connections – Route Options

Side Road	Route Options and Proposals			
	Red	Purple A	Purple B	Green
A29 Dungannon Road	Ch0m Fifth-arm connection to Loughry Rbtt	Ch0m Fifth-arm connection to Loughry Rbt	Ch0m Fifth-arm connection to Loughry Rbt	Ch0m Fifth-arm connection to Loughry Rbt
Castle Road	Ch795m LILO	Ch775m LILO	Ch775m LILO	Ch800m Overbridge
Killymoon Road	Ch1160m LILO	Ch1090m Overbridge	Ch1090m Overbridge	Ch1140m Overbridge
Cloghog Road / Fountain Road	Ch1675m Four-arm Rbt	Ch1900m Four-arm Rbt	Ch1900m Four-arm Rbt	Ch1925m Four-arm Rbt
Molesworth Road	Ch1675m Realigned ghost island	N/A	N/A	N/A
Clare Lane	Ch1675m Minor Road improvements	Ch1900m Minor Road improvements	Ch1900m Minor Road improvements	Ch1925m Minor Road improvements
B73 Coagh Road	Ch2195m Underbridge	Ch2525m Underbridge	Ch2525m Underbridge	Ch2550m Underbridge
Old Coagh Road	Ch2650m Underbridge	Ch2875m Underbridge	Ch2875m Underbridge	Ch2920m Underbridge
A29 Moneymore Road	Ch3550m Four-arm online elongated Rbt	Ch3950m Four-arm online Rbt	Ch4290m Four-arm offline Rbt	Ch3960m Four-arm online Rbt

Table 4-7 - Summary of Key Connections – Sandholes Road

Side Road	Route Option and Proposal	
	Location	Sandholes Link Road
A505 Drum Road	Ch0m	Three-arm online Roundabout
Old Rectory Park	Ch100m	Ghost island junction
Derrylornan Industrial Estate	Ch175m	Ghost Island junction
Direct Access	Ch400m	Simple T-Junction
Strifehill Road (at junction with Sandholes Road)	Ch430m	Stopped up
Ballyreagh Business Park	Ch590m	Simple T-Junction
Private residential accesses	Ch620m	Simple T-Junction
Sandholes Road (from Loughry Roundabout)	Ch690m	Three-arm online Roundabout

4.3. PRELIMINARY COST ESTIMATES

Preliminary Cost Estimates have been prepared to Q3 2019 prices by Chandler KBS and summarised in this report.

4.3.1. ESTIMATE ASSUMPTIONS

The cost estimate for each option has been prepared using 2019 Quarter 3 prices. Base rates are presented in current prices (Q3 2019) in accordance with Roads Service Policy and Procedure Guide (RSPPG_E058). Construction costs were assessed using the pavement area and costs per m² extracted from outturn cost information from relevant highway projects. Details of the assumptions are summarised in Table 4-8 below.

Table 4-8 – Scheme Estimating Methodology

Cost Type	Assumption / Cost Makeup
Site Clearance	Structures were assessed based on cost per m2 of deck area (overbridges and underbridges), base slab area (underpasses) and front faces (retaining walls) and linear length of culverts. Rates used were based on out-turn cost information from recently delivered projects.
Junctions	Junctions were included on a rate per item based on the junction type and size using outturn cost information from recently delivered projects.
Side Roads	Side roads have been assessed based on the linear length, with full depth construction assumed.
Statutory Undertaker Costs	Estimates have been included using outturn cost information from recently delivered projects.
Contractor Works for Statutory Undertakers	This allowance has been calculated based on a per m^2 cost of the carriageway area and allows for works undertaken by the main contractor in diverting and protecting existing services and providing the infrastructure necessary for new services installation by the relevant statutory undertakers.
Contractors Overheads and Profit	This provides an allowance for contractor overheads and profits at 5% of the direct construction costs
Construction Cost	This value will be the sum of the Construction Costs identified under each minor heading
Preparation	The estimated cost for this item is based on current fee projection to Public Inquiry Decision
Supervision	The estimated cost for this item is based on outturn cost information from recently delivered projects.
Total Construction Preparation and Supervision	**This value will be the sum of the Construction Costs, plus Preparation and Supervision**
Risk	A qualitative risk register is in operation for the scheme. @RISK was used to produce the 50 percentile Confidence of Attainment (in accordance with RSPPG E058) applied to the whole scheme.
Optimism Bias (OB)	A value of 19.5% has been applied to all estimated costs excluding land and compensation costs, following completion of RSPPG E058 Appendix 'Optimism Bias Spreadsheet'
Total Construction Cost	**This value will be the sum of the Construction Costs, Preparation and Supervision, plus Risk and OB values.**

Cost Type	Assumption / Cost Makeup
Land Purchase Cost and Other Compensation	Each area of land is valued according to its zoning and use typically; agricultural land, residential, garden, industrial land, amenity land etc. Values of compensation costs such as injurious affection and severance impact have been included. See section 4.3.2 below for further details
Land Optimism Bias	A value of 10% has been applied to the 'Land Purchase Cost and Other Compensation' value.
Total Land Cost	**This value will be the sum of Land Purchase Cost and Other Compensation and OB on Lands.**
ROUTE OPTION ESTIMATE TOTAL	**THIS VALUE IS THE SUM OF ALL COSTS IDENTIFIED ABOVE**

4.3.2. LAND COST ESTMATE (LCE)

The land cost estimates have been undertaken with cognisance of the Land Acquisition and Compensation (Northern Ireland) Order 1973.

Land required for the scheme has been valued according to its typical use (see Table 4-9 below for details). The land values per hectare are based on figures supplied by Land Property Services (LPS). The Cookstown Area Plan 2010 was used to determine land that has been zoned for development. Any lands that are zoned were valued at their projected zoning value rather than their current land use.

Exclusions in the valuation were:

- Public Roads - these are presumed to be in the ownership of DfI.
- Rivers
- Landtake less than 1m^2
- Disposal values have been taken as zero at this stage

Surveyor fees and District Valuer (DV) valuation fees were all presumed to be £500 minimum, with surveyor fees assuming a sliding scale based upon the value of the individual property i.e. the higher the value, the higher the surveyors fee.

Table 4-9 – Typical Land Use Values

Land Use / Classification	Approximate Value per Hectare (£)	Approximate Value per Acre[1] (£)
Agricultural	37,000	15,000
Commercial / Industrial (including development)	309,000	125,000
Residential (including development)	556,000	225,000
Residential (Garden)	52,000	21,000
Community / Amenity Land / Golf Club	75,000	30,400

Notes:

1. Hectare to acre conversion taken as 1ha to 2.471acres. The values have been rounded to the nearest 100 and are for comparison purposes only. The land cost estimates are calculated using hectare values.

4.3.3. SCHEME COST ESTIMATE

A breakdown of the Stage 2 Cost Estimate for each bypass route option and Sandholes Link Road is provided in Table 4-10 below, which is consistent with the RSPPG_E058 format for reporting scheme costs. This gives an estimated cost for each route based on the methodology stated above.

These costs are reflective of the stage of the design and shall be refined as the scheme is progressed.

Table 4-10 – Scheme Cost Estimate Summary

Cost Category	Red Route (£)	Purple A Route (£)	Purple B Route (£)	Green Route (£)	Sandholes Link Road (£)
Preliminary Works	2,445,455	2,664,115	2,667,788	2,759,659	430,510
Road Works	12,705,375	12,977,822	13,041,877	13,629,622	2,010,385
Structures	4,092,442	6,370,078	6,455,278	8,884,840	68,900
Utilities	406,974	443,364	443,975	459,264	117,581
Other Costs	0	0	0	0	0
Total Works Costs	**19,650,247**	**22,455,379**	**22,608,918**	**25,733,385**	**2,627,376**
Land Purchase Cost	6,700,000	3,600,000	3,600,000	3,600,000	350,000
Disturbance / Severance / Injurious Affection / Part 2	4,208,522	2,928,066	2,722,426	3,853,661	879,980
Total Land Costs	**10,908,522**	**6,528,066**	**6,322,426**	**7,453,661**	**1,229,980**
Preparation	4,000,000	4,000,000	4,000,000	4,000,000	Incl.
Supervision	1,250,000	1,250,000	1,250,000	1,250,000	Incl.
Total Consultant Costs	**5,250,000**	**5,250,000**	**5,250,000**	**5,250,000**	**Incl.**
Risk (QRA)	2,561,217	2,561,217	2,561,217	2,561,217	Incl.
Optimism Bias (19.5%)	4,855,548	5,402,549	5,432,489	6,041,760	512,338
Land Optimism Bias (10%)	1,090,852	652,807	632,243	745,366	122,998
Total Risk Element	**8,507,617**	**8,616,572**	**8,625,949**	**9,847,781**	**635,336**
ROUTE OPTION ESTIMATE TOTAL	**44,316,387**	**42,850,017**	**42,807,292**	**47,785,389**	**4,492,693**

Notes:

1. Inflation is not included in the above scheme costs.
2. Sunk costs (consultant and third party costs) are not included in this table however amount to circa. £2.2m.

4.3.4. COST PER KILOMETRE

Table 4-11 below provides a cost per kilometre for comparison purposes.

Table 4-11 - Scheme Cost per Kilometre (£m)

Cost	Red Route	Purple A Route	Purple B Route	Green Route	Sandholes Link Road
Overall Route Option Total	44.3	42.8	42.8	47.8	4.5
Scheme Length	3.93km	4.26km	4.33km	4.30km	0.69km
Cost per km	**11.3**	**10.0**	**9.9**	**11.1**	**6.5**

'Scheme Length' in the above table include the length of proposed works on the A29 Moneymore Road.

4.4. OUTLINE CONSTRUCTION TIMEFRAME

For the development purposes of this document, a timeframe of 18 months has been allowed for the construction of the works. This is made up of typical weeks required for the key construction activities as follows:

- Establishment of site compounds / deposition areas etc.
- Bulk earthworks (excavation of cutting and placement of embankments)
- Installation of structures
- Construction of the carriageway (pavements)
- Ancillary works associated with the scheme (installation of road restraint system, road lighting, traffic signs etc)
- Landscaping
- Minor accommodation works
- Handover

This assumes that works will have been undertaken in advance of the Principal Contractor taking over the site from DfI. Advance works are likely to include fence erection along the vesting boundary, archaeological investigation works, utility diversions and temporary access(es).

With a proposed construction start date of Autumn 2023, the opening year for the scheme has been assumed to be 2025, and a design year of 2040. Refer to section 7.2.1 for timeframe dates and assumptions.

5. ENGINEERING ASSESSMENT

5.1. HIGHWAYS ASSESSMENT

5.1.1. DESIGN STANDARDS

Each route option has been developed in accordance with the design standards contained in the Design Manual for Roads and Bridges (DMRB) listed below: -

- TD 9/93 – Highway Link Design (DMRB Vol 6, Section 1, Part 1);
- TD 27/05 – Cross-Sections and Headrooms (DMRB Vol 6, Section 1, Part 2);
- TD 70/08 – Design of Wide Single 2 + 1 Roads (DMRB Vol 6, Section 1, Part 4);
- TD 16/07 – Geometric Design of Roundabouts (DMRB Vol 6, Section 2, Part 3);
- TD 42/95 – Geometric Design of Major/Minor Priority Junctions (DMRB Vol 6, Section 2, Part 6);
- TD 41/95 – Vehicular Access to All-Purpose Trunk Roads (DMRB Vol 6, Section 2, Part 7);
- TD 90/05 – Geometric Design of Pedestrian, Cycle and Equestrian Routes (DMRB Vol 6, Section 3, Part 5);
- TA 46/97 – Traffic Flow Ranges for Use in the Assessment of New Rural Roads (DMRB Vol 5, Section 1, Part 3), and;
- TA 79/99 – Traffic Capacity of Urban Roads (DMRB Vol 5, Section 1, Part 3)

At commencement of Stage 2 design, the above design standards were current. It was known that most were in the process of being superseded by the updates to the DMRB. Stage 3 will take cognisance of current design standards.

5.1.2. CARRIAGEWAY STANDARD

5.1.2.1. Bypass Route Options

The Route Options are designed as wide single rural all-purpose carriageways with hard strips and verges on both sides. A wide single (WS2) carriageway has been chosen in accordance with TA46/97, “Traffic Flow Ranges for Use in the Assessment of New Rural Roads”, in line with the recommended carriageway standards for minimum and maximum forecast traffic flows. The predicted opening year traffic flows (discussed in detail in section 7 of this report) for each route option lie within the lower range (first quartile) of a dual carriageway option and within the mid-range (between second and third quartiles) for a WS2 option. Both dual carriageway and WS2 standard can be considered within capacity and capable of providing a suitable solution.

Whilst the forecast traffic flows are within the range of both WS2 and a dual carriageway, consideration is given to continuity of route, in this case the trunk road network (T15). The length of existing dual carriageway along the A29 between Cookstown and Moneymore may be described as a-typical, with the majority of the T15 network (along the A29 corridor) comprising predominantly wide single carriageway with limited dedicated overtaking opportunities (such as climbing / crawler lanes or overtaking lanes). Taking this into account, a WS2 layout fits within the wider scheme context.

In assessing high level benefits and disbenefits of WS2 against a dual carriageway, the latter requires a wider overall cross section due to the requirement for a central median as a minimum. A dual carriageway will typically have a larger associated land take than a WS2 arrangement as direct access from private lands and right turn manoeuvres from junctions are prohibited. It therefore follows that a

WS2 is likely to have a lower construction and land cost, and reduced overall impacts, whilst providing the same benefits in reducing congestion, improving journey times and reliability.

5.1.2.2. Sandholes Link Road

Sandholes Link Road as an improvement to the existing carriageway will be designed as an urban single carriageway.

5.1.2.3. Side Roads

Any proposed works to existing minor roads, crossed by the proposed bypass have as a minimum maintained their existing cross section.

5.1.3. DESIGN SPEED

5.1.3.1. Bypass Route Options

The mainline design speed has been set as 100Akph as recommended in the Department for Infrastructure Director of Engineering Memorandum (DEM) 118/16 'Design Speed for Roads' for an unrestricted single carriageway, taking cognisance of the cross section selected as detailed above.

This also applies to A29 Moneymore Road where the scheme is proposed to tie into.

5.1.3.2. Sandholes Link Road

The existing posted speed limit is 30mph from A505 Drum Road for approximately 180m, where the speed limit changes to National Speed limit at the junction with Derrylornan Industrial Estate to Sandholes Road.

The design speed for the link road has been set at 60Bkph (30mph), the lowest speed permitted under DEM118/16 for non-trunk roads as part of a Trunk road scheme and has taken consideration of the overall route improvement strategy.

5.1.3.3. Side Roads

For this stage of assessment, the existing posted speed limit has been used along the side roads.

5.1.4. DESIGN CROSS SECTION

Please refer to drawing reference 718314-WSP-B-D-0800-0097 to 0098 in Appendix A, for Typical Carriageway Cross Sections.

5.1.4.1. Bypass Route Options

The design has taken cognisance of alignment and buildability constraints, as well as safety considerations such as the provision of Non-Motorised User (NMU) facilities, in view of the proximity of the proposed bypass to existing residential and commercial properties.

There are discrete sections on Red, Purple A and Purple B Route Options where due to the vertical geometry, a climbing lane is required in the vicinity of the Wastewater Treatment Works (WwTW). Where the horizontal and vertical geometry permits, the bypass alignments include overtaking facilities in the form of Differential Acceleration Lanes (DALs) from the roundabouts.

A 3.0m wide NMU facility (with an additional 0.5m separation width) has been provided along the length of the northbound carriageway on all bypass options. Further consultation with DfI's Active Travel Team and other statutory bodies (to include SUSTRANS) for agreement regarding this provision shall be undertaken during the development of the specimen design.

The WS2 carriageway consists of two 5.0m lanes with 1.0m hardstrips, 2.5m verge either side and a separation width of 0.5m to the 3.0m footway/cycleway, giving a total cross-section of 20.5m. Where the climbing lane sections are proposed, the overall cross-section does not change, with three lanes being accommodated within the 10m carriageway (lanes of 3.2m, 3.4m and 3.4m). Where DALs are proposed from the roundabouts, the carriageway consists of three 3.5m lanes, a 1.0m hatched area with 1.0m hardstrips, 2.5m verge either side and a separation width of 0.5m to the 3.0m footway/cycleway, giving a total cross-section of 22.0m.

5.1.4.2. A29 Moneymore Road

Where the scheme proposes to extend the existing A29 Moneymore Road dual carriageway to the roundabout on Red, Purple A and Green Route Options the cross section is a four-lane dual all-purpose carriageway (D2AP). As this length of works is proposed to be carried out within lands already owned by DfI it is proposed to reduce verge widths to mitigate the potential impact on third party lands. The D2AP carriageway consists of four 3.65m lanes with a 2.5m central reserve, 1.0m hardstrips either side of the carriageway and 1.25m verges, giving a total cross-section of 23.6m.

The carriageway cross section for A29 Moneymore Road from the roundabout with Purple B towards Cookstown is proposed to be reduced from a dual carriageway to a wide single, tying into the existing single in the vicinity of Tamlaghtmore Road. The WS2 carriageway consists of two 5.0m lanes with 1.0m hardstrips, 2.5m verge either side giving a total cross-section width of 17.0m.

Similar to the bypass options, direct access onto this section shall be limited due to the high-speed nature of this section with a design speed of 100Akph.

5.1.4.3. Sandholes Link Road

The Sandholes Link Road is designed as a single urban all-purpose carriageway (SU2) with kerbed footways. The SU2 carriageway consists of two 3.65m lanes with a 2m footway or footway / cycleway and 0.5m verge either side, giving a total cross-section of 12.3m. Further consultation with DfI's Active Travel Team and other statutory bodies (to include SUSTRANS) for agreement regarding this cross section shall be undertaken during the development of the specimen design.

5.1.5. JUNCTION AND SIDE ROAD STRATEGY

5.1.5.1. Bypass Route Options

The proposals have considered each side roads existing and predicted future use. These are preliminary designs and are subject to change during the development of the preferred route. Maintaining access to the local road network is a priority during design and where the bypass crosses a side road, an appropriate form of connection has been provided considering design speeds, traffic volumes and alignment constraints. It therefore follows that at some side road locations it is not considered appropriate to provide direct access to the bypass. For consistency, along the proposed scheme and in the wider trunk road network context, the junction types / layouts have been kept to a minimum to reduce potential confusion and uncertainty for users.

A preliminary assessment determined at-grade roundabouts were the preferred junction type as they are suitable for the anticipated traffic flows and applicable as a safe interchange between the rural and urban road environment. However, they were not the only form of junction considered.

Direct access (defined as "*a connection to an all-purpose trunk road providing access to a single field or dwelling that does not provide a through route*") to the proposed bypass route options has not been permitted due to the high-speed nature of the options. Access to property and land will be provided via the existing side road network as applicable.

Where side roads have been stopped up, it is intended that traffic would use alternative routes on the local road network.

Section 4 describes in detail the proposed treatment of side roads and junctions for each of the route options. Table 5-1 to Table 5-4 below summarises each route option comparing existing and proposed arrangements.

5.1.5.2. Sandholes Link Road

Direct access and junctions will be maintained along Sandholes Link Road in keeping with its urban nature and lower design speed. Right turn lanes are proposed for the junctions with Old Rectory Park and Derryloran Industrial Estate.

Section 4 describes in detail the proposed junctions on Sandholes Link Road. Table 5-5 below provides a summary comparison of the existing and proposed arrangements.

Table 5-1 - Summary of Junctions and Side Road Treatment – Red Route Option

Chainage (m)	Side Road	Existing Layout	Proposed Layout	Comments
0	A29 Dungannon Road	Four-arm Roundabout	Fifth-arm connection to the existing Roundabout	A roundabout layout is considered appropriate for the required traffic movements. Minor adjustments to the existing layout would be required (A29 Dungannon Road exit arm and Tullywiggan Road entry arm) Provides a suitable connection to the existing road (and Trunk Road) network for the scheme.
795	Castle Road	Side Road Approx. 4.7m width, horizontal and vertical geometry to acceptable standard	Left-In, Left-Out (LILO) Access to and from the side road via southbound carriageway of the bypass only. West of the bypass will be stopped up with a turning head provided.	This junction has been designed to provide access for the existing residential and commercial premises on Castle Road as the existing road is a no through road to the east of the proposed bypass. The approximate diversion lengths for vehicles using Castle Road LILO to access Cookstown town centre is 1.5km, with a return journey diversion length of 2.5km[3].
1160	Killymoon Road	Side Road Approx. 5.4m width, horizontal and vertical geometry to acceptable standard	LILO Access to and from the side road via southbound carriageway of the bypass only. West of the bypass will be stopped up with a turning head provided.	This junction has been designed to maintain access to and from Killymoon Golf Course and Killymoon Castle. The approximate diversion length for vehicles using Killymoon Road LILO to access Cookstown town centre is 2.1km, with a return journey diversion length of 2.0km[3].
1675	Cloghog Road / Fountain Road	Side Road Approx. 5.6m width, horizontal and vertical geometry to acceptable standard	Four-arm online Roundabout (50m ICD)	A roundabout layout is considered appropriate for the required traffic movements as well as providing accessibility between the bypass and the local road network at the approximate mid-point of the scheme.
1675	Molesworth Road	Major / Minor Priority Junction	Realigned Ghost Island junction	Molesworth Road is proposed to be realigned to the west of its current location to increase the distance between the junction of Molesworth Road / Cloghog Road and the proposed roundabout.
1675	Cloghog Road / Clare Lane	Side Road Approx. 6.0m width, horizontal geometry below acceptable standard but vertical geometry is acceptable	Minor road realignment Increase the existing substandard 20m radius bend to improve geometry and visibility	With an anticipated increase in use by the local community to access the bypass, minor road realignment works are proposed to be carried out to improve the geometry along Clare Lane, primarily to address road safety concerns.
2195	B73 Coagh Road	Side Road Approx. 6.0m width, horizontal geometry to an acceptable standard but vertical geometry is below acceptable standard	Underbridge Side Road beneath the mainline	The bypass passes over the B73 Coagh Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure with improvements proposed to the vertical geometry to increase visibility through the structure.
2650	Old Coagh Road	Side Road Approx. 6.2m width, horizontal geometry to an acceptable standard but vertical geometry is below acceptable standard	Underbridge Side Road beneath the mainline	The bypass passes over Old Coagh Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure Scope to improve the vertical geometry is limited due to existing properties.
3550	A29 Moneymore Road	Side Road Approx. 11.4m width, horizontal and vertical geometry to acceptable standard	Four-arm online elongated Roundabout (72m ICD)	A roundabout layout is considered appropriate for the required traffic movements. The elongated shape is necessary to provide entry deflection for each roundabout arm and accommodate the almost parallel nature of the adjoining roads. An arm to facilitate access for residential properties on Tamlaghtmore Road has been provided. The east arm of the roundabout (A29 Moneymore Road) is proposed to widen / extend the existing dual carriageway within the existing road footprint

Notes:

1. The existing layout is described where the proposed scheme crosses the existing
2. Major / Minor Priority junctions in this context are those where give-way road markings and signs are provided
3. The measured diversion route for those wishing to access the town centre from Castle Road or Killymoon Road will be: use of the LILO junction, travel to Loughry Roundabout then along the existing A29 to their destination. Access to Castle Road and Killymoon Road will only be provided via Cloghog Road Roundabout, onto the bypass in the southbound direction, and utilise the required LILO junction

Table 5-2 - Summary of Junctions and Side Road Treatment – Purple A Route Option

Chainage (m)	Side Road	Existing Layout	Proposed Layout	Comments
0	A29 Dungannon Road	Four-arm Roundabout	Fifth-arm connection to the existing Roundabout	A roundabout layout is considered appropriate for the required traffic movements. Minor adjustments to the existing layout would be required (A29 Dungannon Road exit arm and Tullywiggan Road entry arm) Provides a suitable connection to the existing road (and Trunk Road) network for the scheme.
775	Castle Road	Side Road Approx. 4.1m width, horizontal and vertical geometry to acceptable standard	Left-In, Left-Out (LILO) Access to and from the side road via southbound carriageway of the bypass only. West of the bypass will be stopped up with a turning head provided.	This junction has been designed to provide access for the existing residential and commercial premises on Castle Road as the existing road is a no through road to the east of the proposed bypass. The approximate diversion lengths for vehicles using Castle Road LILO to access Cookstown town centre is 1.5km, with a return journey diversion length of 3.1km[3].
1090	Killymoon Road	Side Road Approx. 5.2m width, horizontal geometry to an acceptable standard but vertical geometry is below acceptable standard	Overbridge Side Road over the mainline	The bypass passes under Killymoon Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the vertical geometry is limited without significant landtake requirements.
1900	Cloghog Road / Fountain Road	Side Road Approx. 5.7m width, horizontal and vertical geometry to acceptable standard	Four-arm online Roundabout (60m ICD)	A roundabout layout is considered appropriate for the required traffic movements as well as providing accessibility between the bypass and the local road network at the approximate mid-point of the scheme.
1900	Cloghog Road / Clare Lane	Side Road Approx. 6.0m width, horizontal geometry below acceptable standard but vertical geometry is acceptable	Minor road realignment Increase the existing substandard 20m radius bend to improve geometry and visibility	With an anticipated increase in use by the local community to access the bypass, minor road realignment works are proposed to be carried out to improve the geometry along Clare Lane, primarily to address road safety concerns.
2525	B73 Coagh Road	Side Road Approx. 6.6m width, horizontal geometry below acceptable standard but vertical geometry is acceptable	Underbridge Side Road beneath the mainline	The bypass passes over the B73 Coagh Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the horizontal geometry is limited due to existing properties.
2875	Old Coagh Road	Side Road Approx. 5.0m width, horizontal geometry to an acceptable standard but vertical geometry is below acceptable standard	Underbridge Side Road beneath the mainline	The bypass passes over Old Coagh Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the vertical geometry is limited without significant landtake requirements.
3950	A29 Moneymore Road	Side Road Approx. 11.4m width, horizontal and vertical geometry to acceptable standard	Four-arm online Roundabout (60m ICD)	A roundabout layout is considered appropriate for the required traffic movements. . An arm to facilitate access for residential properties on Tamlaghtmore Road has been provided. The east arm of the roundabout (A29 Moneymore Road) is proposed to widen / extend the existing dual carriageway within the existing road footprint

Notes:

1. The existing layout is described where the proposed scheme crosses the existing
2. Major / Minor Priority junctions in this context are those where give-way road markings and signs are provided
3. The measured diversion route for those wishing to access the town centre from Castle Road will be: use of the LILO junction, travel to Loughry Roundabout then along the existing A29 to their destination. Access to Castle Road and Killymoon Road will only be provided via Cloghog Road Roundabout, onto the bypass in the southbound direction, and utilise the LILO junction

Table 5-3 - Summary of Junctions and Side Road Treatment – Purple B Route Option

Chainage (m)	Side Road	Existing Layout	Proposed Layout	Comments
0	A29 Dungannon Road	Four-arm Roundabout	Fifth-arm connection to the existing Roundabout	A roundabout layout is considered appropriate for the required traffic movements. Minor adjustments to the existing layout would be required (A29 Dungannon Road exit arm and Tullywiggan Road entry arm) Provides a suitable connection to the existing road (and Trunk Road) network for the scheme.
775	Castle Road	Side Road Approx. 4.1m width, horizontal and vertical geometry to acceptable standard	Left-In, Left-Out (LILO) Access to and from the side road via southbound carriageway of the bypass only. West of the bypass will be stopped up with a turning head provided.	This junction has been designed to provide access for the existing residential and commercial premises on Castle Road as the existing road is a no through road to the east of the proposed bypass. The approximate diversion lengths for vehicles using Castle Road LILO to access Cookstown town centre is 1.5km, with a return journey diversion length of 3.1km[3].
1090	Killymoon Road	Side Road Approx. 5.2m width, horizontal geometry to an acceptable standard but vertical geometry is below acceptable standard	Overbridge Side Road over the mainline	The bypass passes under Killymoon Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the vertical geometry is limited without significant landtake requirements.
1900	Cloghog Road / Fountain Road	Side Road Approx. 5.7m width, horizontal and vertical geometry to acceptable standard	Four-arm online Roundabout (60m ICD)	A roundabout layout is considered appropriate for the required traffic movements as well as providing accessibility between the bypass and the local road network at the approximate mid-point of the scheme.
1900	Cloghog Road / Clare Lane	Side Road Approx. 6.0m width, horizontal geometry below acceptable standard but vertical geometry is acceptable	Minor road realignment Increase the existing substandard 20m radius bend to improve geometry and visibility	With an anticipated increase in use by the local community to access the bypass, minor road realignment works are proposed to be carried out to improve the geometry along Clare Lane, primarily to address road safety concerns.
2525	B73 Coagh Road	Side Road Approx. 6.6m width, horizontal geometry below acceptable standard but vertical geometry is acceptable	Underbridge Side Road beneath the mainline	The bypass passes over the B73 Coagh Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the horizontal geometry is limited due to existing properties.
2875	Old Coagh Road	Side Road Approx. 5.0m width, horizontal geometry to an acceptable standard but vertical geometry is below acceptable standard	Underbridge Side Road beneath the mainline	The bypass passes over Old Coagh Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the vertical geometry is limited without significant landtake requirements.
4290	A29 Moneymore Road	Side Road Approx 21.8m width, horizontal and vertical geometry to acceptable standard	Four-arm offline Roundabout (70m ICD)	A roundabout layout is considered appropriate for the required traffic movements. An arm to facilitate access for residential properties on Tamlaghtmore Road has been provided as well as an arm to replace a private access severed by the proposed tie-in location . The west arm of the roundabout (A29 Moneymore Road) is proposed to reduce / remove the existing dual carriageway to a single.

Notes:

1. The existing layout is described where the proposed scheme crosses the existing
2. Major / Minor Priority junctions in this context are those where give-way road markings and signs are provided
3. The measured diversion route for those wishing to access the town centre from Castle Road will be: use of the LILO junction, travel to Loughry Roundabout then along the existing A29 to their destination. Access to Castle Road and Killymoon Road will only be provided via Cloghog Road Roundabout, onto the bypass in the southbound direction, and utilise the LILO junction

Table 5-4 - Summary of Junctions and Side Road Treatment – Green Route Option

Chainage (m)	Side Road	Existing Layout	Proposed Layout	Comments
0	A29 Dungannon Road	Four-arm Roundabout	Fifth-arm connection to the existing Roundabout	A roundabout layout is considered appropriate for the required traffic movements. Minor adjustments to the existing layout would be required (A29 Dungannon Road exit arm and Tullywiggan Road entry arm) Provides a suitable connection to the existing road (and Trunk Road) network for the scheme.
800	Castle Road	Side Road Approx. 4.1m width, horizontal and vertical geometry to acceptable standard	Overbridge Side Road over the mainline	The bypass passes under Castle Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the vertical geometry is limited due to existing properties.
1140	Killymoon Road	Side Road Approx. 5.2m width, horizontal geometry to an acceptable standard but vertical geometry is below acceptable standard	Overbridge Side Road over the mainline	The bypass passes under Killymoon Road which remains open to users via an underbridge. This option looks at the impact of improving the horizontal and vertical geometry showing these works would require significant additional landtake requirements.
1925	Cloghog Road / Fountain Road	Side Road Approx. 5.7m width, horizontal and vertical geometry to acceptable standard	Four-arm online Roundabout (60m ICD)	A roundabout layout is considered appropriate for the required traffic movements as well as providing accessibility between the bypass and the local road network at the approximate mid-point of the scheme.
1925	Cloghog Road / Clare Lane	Side Road Approx. 6.0m width, horizontal geometry below acceptable standard but vertical geometry is acceptable	Minor road realignment Increase the existing substandard 20m radius bend to improve geometry and visibility	With an anticipated increase in use by the local community to access the bypass, minor road realignment works are proposed to be carried out to improve the geometry along Clare Lane, primarily to address road safety concerns.
2550	B73 Coagh Road	Side Road Approx. 5.9m width, horizontal and vertical geometry is acceptable	Underbridge Side Road beneath the mainline	The bypass passes over the B73 Coagh Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the horizontal geometry is limited due to existing properties.
2920	Old Coagh Road	Side Road Approx. 5.2m width, horizontal geometry to an acceptable standard but vertical geometry is below acceptable standard	Underbridge Side Road beneath the mainline	The bypass passes over Old Coagh Road which remains open to users via an underbridge. Minor tie-in works are likely to be required in the vicinity of the proposed structure. Scope to improve the vertical geometry is limited without significant landtake requirements.
3960	A29 Moneymore Road	Side Road Approx. 11.4m width, horizontal and vertical geometry to acceptable standard	Four-arm online Roundabout (60m ICD)	A roundabout layout is considered appropriate for the required traffic movements. . An arm to facilitate access for residential properties on Tamlaghtmore Road has been provided. The east arm of the roundabout (A29 Moneymore Road) is proposed to widen / extend the existing dual carriageway within the existing road footprint

Notes:

1. The existing layout is described where the proposed scheme crosses the existing
2. Major / Minor Priority junctions in this context are those where give-way road markings and signs are provided

Table 5-5 – Summary of Junctions and Side Road Treatment – Sandholes Link Road

Chainage (m)	Side Road	Existing Layout	Proposed Layout	Comment
0	A505 Drum Road	Major / Minor Priority Junction	Three-arm online Roundabout (42m ICD)	Roundabout layout is better equipped to cope with the required traffic movements and encourage use of Sandholes Link Road to access the bypass to the east of the town.
100	Old Rectory Park	Major / Minor Priority Junction (staggered crossroads)	Ghost island junction	Provides a safer turning option and decreases the delay experienced compared with a simple priority junction with increased traffic volumes expected along the link road. Due to the proximity of the junction to Derrylornan Industrial Estate, provision of ghost islands aims to prevent conflicting movements causing collisions in this location.
175	Derrylornan Industrial Estate	Major / Minor Priority Junction (staggered crossroads)	Ghost Island junction	Provides a safer turning option and decreases the delay experienced compared with a simple priority junction with increased traffic volumes expected along the link road. Due to the proximity of the junction to Old Rectory Park, provision of ghost islands aims to prevent conflicting movements causing collisions in this location.
400	Direct Access	Simple T-Junction	Simple T-Junction	Number of turning movements expected is low and a simple T-junction is appropriate
430	Strifehill Road (at junction with Sandholes Road)	Major / Minor Priority Junction	Stopped up	Access to Sandholes Link Road from Strifehill Road will be stopped up to reduce the number of junctions along its length, and remove this potential 'rat-run'. Strifehill Road will become a no through road, with no further changes proposed along its length. Access to the east-west Sandholes Road is proposed to be maintained.
590	Ballyreagh Business Park	Major / Minor Priority Junction	Major / Minor Priority Junction	Number of turning movements expected is manageable and a priority junction is appropriate
620	Private residential accesses	Simple T-Junction	Simple T-Junction	Number of turning movements expected is low and a simple T-junction is appropriate
690	Sandholes Road (from Loughry Roundabout)	Major / Minor Priority Junction	Three-arm online Roundabout (50m ICD)	Roundabout layout is better equipped to cope with the required traffic movements and encourage use of Sandholes Link Road to access the bypass to the east of the town.

Notes:

1. The existing layout is described where the proposed scheme crosses the existing
2. Major / Minor Priority junctions in this context are those where give-way road markings and signs are provided
3. Simple T-junctions in this context are those without road markings – typical of driveway or single commercial premises access

5.1.6. OVERTAKING OPPORTUNITIES

Overtaking Opportunities at this Preliminary Design Stage are introduced by provision of a minimum length (250m) of Differential Acceleration Lanes (DALs) and climbing lanes (CL) where these are required by the proposed vertical geometry.

Table 5-6 – Summary of Overtaking Opportunities

Route Option	Climbing Lane Location (Ch) (m)	Loughrey Rbt	Cloghog Road Rbt		A29 Moneymore Road Rbt	Total Length of Overtaking	Balance (NB/SB) (%)
		NB	NB	SB	SB		
Red	510-960	×	✔	×	✔	950m	74 : 26
Purple A	510-940	×	✔	×	✔	1180m	58 : 42
Purple B	510-940	×	✔	×	✔	1180m	58 : 42
Green	-	✔	✔	✔	✔	1000m	50 : 50

The Green Route Option is considered to be the preferred option from an overtaking perspective. Whilst it has the second longest length of overtaking opportunities (1000m) this is provided via DALs only, without the requirement for a climbing lane, and provides a 50:50 balance between northbound and southbound overtaking.

Purple A and Purple B Route Options provide 1180m total overtaking length with a 58:42 balance between northbound and southbound overtaking. The additional length compared to the Green Route Option is due to a climbing lane provision. A southbound DAL from Cloghog Road Roundabout cannot be provided (without approval of a Departure from Standard) due to the proximity of the LILO junction at Castle Road.

The Red Route Option provides the shortest length of overtaking opportunity and the weakest balance between northbound and southbound opportunities (74:26). The location of the LILO junction to Killymoon Road precludes provision of a southbound DAL from Cloghog Road Roundabout.

It is noted at Specimen Design that overtaking opportunities north of Cloghog Road will be investigated further for the preferred route option. Due to the proposed horizontal geometry and the location of the LILO junctions, only the Green Route Option currently provides scope to increase the DAL length south of Cloghog Road.

5.1.7. ROAD LIGHTING

Due to the rural nature of the scheme, road lighting is only proposed at and on the approach to junctions to increase visibility and provide prior warning of the junction. Details of the type and extents of road lighting to provided shall form part of the proposed specimen design at Stage 3. No road lighting is currently proposed at locations where the bypass crosses side roads and structures are provided.

As Sandholes Link Road is in an urban setting road lighting shall be provided along its full length.

5.1.8. NON-MOTORISED USER (NMU) FACILITIES

5.1.8.1. Bypass Route Options

An initial NMU assessment looked at existing facilities, usage patterns and trip generators under stage 1 of GG142 “Walking, Cycling and Horse Riding Assessment and Review”. The key findings relevant to this report are summarised as follows:

- Cars are the main mode of transport for the majority of work-related activity, trips to local amenities and other trip generators. There is light pedestrian use of the footways within the scheme extents, with a total of 130 recorded journeys along the footways within the scheme extents surveyed in March 2019 throughout a full day.
- Walking facilities are generally provided in the town centre with their termination close to the extents of residential development to the east of Cookstown and are typically between 1-2m width.
- Cycling facilities include the National Cycle Network Route 95, interacting with the bypass at the proposed Cloghog Road Roundabout. This network is generally on-road with route signage only (no road markings for example). Within the town, there are discrete lengths which are off-road shared footway / cycleway.
- These existing facilities are in acceptable condition, with adequate signage, road markings and surfacing where applicable. There are no current plans publicly available for additional pedestrian or cycling facilities or upgrades to the network within Cookstown town centre, in the vicinity of the bypass route options or Sandholes Link Road
- There are no existing equestrian facilities impacted by the route options
- North of B73 Coagh Road there are limited existing pedestrian or cyclist facilities and few trip attractors, however south of B73 Coagh Road there are notably more trip generators / attractors such as schools, sports facilities, centres of employment and other amenity locations including Killymoon Golf Club, Killymoon Castle and Demesne, and Cabin Wood.

There are a number of opportunities for the provision and / or enhancement of the existing facilities for walking and cycling in the Cookstown area which may be realised as part of the construction of the bypass, although are not included within the current scope of this commission. A Feasibility Assessment of additional walking and cycling facilities will be undertaken during the development of the proposed specimen design at Stage 3. Any additional walking and cycling facilities identified in the Feasibility study may be advanced separately to, and after completion of the main bypass works.

Where existing footways / cycleways are severed by a proposed junction (such as Loughry Roundabout) it is proposed to provide appropriate NMU facilities (e.g. dropped kerb crossing points) to accommodate NMU movements. Each of the route options include a 3.0m wide shared footway / cycleway on the northbound side of the carriageway with an additional 0.5m separation width (in accordance with TA90/05). This facility is proposed on the “townside” of the bypass to permit access from the town to the facilities without having to cross the bypass. The appropriate provision and need for NMU facilities will be further explored at Stage 3.

An extension of the existing footway and road lighting has been proposed for the Purple A, Purple B and Green Route Options at Cloghog Road to provide NMU access to the bypass and its shared footway / cycleway. Cloghog Road Roundabout on the Red Route Option will similarly provide this access, without the requirement for an extension to the existing footway.

Further consultation with statutory bodies and other interested stakeholders during the development of the proposed specimen design at stage 3 shall confirm the extents and type of NMU facilities to be provided. Should stakeholders be in agreement, it is recommended that as a minimum an NMU facility is provided from Loughry Roundabout to Cloghog Road Roundabout as this section has a higher likelihood of attracting NMU movements due to the proximity of trip generators and attractors such as schools, residential developments and amenity space to the proposed bypass. North of Cloghog Road there is a lower concentration of housing and trip generators / attractors as the bypass is further away from the town centre.

It is recommended that cycling facilities are provided at the proposed junction with Cloghog Road where the National Cycle Network (NCN) 95 is crossed by the bypass to encourage safe use by all users.

5.1.8.2. Sandholes Link Road

It is proposed to retain the current footway provision along the Sandholes Link Road as a minimum. This will provide continued access to and from residential developments such as Old Rectory Park, as well as recreational areas, Derrylornan Church and industrial units along the link road.

During the development of the proposed specimen design at Stage 3, the feasibility of providing additional walking and cycling facilities along the Sandholes Link Road, such a wider shared footway / cycleway on the northbound carriageway provide better connections to the existing shared facilities on the main Sandholes Road and Drum Road will be examined.

Further consultation with statutory bodies such as Translink and SUSTRANS will be undertaken during the development of the proposed specimen design at Stage 3 to confirm the extents and type of bus facilities to be provided. As a minimum it is anticipated that the scheme will retain existing bus stop and shelter at their current locations.

5.1.9. HIGHWAYS GEOMETRY AND DEPARTURES FROM STANDARDS

Each of the proposed Route Options has been assessed against the follow DMRB Standards:

- TA90/05 The Geometric Design of Pedestrian, Cycle and Equestrian. Routes.
- TD9/93 Highway Link Design
- TD16/07 Geometric Design of Roundabouts
- TD42/95 Geometric Design of Major-Minor Priority Junctions

It is not always possible to design and construct a completely ‘to standard’ scheme due to existing constraints and the need to balance the schemes requirements against its impacts.

A number of side road realignments along the route options have been designed with substandard geometry in order to minimise the impact on the surrounding area. In each case a Relaxation from Standard and/or a Departure from Standard will be required. These details have not been included at this stage, with the focus of the assessment on the mainline.

All Relaxations and Departures from Standard will be submitted for approval in principle by the relevant Overseeing Organisation prior to the completion of the Specimen Deisgn at Stage 3.

5.1.9.1. Red Route Option

The Red Route has been designed as a wide single rural all-purpose road with a design speed of 100kph (60mph). Please refer to drawing reference 718314-WSP-B-D-0800-0099 to 0103 in

Appendix A for Red Route general arrangement drawings which illustrate the proposed horizontal and vertical alignment.

A minimum 2.5m wide verges and 1m hard strips are provided on both sides of the bypass. A 3m wide NMU provision (shared footway/cycleway) with a 0.5m segregation width has been provided on the northbound side of the carriageway from Loughry Roundabout to A29 Moneymore Road Roundabout, with a crossing point and refuge island on the west arm of Cloghog Road Roundabout.

Overtaking opportunities would be provided in both directions along the Red Route in the form of a climbing lanes and Differential Acceleration Lanes (DALs). A climbing lane designed in accordance with TD9/93 is proposed near the WwTW (circa. Ch450m) which would extend north for 500m with 2 lanes northbound and 1 lane southbound to mitigate a vertical gradient of +2% up to ≤6%. DALs (3.5m lane widths) are proposed for the northbound exit from the Cloghog Road Roundabout and the southbound exit off the A29 Moneymore Road Roundabout. DALs cannot be accommodated on the southbound exit from Cloghog Road Roundabout or the northbound exit from Loughry Roundabout as each would conflict with the proposed climbing lane.

All horizontal alignment elements of the bypass comply with design standard TD9/93, with the desirable minimum radius of 720m for a 100kph design speed achieved.

The vertical crest curve between Castle Road and Killymoon Road is one step below the Desirable minimum crest curve for a 100kph design speed. This relaxation of standard is required to ensure the bypass crosses both Castle Road and Killymoon Road at approximately the same level as the existing carriageway to provide junction access to each side road. However, this sub-optimum crest curve results in the Stopping Sight Distance (SSD) in each direction on the bypass falling one step below the desirable minimum for a 100kph design speed and restricts visibility for road users joining the bypass at each of the side road junctions. While on all approaches the full extent of each junction would be visible to road users, the siting of Castle Road junction on a decline should also be considered as relaxations of standard (Para. 3.6 TD42/95). All other vertical alignment elements of the bypass are to standard for a 100kph design speed.

The restrictions on right turning movements of the Left in Left Out only (LILO) junctions at Castle Road and Killymoon Road would each be a relaxation of standard. However, the siting of both junctions within a climbing lane section is also a Departure from Standard (TD42/94 Para. 7.68).

Departures and relaxations of standard for the Red Route Option are summarised in Table 5-7 and Table 5-8 below.

Table 5-7 - Departure from Standards (DfS) – Red Route Option

Item	Chainage (m)	Departure from Standards
DfS-RR-01	723 - 1197	The Desirable Minimum Crest K Value for a 100kph Design Speed is 100. The vertical crest curve between Ch723m-1197m has a K value of 66.7 which would be 1 step below standard for a 100kph road. This would require a departure from standard when considered in conjunction with the LILO junctions located at Ch800m and C1160m.
DfS-RR-02	631 - 1038 NB	The Desirable Minimum SSD for a 100kph Design Speed is 215m. An SSD of 215m would not be achieved in the northbound direction between Ch631m-1038m (inc.). However, an SSD of >160m would be achieved - 1 step below standard for a 100kph road. This would require a departure from standard when considered in conjunction with the sub-optimum vertical alignment between Ch723-1197m.

Item	Chainage (m)	Departure from Standards
DfS-RR-03	1270 - 900 SB	The Desirable Minimum SSD for a 100kph Design Speed is 215m. An SSD of 215m would not be achieved in the southbound direction between Ch1272m-894m (inc.). However, an SSD of >160m would be achieved - 1 step below standard for a 100kph road. This would require a departure from standard when considered in conjunction with the sub-optimum vertical alignment between Ch723-1197m.
DfS-RR-04	800	Full visibility (215m) to the left at the proposed Castle Road junction is achieved. Visibility to the right for an eye height of 1.05m and a target height of 0.26m is restricted by the vertical alignment of the proposed bypass. Visibility to the right at a 'x' distance of 9m would be 18m. At a relaxed 'x' distance of 2.4m visibility to the right would be 60m which would represent a >4 Step departure from standard. When the target height is raised to ≥0.9m, full visibility of 215m is achieved at a relaxed 'x' distance of 4.5m.
DfS-RR-05	800	The LILO junction for Castle Road is located within a climbing lane section which would require a Departure from Standard (TD42/94 Para. 7.68).
DfS-RR-06	1160	At a relaxed 'y' distance of 4.5m full visibility to the right at the proposed Killymoon Road junction for an eye height of 1.05m and a target height of 0.26m is achieved. Visibility to the left is restricted by the vertical alignment of the proposed bypass. Visibility to the left at an 'x' distance of 9m would be 72m. At a relaxed 'x' distance of 2.4m visibility to the left would be 74m which would represent a 4 Step departure from standard. When the target height is raised to ≥0.7m, full visibility of 215m is achieved at a relaxed 'x' distance of 4.5m.
DfS-RR-07	1160	The LILO junction for Killymoon Road is located within a climbing lane section which is a Departure from Standard (TD42/94 Para. 7.68).

Table 5-8 – Relaxations of Standards (RoS) – Red Route Option

Item	Chainage (m)	Relaxation of Standards
RoS-RR-01	800	The LILO for Castle Road is designed to layout 4 in TD41/95; for a single carriageway road this requires a relaxation of standard as right turning movements are not permitted.
RoS-RR-02	800	Para. 3.6 of TD 42/95 advises "*The best locations for junctions are on level ground, or where the gradient of the approaches does not exceed 2% either uphill or downhill. Downhill approaches in excess of this figure, particularly on high speed roads, can induce traffic speeds above those desirable through the junction, and lead to a misjudgment of the approach speed by drivers entering from the minor road.*" The siting of the Castle Road junction on a 5-6% decline should be considered as a relaxation of standard.
RoS-RR-03	1150	The LILO for Killymoon Road is designed to layout 4 in TD 41/95; for a single carriageway road this requires a relaxation of standard as right turning movements are not permitted.

5.1.9.2. Purple A Route

The Purple A Route Option has been designed as a wide single rural all-purpose road with a design speed of 100kph (60mph). Please refer to drawing reference 718314-WSP-B-D-0800-0109 to 0114 in Appendix A for Purple A Route general arrangement drawings which illustrate the proposed horizontal and vertical alignment.

A minimum 2.5m wide verges and 1m hard strips are provided on both sides of the bypass. A 3m wide NMU provision (shared footway/cycleway) with a 0.5m segregation width has been provided on the northbound side of the carriageway from Loughry Roundabout to A29 Moneymore Road Roundabout, with a crossing point and refuge island on the west arm of Cloghog Road Roundabout.

Overtaking opportunities have been provided along the Purple A Route in both directions. A climbing lane, which has been designed in accordance with TD9/93 is proposed from near the WwTW (circa. Ch450m) which would extend north for 500m with 2 lanes northbound and 1 lane southbound to mitigate a vertical gradient of +2% up to ≤6%. DALs are located on the southbound and northbound exits from Cloghog Road Roundabout and southbound exit from the Moneymore Road Roundabout. A DAL has not been provided on the northbound exit from Loughry Roundabout as it would conflict with the proposed climbing lane located at the WwTW.

The horizontal alignment passes between the Ballinderry River and the WwTW on a left hand 510m radius and then follows the boundaries of several residential properties between Castle Road and Golf View on a right hand 510m radius. These radii would be one step below the Desirable Minimum Radius. However, each would require a departure from standard when considered in conjunction with a relaxation in vertical alignment standards at this location. Tighter radii have been used to reduce the impact of the route on Killymoon Golf Course. All other horizontal alignment elements comply with design standards (TD9/93) for a 100kph design speed achieved.

As discussed above the vertical crest curve between Castle Road and Killymoon Road (K = 55) would be one step below the desirable minimum crest K value. This sub-optimum alignment is required to connect the bypass with Castle Road at the existing carriageway level and to provide sufficient headroom for the bridge taking Killymoon Road over the bypass. However, the K = 55 crest curve results in the SSD in both directions falling one step below the desirable minimum. All other vertical alignment elements on the bypass are to standard for a 100kph design speed.

It should be noted that the siting of the Moneymore Roundabout at the end of a >450m descent (northbound) and the Cloghog Road Roundabout at the end of a >350m descent (southbound) would each be a relaxation of standard (as per TD16/07 Para. 4.6).

The restriction on right turning movements of the LILO junction at Castle Road would be a relaxation of standard. However, the siting of this junction within a climbing lane section would also require a Departure from Standard.

Departures and relaxations of standard for the Purple A Route Option are summarised in Table 5-9 and Table 5-10 below.

Table 5-9 - Departure from Standards (DfS) – Purple A Route Option

Item	Chainage (m)	Departure from Standards
DfS-PA-01	446-759	A horizontal curve (R = 510m) with 7% superelevation is 1 step below the Desirable minimum radius for a 100kph Design Speed. This requires a departure from standard (between Ch710-760m) when considered in conjunction with the sub-optimum vertical alignment between at Ch710-1142m.

Item	Chainage (m)	Departure from Standards
DfS-PA-02	899-1310	A horizontal curve (R = 510m) with 7% superelevation is 1 step below the Desirable minimum radius for a 100kph Design Speed. This requires a departure from standard (between Ch899-1142m) when considered in conjunction with the sub-optimum vertical alignment between Ch710-1142m.
DfS-PA-03	710-1142	The Desirable Minimum Crest K Value for a 100kph Design Speed is 100. The vertical crest curve between Ch710m-1142m has a K value of 55 which would be 1 step below standard for a 100kph road. This would require a departure from standard when considered in conjunction with the LILO junction located at Ch775m.
DfS-PA-04	630-790 NB	The Desirable Minimum SSD for a 100kph Design Speed is 215m. An SSD of 215m would not be achieved in the northbound direction between Ch630m-790m (inc.). However, an SSD of >160m would be achieved. This would be 1 step below standard for a 100kph road. This would require a departure from standard when considered in conjunction with the sub-optimum vertical alignment between Ch710m-1142m.
DfS-PA-05	1180-880 SB	The Desirable Minimum SSD for a 100kph Design Speed is 215m. An SSD of 215m would not be achieved in the southbound direction between Ch1180m-880m (inc.). However, an SSD of >160m would be achieved. This would be 1 step below standard for a 100kph road. This would require a departure from standard when considered in conjunction with the sub-optimum vertical alignment between Ch710m-1142m.
DfS-PA-06	775	The LILO junction for Castle Road is located within a climbing lane section which would require a Departure from Standard (TD42/94 Para. 7.68).
DfS-PA-07	775	Full visibility (215m) to the left at the proposed Castle Road junction is achieved. Visibility to the right for an eye height of 1.05m and a target height of 0.26m is restricted by the cut slope at the back of verge and the vertical alignment of the proposed bypass. Visibility to the right at a 'x' distance of 9m would be 18m. At a relaxed 'x' distance of 2.4m visibility to the right would be 132m which would represent a 2 Step departure from standard. With verge widening and the target height raised to ≥0.8m, full visibility of 215m is achieved at a relaxed 'x' distance of 4.5m.

Table 5-10 – Relaxations of Standards (RoS) – Purple A Route Option

Item	Chainage (m)	Relaxation of Standards
RoS-PA-01	775	The LILO junction for Castle Road is designed to layout 4 in TD 41/95; for a single carriageway road this is a relaxation of standard as right turning movements are not permitted.
RoS-PA-02	1890	Para. 4.6 of TD 16/07 advise that "*… Roundabouts should not be sited at the bottom of or on long descents*." The proposed Cloghog Road Roundabout would be sited at the end of a >350m descent (southbound) which would be a relaxation of standard.
RoS-PA-03	3600	Para. 4.6 of TD 16/07 advise that "*… Roundabouts should not be sited at the bottom of or on long descents.*" The proposed Moneymore Roundabout would be sited at the end of a >450m descent which would be a relaxation of standard.

5.1.9.3. Purple B Route

The Purple B Route Option has also been designed as a wide single rural all-purpose road with a design speed of 100kph (60mph). Please refer to drawing reference 718314-WSP-B-D-0800-0120 to 0126 in Appendix A for Purple B Route general arrangement drawings which illustrate the proposed horizontal and vertical alignment.

A minimum 2.5m wide verges and 1m hard strips are provided on both sides of the bypass. A 3m wide NMU provision (shared footway/cycleway) with a 0.5m segregation width has been provided on the northbound side of the carriageway from Loughry Roundabout to A29 Moneymore Road Roundabout, with a crossing point and refuge island on the west arm of Cloghog Road Roundabout.

Overtaking opportunities have been provided along the Purple B Route in both directions. A climbing lane, which has been designed in accordance with TD9/93 is proposed from near the WwTW (circa. Ch450m) which would extend north for 500m with 2 lanes northbound and 1 lane southbound to mitigate a vertical gradient of +2% up to ≤6%. DALs are located on the southbound and northbound exits from Cloghog Road Roundabout and southbound exit from the Moneymore Road roundabout. A DAL has not been provided on the northbound exit from Loughry Roundabout as it would conflict with the proposed climbing lane located at the WwTW.

The departures from standard and relaxations of standard identified on the Purple A Route also apply to the Purple B route Option. The horizontal alignment between the Ballinderry River and the WwTW on a left hand 510m radius and then follows the boundaries of several residential properties between Castle Road and Golf View on a right hand 510m radius. These radii would be one step below the Desirable Minimum Radius. However, each would each require a departure from standard when considered in conjunction with a relaxation in vertical alignment standards at this location. Tighter radii have been used to reduce the impact of the route on Killymoon Golf Course. All other horizontal alignment elements comply with design standards (TD9/93) for a 100kph design speed achieved.

As discussed above the vertical crest curve between Castle Road and Killymoon Road (K = 55) would be one step below the desirable minimum crest K value. This sub-optimum alignment is required to connect the bypass with Castle Road at the existing carriageway level and to provide sufficient headroom for the bridge taking Killymoon Road over the bypass. However, the K = 55 crest curve results in the SSD in both directions falling one step below the desirable minimum. All other vertical alignment elements on the bypass are to standard for an all-purpose single carriageway.

The Moneymore Roundabout would be sited at the bottom of a >760m descent which is interrupted by a short ascent (circa. 120m) immediately prior to the yield line for the circulatory carriageway of the roundabout. While not strictly stated in TD16/07 Para. 4.6 this arrangement could be considered as a relaxation of standard.

Departures and relaxations of standard for the Purple B Route Option are summarised in Table 5-11 and Table 5-12 below.

Table 5-11 - Departure from Standards (DfS) – Purple B Route Option

Item	Chainage (m)	Departure from Standards
DfS-PB-01	446-759	A horizontal curve (R = 510m) with 7% superelevation is 1 step below the Desirable minimum radius for a 100kph Design Speed. This requires a departure from standard (between Ch710-760m) when considered in

Item	Chainage (m)	Departure from Standards
		conjunction with the sub-optimum vertical alignment between at Ch710-1142m.
DfS-PB-02	899-1310	A horizontal curve (R = 510m) with 7% superelevation is 1 step below the Desirable minimum radius for a 100kph Design Speed. This requires a departure from standard (between Ch899-1142m) when considered in conjunction with the sub-optimum vertical alignment between Ch710-1142m.
DfS-PB-03	710-1142	The Desirable Minimum Crest K Value for a 100kph Design Speed is 100. The vertical crest curve between Ch710m-1142m has a K value of 55 which would be 1 step below standard for a 100kph road. This requires a departure from standard when considered in conjunction with the LILO junction located at Ch775m.
DfS-PB-04	630-790 NB	The Desirable Minimum SSD for a 100kph Design Speed is 215m. An SSD of 215m would not be achieved in the northbound direction between Ch630m-790m (inc.). However, an SSD of >160m would be achieved. This would be 1 step below standard for a 100kph road. This would require a departure from standard when considered in conjunction with the sub-optimum vertical alignment between Ch710m-1142m.
DfS-PB-05	1180-880 SB	The Desirable Minimum SSD for a 100kph Design Speed is 215m. An SSD of 215m would not be achieved in the southbound direction between Ch1180m-880m (inc.). However, an SSD of >160m would be achieved. This would be 1 step below standard for a 100kph road. This would require a departure from standard when considered in conjunction with the sub-optimum vertical alignment between Ch710m-1142m.
DfS-PB-06	775	The LILO junction for Castle Road is located within a climbing lane section which would require a Departure from Standard (TD42/94 Para. 7.68).
DfS-PB-07	775	Full visibility (215m) to the left at the proposed Castle Road junction is achieved. Visibility to the right for an eye height of 1.05m and a target height of 0.26m is restricted by the cut slope at the back of verge and the vertical alignment of the proposed bypass. Visibility to the right at a 'x' distance of 9m would be 18m. At a relaxed 'x' distance of 2.4m visibility to the right would be 132m which would represent a 2 Step departure from standard. With verge widening and the target height raised to ≥0.8m, full visibility of 215m is achieved at a relaxed 'x' distance of 4.5m.

Table 5-12 – Relaxations of Standards (RoS) – Purple B Route Option

Item	Chainage (m)	Relaxation of Standards
RoS-PB-01	775	The LILO junction for Castle Road is designed to layout 4 in TD 41/95; for a single carriageway road this is a relaxation of standard as right turning movements are not permitted.
RoS-PB-02	3600	Para. 4.6 of TD 16/07 advise that "*… Roundabouts should not be sited at the bottom of or on long descents.*" The proposed Moneymore Roundabout would be sited at the bottom of a >760m descent followed by a short accent (circa. 120m) should also be considered as a relaxation of standard

5.1.9.4. Green Route

The Green Route has been designed as a wide single rural all-purpose road with a design speed of 100kph (60mph). Please refer to drawing reference 718314-WSP-B-D-0800-0191 to 0196 in Appendix A for Green Route general arrangement drawings which illustrate the proposed horizontal and vertical alignment.

A minimum 2.5m wide verges and 1m hard strips are provided on both sides of the bypass. A 3m wide NMU provision (shared footway/cycleway) with a 0.5m segregation width has been provided on the northbound side of the carriageway from Loughry Roundabout to A29 Moneymore Road Roundabout, with a crossing point and refuge island on the west arm of Cloghog Road Roundabout.

Overtaking opportunities would be provided in both directions along the Green Route in the form of Differential Acceleration Lanes (DALs). DALs (3.5m lane widths) are proposed for the northbound exit from Loughrey Roundabout, both the northbound and southbound exits from Cloghog Road Roundabout and the southbound exit from A29 Moneymore Road roundabout. No climbing lanes are required.

The horizontal alignment passes between the Ballinderry River and the WwTW on two 510m radii. A right hand 510m radius followed by a left hand 510m radius has been applied to follow the boundaries of several residential properties between Castle Road and Golf View. Each of these radii would be one step below the Desirable Minimum Radius. Tighter radii have been used to reduce the impact of the route on the WwTW and Killymoon Golf Course. All other horizontal alignment elements of the bypass comply with design standards (TD9/93) for a 100kph design speed achieved.

All vertical alignment elements of the bypass comply with design standards (TD9/93) for a 100kph design speed.

The desirable minimum SSD for a 100kph design in each direction on the bypass can be achieved. While the positioning of the Killymoon Road Overbridge abutments and/or piers may restrict forward visibility in the southbound direction, Para. 2.7 TD9/93 advises that short intermittent obstructions such as these can be ignored.

It should be noted that the siting of the Cloghog Road Roundabout (southbound) and the Moneymore Roundabout (northbound) at the bottom of a >850m descent in southbound direction would each be a relaxation of standard (as per TD16/07 Para. 4.6).

A summary of the relaxations of standard for the Green Route Option are summarised in Table 5-11 below.

Table 5-13 - Relaxations of Standards (RoS) – Green Route Option

Item	Chainage (m)	Relaxation of Standard
RoS-GR-01	34-296	A horizontal curve (R = 510m) with 7% superelevation is 1 step below the Desirable minimum radius for a 100kph Design Speed.
RoS-GR-02	504-631	A horizontal curve (R = 510m) with 7% superelevation is 1 step below the Desirable minimum radius for a 100kph Design Speed.
RoS-GR-03	1080-1212	A horizontal curve (R = 510m) with 7% superelevation is 1 step below the Desirable minimum radius for a 100kph Design Speed.

Item	Chainage (m)	Relaxation of Standard
RoS-GR-04	1675-1940	A horizontal curve (R = 510m) with 7% superelevation is 1 step below the Desirable minimum radius for a 100kph Design Speed.
RoS-GR-05	1940	Para. 4.6 of TD 16/07 advise that "… Roundabouts should not be sited at the bottom of or on long descents." The proposed Cloghog Road Roundabout would be sited at the bottom of a >850m descent (southbound) which would require a relaxation of standard.
RoS-GR-06	3900	Para. 4.6 of TD 16/07 advise that "… Roundabouts should not be sited at the bottom of or on long descents." The proposed Moneymore Roundabout would be sited at the bottom of a >850m descent (northbound) which would require a relaxation of standard.

5.1.9.5. Bypass Route Options Summary

It follows that the fewer the number of departures and relaxations inherent in the design, the more preferable from a geometry and safety assessment point of view that option will be. Table 5-14 summarises the number of DfS and RoS for each option and illustrates that the optimal route option from a geometry assessment is the Green Route Option.

Table 5-14 – Summary of Departures from Standard and Relaxations of Standards (RoS)

Route Option	No. of DfS	No. of RoS
Red	7	3
Purple A	7	3
Purple B	7	3
Green	0	6

5.1.9.6. Sandholes Link Road

The right hand 250m radius proposed between Ch343m-467m is one step below the desirable minimum radius for a 60kph (30mph) design speed if a superelevation of 7% was to be provided. However, a 7% superelevation would not be appropriate in this low speed, urban environment as it may present issues for both larger vehicles (LGV / HGVs) and non-motorised road users such as the mobility impaired and exacerbate level differences and gradients at existing accesses. These issues are likely to be compounded between Ch346m-376m where a 6% gradient is proposed. A reduced superelevation of 3.5-5% at this location would be more appropriate however would require a departure from standard.

Similarly, the left hand 127m radius proposed between Ch552m-656m would be two steps below the desirable minimum radius for a 60kph (30mph) design speed if a superelevation of 7% was to be provided. For the same reasons outlined above a superelevation of 3.5-5% at this location would be more appropriate and would require a departure from standard.

While the vertical alignment of the Link Road complies with TD9/93,it should be noted that the siting of the proposed A505 Drum Road Roundabout at the bottom of a descent in eastbound direction would be a relaxation of standard (as per TD16/07 Para. 4.6). The proposed vertical realignment of both Drum Road approaches to the new roundabout exceed 6% in places which would be a relaxation of standard (as per TD16/07 Para. 4.1). On the Drum Road east approach to the new roundabout the gradient exceeds 8% between approximately Ch40m-50m which would require a departure from standard (as per TD16/07 Para. 4.2). These gradients are necessary to tie-in to existing levels on Drum Road, which fall steeply towards Derryloran Bridge, whilst ensuring the proposed roundabout does not impact on Derryloran Church and grounds.

A left/right stagger junction is proposed between Old Rectory Park and the Derryloran Industrial Estate. The confined nature of the site means that the minimum stagger of 50m between junctions (Para.7.65 TD42/95) and minimum deceleration lengths have not been achieved so a departure from standard would be required. The proposed arrangement maintains the existing layout to minimise the impact on adjacent properties and retains access to the existing residential and industrial units. It is noted that planning permission was previously granted to relocate the existing junction to Old Rectory Park further north, increasing the stagger distance, but decreasing the distance between it and the proposed roundabout with A505 Drum Road. The location of the junction to Old Rectory Park will be confirmed during the development of the proposed specimen design at Stage 3.

Between Ch220m-260m southbound and Ch330m-240m northbound (inclusive) the SSD falls one step below the desirable minimum for a 30mph all-purpose single carriageway.

Departures and relaxations of standard for the Sandholes Link Road are summarised in Table 5-15 and Table 5-16 below.

Table 5-15 - Departure from Standards (DfS) – Sandholes Link Road Option

Item	Chainage (m)	Departure from Standards
DfS-SHL-01	140-180	The minimum distance for a left/right stagger junction is 50m. A stagger of <40m has been achieved which would require a departure from standard.
DfS-SHL-02	140	The minimum deceleration length for ghost Island and single lane dualling is 25m for a 60kph Design Speed. This has not been achieved for the Old Rectory Park right turn lane and requires a departure from standard.
DfS-SHL-03	180	The minimum deceleration length for ghost Island and single lane dualling is 25m for a 60kph Design Speed. This has not been achieved for the Derrylornan Industrial Estate right turn lane and requires a departure from standard.
DfS-SHL-04	343-467	The horizontal radius of 250m (one step below desirable minimum) requires use of superelevation of 7%. Use of 3.5-5% superelevation requires a departure from standard.
DfS-SHL-05	552-656	The horizontal radius of 127m (two steps below desirable minimum) requires use of superelevation of 7%. Use of 3.5-5% superelevation requires a departure from standard.
DfS-SHL-06	40-50 (Drum Rd. East)	The provision of vertical gradient of 8% between Ch40m-50m requires a departure from standard as stated in para. 4.2 of TD 9/93.

Table 5-16 – Relaxations of Standards (RoS) – Sandholes Link Road Option

Item	Chainage	Relaxation of Standards
RoS-SHL-01	220-260	The Desirable Minimum SSD for a 60kph Design Speed is 90m. An SSD of 90m would not be achieved in the southbound direction between Ch220m-260m (inc.). However, an SSD of >70m would be achieved. This would be 1 step below standard for a 100kph road.
RoS-SHL-02	330-240	The Desirable Minimum SSD for a 60kph Design Speed is 90m. An SSD of 90m would not be achieved in the northbound direction between Ch330m-240m (inc.). However, an SSD of >70m would be achieved. This would be 1 step below standard for a 100kph road
RoS-SHL-03	60 (Drum Road West)	Para. 4.6 of TD 16/07 advise that "… Roundabouts should not be sited at the bottom of or on long descents." The proposed Drum Road Roundabout would be sited at the bottom of a >200m descent (eastbound) which would require a relaxation of standard.
RoS-SHL-04	Drum Road West	The provision of a vertical gradient of which exceeds 6% (but <8%) on an all-purpose single carriageway would require a relaxation of standard as stated in para. 4.1 of TD 9/93.
RoS-SHL-05	Drum Road East	The provision of a vertical gradient of which exceeds 6% (but <8%) on an all-purpose single carriageway would require a relaxation of standard as stated in para. 4.1 of TD 9/93.

5.1.10. ROAD SAFETY

This part of the assessment has focussed on locations where collision rates are normally higher specifically at junctions and areas where poor visibility caused by substandard stopping sight distances / visibility issues are present. Table 5-17 summarises the number of proposed junctions per Route Option with the numbers of Dfs and RoS associated with junctions or visibility.

Table 5-17 – Summary of Junctions and Departures from Standard and Relaxations of Standards associated with visibility and junctions.

Route Option	No. of Junctions	No. of DfS / RoS: Visibility	No. of DfS / RoS: LILO
Red	5	2 DfS / 2 RoS	4 DfS / 2 RoS
Purple A	4	2 DfS / 1 RoS	2 DfS / 1 RoS
Purple B	4	2 DfS / 1 RoS	2 DfS / 1 RoS
Green	3	0	0

The principal objective of roundabout design is to provide the safe interchange of traffic between crossing traffic streams with minimum delay. This is achieved by geometric layout features that complement the networks traffic volume, speed and other location constraints. Roundabouts are particularly suitable for rural environments and are considered the safest form of at-grade junction over a wide range of entry flows and approach speeds. Roundabouts are especially effective where large numbers of right turn movements occur, which can lead to collisions at major/minor junctions. It is recognised that roundabouts are generally safer than other forms of at-grade junction and the inclusion of road lighting has been considered and included as an essential safety requirement in line with recommendations in TD 16/07.

As the tie-ins for each of the four Route Options consist of a fifth arm off the Loughry Roundabout and a new 4-arm roundabout at the Moneymore Road tie-in, with one dual carriageway approach, no one Route Option is more preferential than another from a safety at roundabout perspective in line with TD16/07 chapter 2.

The key differentiator between the presented route options are the inclusion and number of junctions outside of the three roundabouts proposed. These have been designed as Left-In, Left-Out junctions, typically used in locations where very minor roads encounter major limited-access roads as an alternative to stopping them up or where the justification for a bridge structure is difficult to justify. They are typically placed on dual carriageways where a full T-junction or crossroads would require a gap in the central reservation which could result in dangerous right-turns across oncoming traffic.

The bypass route options are designed as WS or WS2+1, without a central reserve. This can lead to a misunderstanding or in some cases, a disregard of the junctions prohibited movements. Allowing road users to turn right onto a high speed route from the side road increases the potential for side impact, right turning and rear impact type collisions. Road users slowing to a potential halt on the climbing lane of the bypass to accommodate right turning vehicles off the mainline would also increase the potential for serious rear impact type collisions.

To counter this, a prohibition on right turning manoeuvres would be required to address the road safety concerns. This is proposed to be via formation of a curved splitter island which forces vehicles to manoeuvre left on the approach and at the give way line. Reduced visibility from the LILO junctions is likely to be exacerbated by the splitter island as this will require the driver to utilise their mirrors or look slightly backwards over their right shoulder along the bypass to oncoming traffic. Visibility on the approach to junctions for road users joining the bypass at both side road junctions shall be reviewed during the development of the proposed specimen design at Stage 3.

Due to the existing physical constraints in the vicinity of Castle Road in particular (Ballinderry River and the WwTW), increasing the cross section of the carriageway to include a central reserve is unlikely to be feasible.

Should Red, Purple A or Purple B be taken forward as the Preferred Route, it is recommended that the LILO junction incorporates merge and diverge tapers to reduce the likelihood of rear-end collisions to those slowing down on the mainline to turn into the side road, as well as for those joining the bypass from the side road from a standstill.

From a safety assessment perspective, the Green Route Option provides the best solution with no side roads having direct access onto the mainline (i.e.. no LILO junctions) other than at the roundabout at Cloghog Road and there are no Departures from Standard (DfS) relating to visibility. Each of these elements should lead to lower collision rates when compared to the other routes. Purple A and B Route Options, with a LILO proposed at Castle Road and 2No. combination DfS relating to stopping sight distance on the bypass, may result in higher collision rates when compared to the Green route.

The Red Route Option provides the least preferred solution from a safety perspective with two LILOs at Castle Road and Killymoon Road and 2No. combination DfS relating to stopping sight distance on the bypass. Whilst this is the same number as the Purple A and B Route Options, the DfS relating to SSD in the proximity of the Castle Road LILO junction combined with the >4Step DfS for road users exiting the side road looking left is likely to be considered as a road safety issue.

Further consideration shall also be given to a reduction in the number of direct accesses provided on the A29 Moneymore Road in the vicinity of the proposed roundabout tie-in. There are a number of existing accesses for varying purposes (residential / farm / field / commercial etc) and a reduction or reconfiguration of these would provide a benefit in terms of road safety.

5.1.11. BUILDABILITY CONSTRAINTS

For Stage 2 assessment, buildability has been considered at an appropriate level. During the development of the proposed specimen design at Stage 3 buildability constraints will be considered in more detail..

All route options are located between the Ballinderry River and the WwTW to the south of the scheme where retaining walls are necessary and availability of working space is limited between the WwTW and the river. This will require carefully managed and sequenced construction techniques on all options.

The outfall pipes from the WwTW are expected to require diversion and / or protection on all route options. (Refer to Section 5.6 for Public Utilities Assessment.) As direct access from the bypass to the WwTW pipe outfalls is not desirable due to the high design speed of the route, provision has been made for pedestrian access to the WwTW pipe outfalls via the accommodation underpass at the WwTW. This underpass requires access steps along the highway boundary on each side of the alignment. This will further reduce working space available at this location.

Disruption to Killymoon Golf Course is likely to be significant and seasonal requirements of work to reconfigure the Golf Course, may have an impact on the construction programme. This impact is likely to be most significant on the Red Route, followed by the Green Route with the Purple A and Purple B Route Options considered to be more preferable.

Local residents are likely to be affected by noise and vibration at Castle Road, Killymoon Road, Golf View, Festival Park and Tamlaghtmore Road on all route options. Rural dwellings located along all each of the route options will also be affected. The Red Route Option is likely to cause more disruption and have a greater impact in terms of traffic noise and vibration during construction due to its closer proximity to the town and impact on Molesworth Road and The Dales.

Construction activities are likely to be constrained by existing properties on the Red Route Option. The Red Route will pass close to the east of the Karro Food Group Ltd (pork factory), where construction activities for both the bypass and the realignment of Molesworth Road are likely to affect accesses and cause disruption for road users in this location

On all route options, disruption to traffic through temporary road closures and diversions is expected where the route crosses side roads. Traffic disruption is also expected at both tie-ins of the alignment, particularly at the A29 Moneymore Road where the existing dual carriageway is to be extended and an online roundabout constructed on Red, Purple A and Green Route Options. While the offline roundabout proposed as part of the Purple B Route offers an opportunity to reduce the potential disruption, delays will still be experienced where the existing dual carriageway is to be reduced to single carriageway.

Due to the online nature of Sandholes Link Road, a phased approach to construction and traffic management (lane closures and diversions etc) will be necessary to maintain access and minimise disruption to residential and commercial premises all the route. Disruption will be particularly severe at A505 Drum Road tie-in which is heavily constrained by residential and commercial properties, a playground area and the Derryloran Church. A phased approach would also be required in demolition and replacement of the Fairy Burn Culvert.

5.2. DRAINAGE ASSESSMENT

5.2.1. ROAD DRAINAGE DESIGN PRINCIPLES

The general principle applied in the development of drainage proposals is to discharge where possible to the existing network of watercourses by gravity. Further drainage constraints associated with geotechnical, environmental and flooding considerations were also considered in the design for each route.

At this stage of the assessment process it has been established with DfI Rivers that 'Agreements in Principle' (AIPs) in relation to proposed drainage outfalls are not required given the scale of the project and number of route options. DfI Rivers has however provided guidelines in relation to the discharge of road related runoff as follows:

- The proposed rate of storm runoff should be no greater than the existing rate which is considered to be 10litres/second/hectare for greenfield runoff.
- Where this is not achieved, a flood risk assessment is required to assess the impacts of additional flow

To achieve greenfield run off rates at outfalls, it is proposed to incorporate elements of Sustainable Urban Drainage Systems (SuDS). Flood risk assessment will be undertaken during the development of the proposed specimen design at Stage 3 to determine impacts of drainage discharges, and any associated mitigation, incorporating attenuation where necessary.

Detention / retention ponds have been proposed as a preferred approach to SuDS storage. These have been designed to attenuate peak flows from the highway. The design of these ponds will be based on the principles outlined within the SuDS Manual CIRIA C753 and will also take into consideration relevant DMRB standards including HA103/06 – Vegetative Treatment Systems for Highway Runoff.

It is proposed that a combination of kerb drainage units, kerbs and gullies with carrier sewers, or filter drains will collect highway runoff directly from the highway to the receiving watercourses. These systems will be designed in accordance with DMRB: Volume 4, Section 2, Part CG 501 - Design of Highway Drainage Systems.

The construction of new roads may form barriers where they bisect existing drainage routes, thereby altering local catchment areas and boundaries. It is usual practice to keep the existing land drainage separate from the road drainage network wherever possible. Provision for edge of highway pre-earthwork drainage (PED) to intercept flows arising from natural catchments surrounding all proposed route options together with an assessment of flows from surrounding natural catchments, will be considered further during the development of the proposed specimen design at Stage 3. Filter drainage collection systems shall only be considered where there are restrictions on the use of PED. Alternative drainage strategies have been considered for the route options, as outlined below in Table 5-18.

Drainage proposals at this stage have been based on volumetric control only. The environmental mitigation aspect of these SuDS systems will be subject to further consideration during the development of the proposed specimen design at Stage 3.

Table 5-18 - Drainage Infrastructure Requirements by Route Option

Route Option	Carriageway Drainage - Cut	Carriageway Drainage - Fill	Embankment Drainage - Cut	Embankment Drainage – Fill
Red	Filter Drains	Kerb and gully with carrier sewers adjacent to shared footway / cycleway Over the edge / filter drains on southbound carriageway	Filter drains top and bottom	Filter drains at base
Purple A	Filter Drains	Kerb and gully with carrier sewers adjacent to shared footway / cycleway Over the edge / filter drains on southbound carriageway	Filter drains top and bottom	Filter drains at base
Purple B	Filter Drains	Kerb and gully with carrier sewers adjacent to shared footway / cycleway Over the edge / filter drains on southbound carriageway	Filter drains top and bottom	Filter drains at base
Green	Filter Drains	Kerb and gully with carrier sewers adjacent to shared footway / cycleway Over the edge / filter drains on southbound carriageway	Filter drains top and bottom	Filter drains at base
Sandholes Link Road	Kerb and gully with carrier sewers	Kerb and gully with carrier sewers	Filter drains top and bottom	Filter drains at base

5.2.2. OUTFALL LOCATIONS AND DISCHARGES

For the purposes of the current assessment, it is assumed that discharges will be restricted to greenfield runoff rates (maximum of 10l/s/Ha) prior to discharge. To meet these requirements, attenuation will be required at each outfall. Where outfalls have limited potential to utilise standard attenuation methods such as ponds, it may be appropriate to use alternative methods for attenuating flow, such as online storage within large diameter pipes and/or off-line storage tanks in conjunction with flow control devices.

Table 5-19 to Table 5-23 identify proposed outfall locations, the amount of contributing highway area associated with each of the outfalls, and the proposed attenuation requirements at each of the outfalls.

Table 5-19 - Preliminary Discharge Data & Indicative Attenuation Requirements - Red Route Option

Outfall ID	Approx. Chainage (m)	Contributing Area of Highway (ha)	Un-attenuated Design Discharge (l/s)	Greenfield Run-off Volume (l/s)	Approx. Pond Attenuation (m^3)
OF-RR-01	170	0.22	8	2.1	94
OF-RR-02	300	0.79	48	12.3	536
OF-RR-03	550	0.7	42	10.8	473
OF-RR-04	1350	1.47	89	22.9	999

Outfall ID	Approx. Chainage (m)	Contributing Area of Highway (ha)	Un-attenuated Design Discharge (l/s)	Greenfield Run-off Volume (l/s)	Approx. Pond Attenuation (m^3)
OF-RR-05	1700	0.56	29	7.5	Online Storage
OF-RR-06	2780	1.0	41	10.6	461
OF-RR-07	2780	0.7	34	8.6	375
OF-RR-08	3980	0.67	39	10.0	433

Table 5-20 – Preliminary Discharge Data & Indicative Attenuation Requirements - Purple A Route Option

Outfall ID	Approx. Chainage (m)	Contributing Area of Highway (ha)	Un-attenuated Design Discharge (l/s)	Greenfield Run-off Volume (l/s)	Approx. Pond Attenuation (m^3)
OF-PA-01	160	0.24	16	4.2	183
OF-PA-02	160	0.62	35	8.9	389
OF-PA-03	535	0.92	74	18.9	825
OF-PA-04	1415	0.92	66	16.9	735
OF-PA-05	1800	1.3	99	25.3	1103
OF-PA-06	3050	1.97	151	38.8	1687
OF-PA-07	4000	1.68	113	29.1	1265

Table 5-21– Preliminary Discharge Data & Indicative Attenuation Requirements - Purple B Route Option

Outfall ID	Approx. Chainage (m)	Contributing Area of Highway (ha)	Un-attenuated Design Discharge (l/s)	Greenfield Run-off Volume (l/s)	Approx. Pond Attenuation (m^3)
OF-PB-01	160	0.24	15	3.9	172
OF-PB-02	160	0.62	34	8.7	379
OF-PB-03	535	0.92	70	17.9	780
OF-PB-04	1415	0.92	63	16.1	701
OF-PB-05	1800	1.3	95	24.4	1061
OF-PB-06	3050	1.66	117	30.2	1313
OF-PB-07	4275	2.85	187	48.1	2090

Table 5-22 - Preliminary Discharge Data & Indicative Attenuation Requirements – Green Route Option

Outfall ID	Approx. Chainage (m)	Contributing Area of Highway (ha)	Un-attenuated Design Discharge (l/s)	Greenfield Run-off Volume (l/s)	Approx. Pond Attenuation (m^3)
OF-GR-01	180	0.64	18	6.56	273
OF-GR-02	555	2.4	80	48.1	Online Storage
OF-GR-03	1480	0.51	14	5.13	216
OF-GR-04	1700	2.04	59	21.7	917
OF-GR-05	2580	0.71	25	9.33	395
OF-GR-06	3200	0.8	22	8.02	342
OF-GR-07	3900	1.67	53	19.4	822
OF-GR-08	4000	0.5	17	6.22	274

Sandholes Link Road closely follows the existing alignment, and it is proposed that existing outfall locations will be utilised, with additional online storage to accommodate increases in the carriageway cross section.

Table 5-23– Preliminary Discharge Data & Indicative Attenuation Requirements - Sandholes Link Road

Outfall ID	Approx. Chainage (m)	Contributing Area of Highway (ha)	Un-attenuated Design Discharge (l/s)	Greenfield Run-off Volume (l/s)	Approx. Pond Attenuation (m^3)
OF-SHL-01	0	0.53	15	5.3	Online Storage
OF-SHL-02	430	0.25	7	2.5	Online Storage
OF-SHL-03	425	0.41	12	4.1	Online Storage

5.2.3. BUILDABILITY CONSTRAINTS

5.2.3.1. Red Route Option

Existing sewers and outfalls from the WwTW at approximate Ch500m conflict with the line of the new road limiting the size and space available for proposed road drainage collection systems.

The asymmetric cutting between Ch3050-3250m (maximum approximate excavation depth of 13m), may pose slope stability issues, the potential for trench excavation in rock and/or the introduction of special measures such as counterfort drains, etc.. This is likely to increase costs and time required during construction.

Ponds located at outfalls OF-RR-01, OF-RR-02, OF-RR-06, OF-RR-07 and OF-RR-08 are within flood plain areas. Therefore, non-return valves, flood protection bunds and compensation areas will be required. Outfalls OF-RR-01, OF-RR-04 and OF-RR-08 would be fitted with non-return valves due to the Q_{100} water level of the receiving watercourse.

5.2.3.2. Purple A Route Option

Similar to the Red Route Option, existing sewers from the WwTW at approximate Ch500m conflict with the line of the new road limiting the size and space available for proposed road drainage collection systems.

An extensive length of drainage,remote from the bypass would be required for Outfall OF-PA-05 due to the location and depth of the receiving watercourse.

The proposed cutting Ch3600-3900m occurs in low lying, soft ground which has the potential for settlement, dewatering and stability issues.

Ponds located at outfalls OF-PA-01, OF-PA-04, OF-PA-06 and OF-PA-07 are within flood plain areas. Therefore, non-return valves, flood protection bunds and compensation areas will be required. Outfalls OF-PA-01, OF-PA-04 and OF-PA-07 are likely to be fitted with non-return valves due to the Q_{100} water level of the receiving watercourse.

5.2.3.3. Purple B Route Option

Similar to previous route options, existing sewers from the WwTW at approximate Ch500m conflict with the line of the new road limiting the size and space available for proposed road drainage collection systems.

An extensive length of drainage, remote from the bypass would be required for Outfall OF-PB-05 due to the location of the receiving watercourse is remote.

The route option between Ch3900-4300m comprises a significant embankment within an area of soft ground (alluvium) which would have the potential for settlement issues.

Ponds located at outfalls OF-PB-01, OF-PB-04, OF-PB-06 and OF-PB-07 are within flood plain areas. Therefore, non-return valves, flood protection bunds and compensation areas will be required. Outfalls OF-PB-01 and OF-PB-04 would be fitted with non-return valves due to the Q_{100} water level of the receiving watercourse.

5.2.3.4. Green Route Option

Similar to previous route options, existing sewers from the WwTW at approximate Ch600 conflict with the line of the proposed road, limiting the size and space available for drainage and collection / storage systems. Due to its proximity to the WwTW (closer than the previous options in this location) it is proposed to attenuate run-off through a combination of online storage, a combined v-channel and pipe, and kerb/gully arrangement for the road throughout this network. A swale would treat the water as it leaves the Green Route before discharging into the Ballinderry.

Ponds located at outfalls OF-GR-01, OF-GR-06 and OF-GR-08 are within flood plain areas. Therefore, non-return valves, flood protection bunds and compensation areas will be required. Outfalls OF-GR-01, OF-GR-04, OF-GR-07 and OF-GR-08 would be fitted with non-return valves due to the Q_{100} water level of the receiving watercourse.

5.2.3.5. Sandholes Link Road

Attenuation ponds are considered impractical for highway runoff attenuation along the Sandholes Link Road due to the constrained urban nature of the proposed route. Attenuation is, instead, proposed via online storage. It is expected that as the increase in impermeable areas will be minimal it will not necessitate a significant requirement for additional storage and could be accommodated by upsizing the existing infrastructure.

5.3. HYDROLOGY & FLOODING ASSESSMENT

At this stage in the assessment process, in order to undertake the hydrology assessment on a consistent basis, several engineering assumptions have been used. These assumptions and the proposed strategy for watercourse crossings, river engineering and flood risk are outlined below.

5.3.1. FLOOD PLAIN MODELLING AND MITIGATION

The increase in impermeable area arising from the proposed scheme has the potential to increase flow rates and volumes reaching receiving watercourses, which has the potential to increase flood risk. Although the impact of a single drainage outfall on a watercourse may not be significant, the cumulative effect of several outfalls could potentially increase flood risk within the overall catchment area.

It is not practical to undertake detailed hydraulic modelling for all watercourses / flood plains at the preliminary design stage. Therefore, assessment of flood plains has been based on available data; flood maps (DfI strategic and detailed flood maps, as well as surface water maps), historical flooding records and alluvium mapping from drift geology. It is recognised that in many instances there is close correlation between alluvium mapping and flood plains and it has been assumed that where alluvium is present, there is a flood plain at this location. The alluvium mapping has been used in conjunction with flood maps and historical flooding records for the preliminary flood risk assessment.

During the development of the proposed specimen design at Stage 3 further flood risk modelling will be undertaken to ensure that the Preferred Route road levels are above the required flood risk level. The potential impacts to habitat and / or wildlife will also be assessed during the development of the proposed specimen design at Stage 3.

The Preferred Route will be subjected to a Flood Risk Assessment as required within the following guidance and legislation:

- DMRB: LA113 - Road Drainage and the Water Environment (Revision 1)
- Regional Development Strategy 2035;
- Strategic Planning Policy Statement for Northern Ireland (SPPS);
- Planning Policy Statement (PPS) 15 – Planning and Flood Risk.

Once the scope, location and impact of the preferred route on the existing flow regime has been identified, proposals for flood mitigation measures will also be considered.

Please refer to 718314-WSP-B-D-0500-0014 to 0017 and 718314-WSP-B-D-0500-0031 in Appendix A for the extents of potential and existing flood plains of each route option.

5.3.1.1. Red Route

Potential flood plains have been identified along the Fairy Burn at Loughry Roundabout and Fountain Road Stormwater Drain adjacent to Golf View. Another potential area is associated with an undesignated watercourse (LW_Trib 06) close to Coagh Road. This undesignated watercourse (LW_Trib 06) extends upstream to the north with a potential associated flood plain close to The Dales housing development, adjacent to East Circular Road (LW_Trib 02). It is noted that at each of these locations, the proposed route option is on embankment. The length of proposed highway in potential flood plain for Red Route is approximately 723m.

5.3.1.2. Purple A Route

Potential flood plains have been identified along the Fairy Burn at Loughry Roundabout and Fountain Road Stormwater Drain adjacent to Golf View and south of Clare Lane. Another potential area of flood plain is associated with an undesignated watercourse (LW_Trib 01) parallel to Coagh Road. There is a further potential flood plain associated with three undesignated watercourses (LW_Trib 02, LW_Trib 04 and LW_Trib 05), north of Old Coagh Road. It is noted that at each of these locations, the proposed route is on embankment. The length of proposed highway in potential flood plain for Purple A Route is approximately 669m.

5.3.1.3. Purple B Route

Potential flood plains have been identified along the Fairy Burn at Loughry Roundabout and Fountain Road Stormwater Drain adjacent to Golf View and south of Clare Lane. Another potential area of flood plain is associated with an undesignated watercourse parallel to Coagh Road (LW_Trib 01). There is a further potential flood plain associated with three undesignated watercourses (LW_Trib 02, LW_Trib 04 and LW_Trib 05), north of Old Coagh Road.

The route option crosses a potential flood plain at approximately Ch3500m with a further potential flood plain associated with an undesignated watercourse (LW_Trib 07) and the Lissan Water, close to Moneymore Road. It is noted that at each of these locations, the proposed route is on embankment. The length of proposed highway in potential flood plain for Purple B Route is approximately 1,596m.

5.3.1.4. Green Route

Potential flood plains have been identified along the Fairy Burn at Loughry Roundabout and Fountain Road Stormwater Drain adjacent to Golf View and south of Clare Lane. Another potential area of flood plain is associated with an undesignated watercourse (LW_Trib 01) parallel to Coagh Road. There is a further potential flood plain associated with two undesignated watercourses (LW_Trib 02 and LW_Trib 04) north of Old Coagh Road, with another potential floodplain associated with LW_Trib 05, tying into Old Coagh Road. It is noted that at each of these locations, the proposed route is on embankment. The length of proposed highway in potential flood plain for Green Route is approximately 516m.

5.3.2. WATERCOURSE CROSSINGS

The designated and undesignated watercourses which may potentially be affected by each of the route options are illustrated below in Table 5-24. Watercourse crossings for each bypass route option can be seen in drawing references 718314-WSP-B-D-0500-0018 to 0020, 718314-WSP-B-D-500-0021 to 0023, 718314-WSP-B-D-0500-0024 to 0026, 718314-WSP-B-D-0500-0028 to 0030 and 718314-WSP-B-D-0500-0027, in Appendix A.

Table 5-24– Impacts on Watercourses – Bypass Options

Water Framework Directive ID	Watercourse Name	Red Route Chainage (m)	Purple A Route Chainage (m)	Purple B Route Chainage (m)	Green Route Chainage (m)
UKGBNI1NB030304060	Fairy Burn	0	0	0	0
UKGBNI1NB030304060	Ballinderry River Extension	175	175	175	175

Water Framework Directive ID	Watercourse Name	Red Route Chainage (m)	Purple A Route Chainage (m)	Purple B Route Chainage (m)	Green Route Chainage (m)
UKGBNI1NB030304063	Fountain Road Stormwater Drain	1325 (0.0)	1350	1350	1375
UKGBNI1NB030304063	Molesworth Road Stormwater Drain	1650 (0.0 and 140)	-	-	-
LW_Trib 01	Undesignated	-	2525	2525	2550 (225)
LW_Trib 02	Undesignated	2775	3050	3050	3025
LW_Trib 04	Undesignated	-	3125	3125	3175
LW_Trib 05	Undesignated	-	2975	2975	2900 (525)
LW_Trib 06	Undesignated	2650	-	-	-
LW_Trib 07	Undesignated	-	-	4300	-
LW_Trib 08	Undesignated	3550 (50.0)	0.0	-	3950
LW_Trib 09	Undesignated	3550	-	-	-
	Total	**9**	**8**	**8**	**8**

Notes:

1. Bracketed chainages relate to the crossing location on a minor road
2. Number of crossing do not include the Fairy Burn crossing on Sandholes Link Road which is applicable to all route options

As mentioned previously, the Ballinderry River is the principal watercourse within the study area and is impacted by each of the proposed bypass route options. A new bridge structure is proposed to cross the Ballinderry River.

Each route option crosses designated and undesignated watercourses which would necessitate culvert works and / or watercourse diversions / realignments. The Fairy Burn watercourse is located at Loughry Roundabout and would also require significant engineering works. An existing 3.3m diameter corrugated steel culvert is located at the Fairy Burn (Ch0-50m), which would be replaced / extended, along with associated river diversion works. It should be noted that both the Ballinderry River and the Fairy Burn have been confirmed by the Department of Culture, Arts and Leisure (DCAL) Inland Fisheries as having a Fisheries interest; so works would also be designed to accommodate the passage of fish.

5.3.3. RIVER ENGINEERING CULVERTS

Watercourse cross-sectional surveys and flow estimation calculations (using Flood Estimation Handbook techniques) have been completed to assist with this assessment. To facilitate the assessment of the proposed route options; preliminary culvert sizing has been undertaken for the watercourses crossed using the following:

- CIRIA Report 689 – Culvert Design and Operation Guide
- DMRB: Volume 4, Section 2, Part 7, HA107/04 – Design of Outfall and Culvert Details

Culverts associated with flood plains will also be hydraulically modelled during design of the Preferred Route to assess the potential flood risk. Preliminary culvert sizing has been undertaken for each bypass route option, and are summarised in Table 5-25 to Table 5-29 below and shown in Appendix A.

Table 5-25– Preliminary Culvert Proposals – Red Route Option

Structure Reference	Chainage (m)	Location Description	Culvert Type	Culvert Size	Culvert Length (m)
SP-RR-01	0	Fairy Burn	Box	2.4m x 2.4m	90
SP-RR-08	1350	Fountain Road Stormwater Drain	Box	2.4m x 2.4m	25
SP-RR-09	1650 (0)	Molesworth Road Stormwater Drain	Pipe	1500mm	10
SP-RR-10	1800	Molesworth Road Stormwater Drain	Pipe	1500mm dia.	20
SP-RR-12	2650	Undesignated - (LW_Trib 06)	Pipe	1500mm dia.	15
SP-RR-14	2780	Undesignated - (LW_Trib 02)	Pipe	1500mm dia.	65
SP-RR-16	3550	Undesignated - (LW_Trib 08)	Pipe	1500mm dia.	25

Notes:

1. Structure Reference 'SP-RR-01' refers to 'Structure Proposed-Red Route-Structure Number'
2. 'Culvert Length' does not include length of Wing Walls.

Table 5-26– Preliminary Culvert Proposals – Purple A Route Option

Structure Reference	Chainage (m)	Location Description	Culvert Type	Culvert Size	Culvert Length (m)
SP-PA-01	0	Fairy Burn	Box	2.4m x 2.4m	90
SP-PA-08	1400	Fountain Road Stormwater Drain	Box	2.4m x 2.4m	22
SP-PA-10	2535	Undesignated - (LW_Trib 01)	Pipe	1500mm dia.	20
SP-PA-12	3120	Undesignated - (LW_Trib 02 and LW_Trib 04)	Pipe	1500mm dia.	105
SP-PA-14	3950	Undesignated – (LW_Trib_08)	Pipe	1500mm dia.	30

Notes:

1. Structure Reference 'SP-PA-01' refers to 'Structure Proposed-Purple A Route-Structure Number'
2. 'Culvert Length' does not include length of Wing Walls.

Table 5-27– Preliminary Culvert Proposals – Purple B Route Option

Structure Reference	Chainage (m)	Location Description	Culvert Type	Culvert Size	Culvert Length (m)
SP-PB-01	0	Fairy Burn	Box	2.4m x 2.4m	90
SP-PB-08	1400	Fountain Road Stormwater Drain	Box	2.4m x 2.4m	22
SP-PB-10	2535	Undesignated - (LW_Trib 01)	Pipe	1500mm dia.	20

Structure Reference	Chainage (m)	Location Description	Culvert Type	Culvert Size	Culvert Length (m)
SP-PB-12	3120	Undesignated - (LW_Trib 02 and LW_Trib 04)	Pipe	1500mm dia.	79
SP-PB-14	3950	Undesignated - (LW_Trib_08)	Pipe	1500mm dia.	60

Notes:

1. Structure Reference 'SP-PB-01' refers to 'Structure Proposed-Purple B Route-Structure Number'
2. 'Culvert Length' does not include length of Wing Walls.

Table 5-28 - Preliminary Culvert Proposals – Green Route Option

Structure Reference	Chainage (m)	Location Description	Culvert Type	Culvert Size	Culvert Length (m)
SP-GR-01	0	Fairy Burn	Box	2.4m x 2.4m	96
SP-GR-11	1370	Fountain Road Stormwater Drain	Box	2.4m x 2.4m	31
SP-GR-14	3010	Undesignated - (LW_Trib 02)	Pipe	1500mm dia.	158
SP-GR-15	3180	Undesignated - (LW_Trib 04)	Pipe	1500mm dia.	142
SP-GR-17	3950	Undesignated - (LW_Trib 08)	Pipe	1500mm dia.	26

Notes:

1. Structure Reference 'SP-GR-01' refers to 'Structure Proposed-Green Route-Structure Number'
2. 'Culvert Length' does not include length of Wing Walls.

Table 5-29– Preliminary Culvert Proposals – Sandholes Link Route Option

Structure Reference	Chainage (m)	Location Description	Culvert Type	Culvert Size	Culvert Length (m)
SD-SHL-01	420	Fairy Burn	Pipe	Unknown	15
SP-SHL-02	420	Fairy Burn	Box	2.4m x 2.4m	13

Notes:

1. Structure Reference 'SD-SHL-01' refers to 'Structure Demolition-Sandholes Link-Structure Number'
2. Structure Reference 'SP-SHL-01' refers to 'Structure Proposed-Sandholes Link-Structure Number'
3. 'Culvert Length' does not include length of Wing Walls.

5.3.4. RIVER ENGINEERING DIVERSION

The preliminary design of watercourse re-alignments / diversions has been undertaken for each bypass route option, and is summarised in Table 5-30 to Table 5-33 below and shown in Appendix A. No watercourse diversions are proposed as part of the Sandholes Link Road.

Table 5-30 - Preliminary Diversion Proposals – Red Route Option

Diversion Reference	Chainage (m)	Impacted Watercourse	Diversion Length (m)
WD-RR-01	40-160	Fairy Burn	260

Diversion Reference	Chainage (m)	Impacted Watercourse	Diversion Length (m)
WD-RR-02	1325-1375	Molesworth Drain	60
WD-RR-03	2275-2800	Undesignated - (LW_Trib 06)	520
WD-RR-04	(300) - (0.0)	Undesignated - (LW_Trib 08 and LW_Trib 09)	290

Notes:

1. Diversion Reference 'WD-RR-01' refers to 'Diversion Proposed-Red Route-Diversion Number'

Table 5-31 - Preliminary Diversion Proposals – Purple A Route Option

Diversion Reference	Chainage (m)	Impacted Watercourse	Diversion Length (m)
WD-PA-01	40-160	Fairy Burn	260
WD-PA-02	1320-1400	Fountain Road Stormwater Drain	155
WD-PA-03	2875-3125	Undesignated - (LW_Trib 05)	329
WD-PA-04	2975-3125	Undesignated - (LW_Trib 02 and LW_Trib 04)	132
WD-PA-05	3950 (0.0)	Undesignated - (LW_Trib 08 and LW_Trib 09)	285

Notes:

1. Diversion Reference 'WD-PA-01' refers to 'Diversion Proposed-Purple A Route- Diversion Number'

Table 5-32 - Preliminary Diversion Proposals – Purple B Route Option

Diversion Reference	Chainage (m)	Impacted Watercourse	Diversion Length (m)
WD-PB-01	40-160	Fairy Burn	260
WD-PB-02	1320-1400	Fountain RoadStormwater Drain	155
WD-PB-03	2880-3140	Undesignated - (LW_Trib 05)	329
WD-PB-04	3010-3110	Undesignated - (LW_Trib 02 and LW_Trib 04)	132

Notes:

1. Diversion Reference 'WD-PB-01' refers to 'Diversion Proposed-Purple B Route- Diversion Number'

Table 5-33 - Preliminary Diversion Proposals – Green Route Option

Diversion Reference	Chainage (m)	Impacted Watercourse	Diversion Length (m)
WD-GR-01	40-180	Fairy Burn	247
WD-GR-02	3000-3125	Undesignated - (LW_Trib 05)	126
WD-GR-03	3950 (0.0)	Undesignated - (LW_Trib 08)	103
WD-GR-04	3950 (0.0)	Undesignated - (LW_Trib 08)	107

Notes:

1. Diversion Reference 'WD-GR-01' refers to 'Diversion Proposed-Green Route- Diversion Number'

5.4. GEOTECHNICAL ASSESSMENT

5.4.1. GEOTECHNICAL INVESTIGATIONS

A preliminary ground investigation (GI) was carried out to provide additional information to inform the route selection process. The aim of the preliminary ground investigation was to provide sufficient information to assess the general ground and groundwater conditions of the Stage 2 Study Area to complement information obtained during the Preliminary Sources Study. This allowed an initial assessment of earthwork slope angles enabling the estimation of cut / fill volumes and the assessment of likely subgrade conditions.

The investigation was designed and supervised by Mouchel (now WSP) and carried out by Soil Mechanics Limited from 13 November to 09 December 2008. This comprised 13No. cable percussion boreholes to a maximum depth of 15m below ground level (bgl), with rotary cored drilling following on at selected locations. 20No. trial pits were also excavated by machine to a maximum depth of 4m bgl. Laboratory testing was carried out on selected samples to provide design parameters for the various material types encountered.

Exploratory holes were positioned along the line of the route options within the study area. Exact locations and findings of the preliminary GI are reported within the Ground Investigation Report, referenced 718314/B/R/5006 dated April 2009.

GI was undertaken on the 2010 Preferred Route from 24 January to 3 March 2011, this was designed and supervised by Mouchel and undertaken by Soil Mechanics LTD. The investigation consisted of 46No. boreholes including 40No. cable percussion holes to a maximum depth of 15m, 6No. rotary drilled holes to a maximum depth of 22.1m, 39No. trial pits and 21No. window sampler boreholes.

In-situ tests were carried out and included standard penetration tests (SPTs), dynamic probe testing and hand-held shear vane tests. Laboratory testing was also carried out on selected samples to provide design parameters for the various material types encountered.

Since 2011 additional historical ground investigation records have become available through the Geological Survey of Northern Ireland. This is referenced in the 2020 PSSR and the findings have been incorporated in the current ground models for each of the routes where relevant.

5.4.2. GROUNDWATER OBSERVATIONS

Standpipe piezometers were installed in 22No. locations during the preliminary and main phase of the ground investigations. Response zones were found to be generally less than 10m deep and groundwater was generally 2-3m bgl. There was no evidence of artesian groundwater conditions observed during the ground investigations.

The GI indicates that groundwater levels are generally between 1 and 4m bgl within the superficial deposits. Groundwater was also recorded within the underlying bedrock. Groundwater is expected to be shallow throughout the study area due to the nature of the drift deposits and may be particularly shallow in low lying areas. Within the Glacial Till, sand lenses within the cohesive till deposits may generate sporadic and unpredictable groundwater flows during excavation which may lead to ‘running sand’ conditions.

5.4.3. GEOLOGICAL CONSTRAINTS

Based on the historical records and available GI data geological constraints across the main routes are generally similar with glacial till deposits predominant. These deposits would primarily be expected in areas of cutting and could be reused in areas of embankment. Some of the deposits can be expected to be too wet for re-use as dug and may require some conditioning or mixing prior to being retained in the works where required.

Glacial till deposits are bisected, and/or overlain by alluvial deposits or river terrace deposits along or adjacent to watercourses. In many cases these watercourses trend in an east–west direction and as such influence all of the generally north–south trending main line route options. The most extensive areas of alluvium are anticipated adjacent to the Ballinderry River in the south-west, Lissan Water in the north-east and Fairy Burn in the west of the study area. Similarily the most extensive areas of river terrace deposits are anticipated near the Loughry Roundabout in the south, associated with the Ballinderry River, and near Lissan Water in the north.

Glaciofluvial deposits and isolated deposits of made ground and peat can be anticipated in the northern and southern extents of the study area. Drawing reference 718314-WSP-B-D-0600-0006 shows the spread of superficial deposits across the study area.

Outwith the glacial till deposits some of the other superficial deposits may be softer or weaker in nature. This could constrain the height that embankments can be constructed to without requiring engineering measures such as excavation and replacement and/or the introduction of special measures such as band drains, etc. Where present in the vicinity of structures such deposits may also prohibit the use of shallow foundations. Further targeted GI will be undertaken along the preferred route at Stage 3 to investigate these constraints further and facilitate the development of specimen design solutions.

Bedrock has not been widely proven across the study area to date although it may be expected in some of the deeper cuttings along each of the route options. Further GI will be undertaken along the preferred route at Stage 3 to allow design development in these areas.

5.4.4. CONTAMINATED LAND

All the proposed route options (excluding Sandholes Link Road) will be constructed predominantly on greenfield land. The NIEA Historical Land Use Layer available on the OSNI Spatial NI Geoportal was consulted and across the full study area (including the Sandholes Link Road) there is no evidence to indicate widespread contamination with only isolated sites being identified as having the potential to contain contamination.

The table below summarises the potential contaminated land constraints including those discussed below and identified from the Constraints Map in Appendix A (drawing reference 718314-WSP-B-D-0600-0001).

Table 5-34 - Summary of Potential Contaminated Land Locations

Constraint	Ch (m)	Affected Route Option				
		Red	Purple A	Purple B	Green	SHL
Area of filled ground at the abandoned development site at the Loughry roundabout	0	✔	✔	✔	✔	×
Possible contaminated soil at 20 Dungannon Road – Paragraph 19 exemption from waste licensing for soil and stones.	250	✔	✔	✔	✔	×
Possible made ground within the Waste Water Treatment Works	550	✔	✔	✔	✔	×
Former mineral workings	550	✔	✔	✔	✔	×
Unspecified: chemical works, engineering works, building works, factories, fuel oil suppliers	800	✔	✔	✔	✔	×
Textile works and dye works - tape and webbing factory	800	✔	✔	✔	✔	×
Former railway line	1650	×	✔	✔	✔	×
Ceramics, cement and asphalt manufacturing works	1800	✔	×	×	×	×
Former railway line	1800	✔	×	×	×	×
Former mineral workings	2300	✔	×	×	×	×
Former railway line	2650	✔	×	×	×	×
Former railway line	3150	×	✔	✔	✔	×
Road vehicle fuelling, service and repair: garages and filling station on Moneymore Road	4300	×	×	✔	×	×
General made ground and urban ground conditions	0 to 650	×	×	×	×	✔
General made ground associated with construction of existing highways	0 to 4300	✔	✔	✔	✔	✔

The disused railway line which crosses each of the route options within the study area is generally in cutting and while some infill of the cutting may have occurred which could contain contaminated materials, hydrocarbons from oils and grease as a result of its previous use are the most likely form of contamination which could be present in these areas.

There is a historic landfill located between Coagh Road and Limekiln Lane and was operated by Cookstown District Council. This could contain contaminated soils and could also be generating landfill gas but is located approximately 400m west of the Red route and is therefore not considered likely to pose a significant risk to geology and soils within the study area.

Several former and infilled quarries / sand and gravel pits are noted on historical maps of the area and within historical land use data. It is possible that each was infilled in an uncontrolled manner and could contain contaminated material.

The possibility of encountering contamination cannot therefore be ruled out during ground investigation or construction works.

5.4.5. BUILDABILITY CONSTRAINTS

There are a number of geo-environmental issues that may have an impact upon the selection of the preferred route discussed in Table 5-35 to Table 5-39 below.

Table 5-35– Ground Conditions and Buildability Constraints – Red Route Option

Chainage (m)	Bypass Description	Issues / Risks
0-250	Embankment up to 7.9m height over Ballinderry River.	GI has identified weaker deposits (made ground / alluvial materials) with high groundwater table on approach embankments to river crossing
250-550	Cutting up to 6.4m depth on approach to WwTW Retaining structures proposed to mitigate the impact	Steeply sloping river bank showing signs of marginal stability in locations. Constrained Working space due to close proximity of WwTW. Access for proposed retaining walls will require a complex construction sequence and temporary works. Bedrock excavation is anticipated in deepest section of cutting
550-700	Cutting up to 7.5m deep slope	GI to inform design groundwater level, and likelihood of bedrock being encountered within the cutting Upper proportions of cutting may require modification for re-use as general fill in the works i.e. anticipated to be too wet as dug
700-800	Embankment up to 3m height on approach to Castle Road	Low design CBR values are anticipated particularly over the made ground deposits.
800-1100	Cutting up to 16m depth north of Castle Road	GI to inform design groundwater level, and likelihood of bedrock being encountered within the cutting Upper proportions of cutting may require modification for re-use as general fill in the works i.e. anticipated to be too wet as dug
1100-Proposed Cloghog Road Roundabout	At or near grade section over Castle Road. Approach embankment to Cloghog Road Roundabout typically 2-3m height, up to 5m at Fountain Road Drain Watercourse	GI has identified weaker materials (alluvial deposits and man-made ground). Infilled railway cutting and bridge with possible contamination.

Chainage (m)	Bypass Description	Issues / Risks
Proposed Cloghog Road Roundabout - 2025	Cutting up to 3m depth	Cutting anticipated to be through glacial till which may require modification for re-use as general fill in the works i.e. anticipated to be too wet as dug. May require bedrock excavation in lower portions of cutting.
2025-2860	Approach embankment up to 7.5m between CH 2025-2250 incorporating B73 Coagh Road Overbridge. Embankment up to 11.2m between 2250 – 2850 incorporating watercourse diversion west of proposed alignment and under Old Coagh Road.	Undesignated watercourse runs below the proposed footprint of the embankment with GI to date encountering alluvial deposits and high water table.
2860-3250	Route continues through drumlin topography with cuttings up to 13m deep.	GI to inform the design groundwater level, identify the potential of contamination associated with infilled railway and the likelihood of the requirement for bedrock excavations within the cutting.
3250-3580	A29 approach to Moneymore Road on slight embankment (less than 2m height) with localised cutting	GI to confirm ground model
3050-350	Cutting south of Moneymore Road	Asymmetric cutting through natural slope with possible stability issues.

Table 5-36– Ground Conditions and Buildability Constraints – Purple A Route Option

Chainage (m)	Bypass Description	Issues / Risks
0-250	Embankment up to 7.9m height over Ballinderry River.	GI has identified weaker deposits (made ground / alluvial materials) with high groundwater table on approach embankments to river crossing
250-550	Cutting up to 4.6m depth on approach to south of WwTW Retaining structures proposed to mitigate the impact	Steeply sloping river bank showing signs of marginal stability in locations. Constrained Working space due to close proximity of WwTW. Access for proposed retaining walls will require a complex construction sequence and temporary works. Bedrock excavation is anticipated in deepest section of cutting
550-650	Cut slope up to 4m Retaining structure at WWTW	GI to inform design groundwater level, and likelihood of bedrock being encountered within the cutting. Upper proportions of cutting may require modification for re-use as general fill in the works i.e. anticipated to be too wet as dug Spatial constraint requires the construction of retaining walls with possible impact on the WWTW foundations..
650-780	Embankment up to 3m height on approach to Castle Road	Low design CBR values are anticipated for at, or near grades sections even after improvement of the formation given the very low CBR values confirmed from existing GI data.

Chainage (m)	Bypass Description	Issues / Risks
780-1250	Route passes through a large drumlin creating a cut of maximum depth 17m continuing over Killymoon Road through golf course.	GI to inform material suitability for re-use, the design groundwater level and likelihood of bedrock being encountered within the cutting
1250-Proposed Cloghog Road Roundabout	At or near grade section over Castle Road. Approach embankment to Cloghog Road Roundabout typically 2-3m height, up to 5m at Fountain Road Drain Watercourse	GI has identified weaker materials (alluvial deposits and man-made ground). Infilled railway cutting and bridge with possible contamination.
Proposed Cloghog Road Roundabout - 2400	Route continues through drumlin topography with cuttings up to 13m deep.	GI to inform the likelihood of bedrock excavation being required and allow an appropriate assessment as to how excavatable material maybe.
2400-3550	Approach embankment up to 8m incorporating B73 Coagh Road Overbridge. Embankment up to 10.9m on approach to Old Coagh Road. Significant embankment of maximum 16.6m on approach to historical infilled railway embankment. A watercourse traverses east-west across the proposed alignment	GI has encountered made ground and weak alluvial deposits overlying glacial till and bedrock, along with a high ground water table. GI to inform the nature of the made ground in the historic infilled railway corridor and identify buildability issues and requirements for any special measures.
3550-3980	The route continues to A29 Moneymore Road in slight cutting (maximum depth of 3.6m)	GI to confirm ground model.

Table 5-37– Ground Conditions and Buildability Constraints – Purple B Route Option

Chainage (m)	Bypass Description	Issues / Risks
0-250	Embankment up to 7.9m height over Ballinderry River	GI has identified weaker deposits (made ground / alluvial materials) with high groundwater table on approach embankments to river crossing
250-550	Cutting up to 4.6m depth on approach to WWTW Retaining structures proposed to mitigate the impact	Steeply sloping river bank showing signs of marginal stability in locations. Constrained Working space due to close proximity of WwTW. Access for proposed retaining walls will require a complex construction sequence and temporary works. Bedrock excavation is anticipated in deepest section of cutting

Chainage (m)	Bypass Description	Issues / Risks
550-650	Cut slope up to 4m	GI to inform design groundwater level, and likelihood of bedrock being encountered within the cutting Upper proportions of cutting may require modification for re-use as general fill in the works i.e. anticipated to be too wet as dug.
650-780	Low height approach embankment (up to 3m) on approach to Castle Road	Low design CBR values are anticipated for at, or near grades sections even after improvement of the formation given the very low CBR values confirmed from existing GI data.
780-1250	Route passes through a large drumlin creating a cut of maximum depth 17m continuing over Killymoon Road through golf course.	GI to inform material suitability for re-use, the design groundwater level and likelihood of bedrock being encountered within the cutting
1250-Proposed Cloghog Road Roundabout	At or near grade section over Castle Road. Approach embankment to Cloghog Road Roundabout typically 2-3m height, up to 5m at Fountain Road Drain Watercourse	GI has identified weaker materials (alluvial deposits and man-made ground). Infilled railway cutting and bridge with possible contamination.
Proposed Cloghog Road Roundabout - 2400	Route continutes through drumlin topography with cuttings up to 13m deep.	GI to inform the likelihood of bedrock excavation being required and thus allow an appropriate assessment as to how excavatable material maybe.
2400-3200	Approach embankment up to 8m incorporating B73 Coagh Road Overbridge. Embankment up to 10.9m on approach to Old Coagh Road. Significant embankment of maximum 16.6m on approach to historical infilled railway embankment. A watercourse traverses east-west across the proposed alignment	GI has encountered made ground and weak alluvial deposits overlying glacial till and bedrock, along with a high ground waterr table. GI to inform the nature of the made ground in the historic infilled railway corridor and identify buildability issues and requirements for any special measures
3200-3400	The route passes in cutting (maximum depth of 8m)	GI to inform material excavatability and suitability for re-use, the design groundwater level and liklihood of bedrock being encountered within the cutting
3400-3650	The route passes on embankment up to 5m depth	Low height embankment over glacio-fluvial materials

Chainage (m)	Bypass Description	Issues / Risks
3650-3900	The route through drumlin topography in cutting up to maximum of 15.5m deep	GI to inform material suitability for re-use, the design groundwater level and likelihood of bedrock being encountered within the cutting
4000-4300	The route continues to A29 Moneymore Road in slight cutting (maximum depth of 4m)	GI to inform material suitability for re-use, the design groundwater level and likelihood of bedrock being encountered within the cutting

Table 5-38– Ground Conditions and Buildability Constraints – Purple B Route Option

Chainage (m)	Bypass Description	Issues / Risks
0-340	Embankment up to approximately 11.3m height over Ballinderry River	GI has identified weaker deposits (made ground / alluvial materials) with high groundwater table on approach embankments to river crossing
340-600	Cutting up to 7.8m depth on approach to WWTW Retaining structures proposed to mitigate the impact of EW on WWTW	Steeply sloping river bank showing signs of marginal stability in locations. Constrained Working space due to close proximity of WwTW. Access for proposed retaining walls will require a complex construction sequence and temporary works. Bedrock excavation is anticipated in deepest section of cutting
600-1300	The route passes in cutting through drumlin topography to a maximum depth of 22.7m, incorporating Castle Road, Killymoon Road and Golf Course	GI to inform the likelihood of bedrock excavation being required and thus allow an appropriate assessment as to how excavatable material maybe.GI to inform the suitability of materials for re-use and the design groundwater level.
1300-1700	Low height approach embankment (up to 3m)	GI has identified weaker materials including alluvial deposits and man-made deposits the latter partly associated with old Infilled railway cutting. Infilled railway cutting and bridge with possible contamination.
1700-2450	The route passes in cutting through drumlin topography to a maximum depth of 13.2m, incorporating Cloghog Road Roundabout	GI to inform material suitability for re-use, the design groundwater level and likelihood of bedrock being encountered within the cutting
2450-2670	The route pass on embankment up to a maximum approximate depth of 10m, over the existing B73 Coagh Road	GI to inform the ground model and allow assessment of settlement, stabilityand indicate if any special measures are required to ensure buildability.
2670-2850	The route passes in cutting with a maximum approximate depth of 5.7m	GI to inform material suitability for re-use, the design groundwater level and likelihood of bedrock being encountered within the cutting
2850-3300	The route crosses Old Coagh Road on	Infilled railway cutting and bridge with possible contamination.

Chainage (m)	Bypass Description	Issues / Risks
	embankment (maximum depth height of 21.6m	
3300-3900	The route continues to A29 Moneymore Road predominantly in cutting (maximum depth of 6.3m)	GI to inform material suitability for re-use, the design groundwater level and likelihood of bedrock being encountered within the cutting

Table 5-39– Ground Conditions and Buildability Constraints – Sandholes Link Option

Chainage (m)	Bypass Description	Issues / Risks
0 -690	Generally at or near grade earthworks and retaining walls	Generally to be constructed over glacial till or glacio-fluvial deposits.
360-480	Fairy Burn Bridge and approach embankments	Soft/compressible ground and a high water table associated with Fairy Burn may mean structure and adjacent embankmentswill need specialised foundation solution.

5.5. STRUCTURES ASSESSMENT

5.5.1. EXISTING STRUCTURES

Please refer to drawing reference 718314-WSP-B-D-0800-0165 in Appendix A for the location of existing structures for each bypass route option and Sandholes Link Road.

5.5.1.1. Red Route Option

For the Red Route Option, the existing unnamed structure (DFI Ref: 62328), which carries the Fairy Burn beneath the Loughry Roundabout would be replaced on a new line with the existing structure most likely infilled and hence decommissioned. There is only one other existing structure (Clare Bridge on Cloghog Road – DFI Ref: 61756) in close proximity to the proposed Red Route. Although full demolition of this structure may not be required for construction of the Red Route, further studies and investigation to establish the full extent of work required would be needed to develop the specimen design at Stage 3 if the Red Route was selected as the preferred route.

5.5.1.2. Purple A Route Option

For the Purple A Route Option, the existing unnamed structure (DFI Ref: 62328), which carries the Fairy Burn beneath the Loughry Roundabout would be replaced on a new line with the existing structure most likely infilled and hence decommissioned. The proposed widening of Cloghog Road to improve accessibility to the town may require works / demolition of Clare Bridge – DFI Ref: 61756. Further studies and investigation to establish the full extent of work required would be needed to develop the specimen design at Stage 3 if the Purple A Route was selected as the preferred route.

5.5.1.3. Purple B Route Option

For the Purple B Route Option, the existing unnamed structure DFI Ref: 62328, which carries the Fairy Burn beneath the Loughry Roundabout would be replaced on a new line with the existing structure most likely infilled and hence decommissioned. The proposed widening of Cloghog Road to improve accessibility to the town may require works / demolition of Clare Bridge – DFI Ref: 61756. Further studies and investigation to establish the full extent of work required would be needed to develop the specimen design at Stage 3 if the Purple B Route was selected as the preferred route.

5.5.1.4. Green Route Option

For the Green Route Option, the existing unnamed structure DFI Ref: 62328, which carries the Fairy Burn beneath the Loughry Roundabout would be replaced on a new line with the existing structure most likely infilled and hence decommissioned. The proposed widening of Cloghog Road to improve accessibility to the town may require works / demolition of Clare Bridge – DFI Ref: 61756. Further studies and investigation to establish the full extent of work required would be needed to develop the specimen design at Stage 3 if the Green Route was selected as the preferred route.

5.5.1.5. Sandholes Link Road

There are two existing structures in close proximity to the proposed Sandholes Link Road. The first is the Derryloran Bridge (DFI Ref: 61758) - a two-span masonry arch bridge, located on the A505 Drum Road to the north east of the link road. Works to this bridge are not anticipated however this would be confirmed during the development of the specimen design at Stage 3.

The second is a bridge over the Fairy Burn watercourse on the Sandholes Road (DFI Ref: 60904), which is proposed to be demolished and replaced. This existing structure is of steel corrugated pipe construction with a span of approximately 3m. The parapets are of masonry construction and the bridge is in fair condition.

5.5.2. PROPOSED STRUCTURES

For locations of the proposed structures, refer to the General Arrangement drawings reference 718314-WSP-B-D-0800-0099 to 0132, 718314-WSP-B-D-0800-0191 to 0201 and 718314-WSP-B-D-0800-0216 in Appendix A.

In line with descriptions used in TD27/05, where the prefixes ‘over’ and ‘under’ are used with bridges, it refers to where the bridge is constructed, in relation to the proposed scheme. An overbridge will therefore span over the bypass, and an underbridge will pass beneath the proposed bypass.

A proposed underbridge for the Ballinderry River will be required with an expected span of approximately 30m common to all the proposed route options (Red, Purple A, Purple B and Green).

Drainage structures / culverts have been described in Section 5.3.

5.5.2.1. Red Route

For the Red Route there is a combination of retaining walls and a pedestrian underpass to support the proposed alignment at the WwTW. The retaining walls would be provided on both sides of the highway with height ranging from 3.5m to the west and 4.5m to the east. The underpass is proposed at the location where the discharge pipes for the WwTW cross the proposed alignments. Access steps to the underpass would be recessed into the ground with associated soil retention on the west and east ends of the structure.

B73 Coagh Road and the Old Coagh Road would both remain open under the Red Route option and would be supported beneath the mainline via underbridges, both with a typical span of 16m.

It is proposed to provide a three-span accommodation overbridge for farm access at approximately Ch3200m. If the Red Route is taken forward as the preferred route option, the size and form of construction of this structure would be designed during the development the specimen design at Stage 3, when access requirements would be better understood.

Table 5-40– Proposed Bridge Structures – Red Route Option

Structure ID	Chainage (m)	Location	Structure	Structure Span (m)	Structure Width (m)	Deck Area (m^2)
SP-RR-02	165-195	Ballinderry River	Underbridge	30	21	630
SP-RR-07	545	WwTW	Accommodation Underpass/Walkway	3 (h) x 3 (w)	21	63
SP-RR-11	2525	B73 Coagh Road	Underbridge	16	23	368
SP-RR-13	2875	Old Coagh Road	Underbridge	16	21	336
SP-RR-15	3200	-	Accommodation Overbridge / Farm Access	60	6	360

Notes:

1. Chainages are referenced from the mainline.
2. Structure Span is measured parallel to the ‘Element Carried’.
3. ‘Structure Width’ does not include length of Wing Walls.
4. Additional structures may be required as accommodation works during development of the preferred route

Table 5-41– Proposed Retaining Structures – Red Route Option

Structure ID	Chainage (m)	Location	Structure	Maximum Retained Height (m)	Average Retained Height (m)	Structure Length (m)	Area – Front Face (m2)
SP-RR-03	380-545	Ballinderry River	Retaining Structure RHS	4.5	3.5	165	558
SP-RR-04	480-535	WwTW	Retaining Structure LHS	2.5	2	55	110
SP-RR-05	535	WwTW	Retaining Structure LHS	3.5	3.5	15	53
SP-RR-06	545	WwTW	Retaining Structure RHS	5	5	15	75

Notes:

1. Structure Length is measured parallel to the proposed carriageway.
2. Additional retaining structures may be required as accommodation works during development of the preferred route, when land constraints are better understood.

5.5.2.2. Purple A Route

For the Purple A route there is a combination of retaining walls and a pedestrian underpass to support the proposed alignment at the WwTW. The retaining walls would be provided on both sides of the highway with height ranging from 5.0m to the west and 9.5m to the east. The underpass is proposed at the location where the discharge pipes for the WwTW cross the proposed alignments. Access steps to the underpass would be recessed into the ground with associated soil retention on the west end of the structure.

It is proposed to provide a three-span structure to carry Killymoon Road over the proposed Purple A Route option, of typical span 85m, and underbridges to carry the proposed routes over the B73 Coagh Road (typical span 20m) and Old Coagh Road (typical span of 18m).

In addition, it is proposed to provide an accommodation structure for farm access at approximate Ch3200m. If the Purple A Route is taken forward as the preferred route option, the size and form of construction of this structure would be designed during the development the specimen design at Stage 3, when access requirements would be better understood. A preliminary size of 5.5m high and 6.5m wide has been used as representative of similar accommodation structures on previous schemes.

Table 5-42– Proposed Bridge Structures – Purple A Route Option

Structure ID	Chainage (m)	Location	Structure	Structure Span (m)	Structure Width (m)	Deck Area (m2)
SP-PA-02	170-200	Ballinderry River	Underbridge	30	21	630
SP-PA-06	545	WwTW	Accommodation Underpass/Walkway	3 (h) x **3 (w)**	21	63
SP-PA-07	1090	Killymoon Road	Overbridge	85	15	1275
SP-PA-09	2525	B73 Coagh Road	Underbridge	20	21	420
SP-PA-11	2875	Old Coagh Road	Underbridge	18	22	396
SP-PA-13	3200	-	Accommodation Underpass / Farm Access	5.5 (h) x **6.5 (w)**	22	150

Notes:

1. Chainages are referenced from the mainline.
2. Structure Span is measured parallel to the ‘Element Carried’.
3. ‘Structure Width’ does not include length of Wing Walls.
4. Additional structures may be required as accommodation works during development of the preferred route

Table 5-43– Proposed Retaining Structures – Purple A Route Option

Structure ID	Chainage (m)	Location	Structure	Maximum Retained Height (m)	Average Retained Height (m)	Structure Length (m)	Area – Front Face (m2)
SP-PA-03	350-560	Ballinderry River	Retaining Structure RHS	9.5	7	210	1390
SP-PA-04	490-555	WwTW	Retaining Structure LHS	5	3	65	190
SP-PA-05	535	WwTW	Retaining Structure LHS	5	5	15	75

Notes:

1. Structure Length is measured parallel to the proposed carriageway.

2. Additional retaining structures may be required as accommodation works during development of the preferred route, when land constraints are better understood.

5.5.2.3. Purple B Route

For the Purple B route there is a combination of retaining walls and a pedestrian underpass to support the proposed alignment at the WwTW. The retaining walls would be provided on both sides of the highway with height ranging from 5.0m to the west and 9.5m to the east. The underpass is proposed at the location where the discharge pipes for the WwTW cross the proposed alignments. Access steps to the underpass would be recessed into the ground with associated soil retention on the west end of the structure.

It is proposed to provide a three-span structure to carry Killymoon Road over the proposed Purple B route option, of typical span 85m, and underbridges to carry the proposed routes over the B73 Coagh Road (typical span 20m) and Old Coagh Road (typical span of 18m).

It is proposed to provide an accommodation structure for farm access at approximate Ch3200m. If the Purple B Route is taken forward as the preferred route option, the size and form of construction of this structure would be designed during the development the specimen design at Stage 3, when access requirements would be better understood. A preliminary size of 5.5m high and 6.5m wide has been used as representative of similar accommodation structures on previous schemes.

Table 5-44– Proposed Bridge Structures – Purple B Route Option

Structure ID	Chainage (m)	Location	Structure	Structure Span (m)	Structure Width (m)	Deck Area (m2)
SP-PA-02	170-200	Ballinderry River	Underbridge	30	21	630
SP-PA-06	545	WwTW	Accommodation Underpass/Walkway	3 (h) x **3 (w)**	21	63
SP-PA-07	1090	Killymoon Road	Overbridge	85	15	1275
SP-PA-09	2525	B73 Coagh Road	Underbridge	20	21	420
SP-PA-11	2875	Old Coagh Road	Underbridge	18	22	396
SP-PA-13	3200	-	Accommodation Underpass / Farm Access	5.5 (h) x **6.5 (w)**	22	154

Notes:

1. Chainages are referenced from the mainline.
2. Structure Span is measured parallel to the 'Element Carried'.
3. 'Structure Width' does not include length of Wing Walls.
4. Additional structures may be required as accommodation works during development of the preferred route

Table 5-45– Proposed Retaining Structures – Purple B Route Option

Structure ID	Chainage (m)	Location	Structure	Maximum Retained Height (m)	Average Retained Height (m)	Structure Length (m)	Area – Front Face (m2)
SP-PB-03	350-560	Ballinderry River	Retaining Structure RHS	9.5	7	210	1390
SP-PB-04	490-555	WwTW	Retaining Structure LHS	5	3	65	190
SP-PB-05	535	WwTW	Retaining Structure LHS	5	5	15	75

Notes:

1. Structure Length is measured parallel to the proposed carriageway.
2. Additional retaining structures may be required as accommodation works during development of the preferred route, when land constraints are better understood.

5.5.2.4. Green Route

For the Green route there is a combination of retaining walls and a pedestrian underpass to support the proposed alignment at the WwTW. The retaining walls would be provided on both sides of the highway with height ranging from 8.0m to the west and 8.4m to the east. An underpass is proposed at the location where the discharge pipes for the WwTW cross the proposed alignments. Access steps to the underpass would be recessed into the ground with associated soil retention on the west end of the structure.

It is proposed to provide a three-span structure to carry both Castle Road and Killymoon Road over the proposed Green route option, with overbridges of 85m and 100m typical spans respectively, and underbridges to carry the proposed routes over the B73 Coagh Road (typical span 20m) and Old Coagh Road (typical span of 18m).

It is proposed to provide an accommodation structure for farm access at approximate Ch3220m. If the Green Route is taken forward as the preferred route option, the size and form of construction of this structure would be designed during the development the specimen design at Stage 3, when access requirements would be better understood. A preliminary size of 5.5m high and 6.5m wide has been used as representative of similar accommodation structures on previous schemes.

Table 5-46 - Proposed Bridge Structures – Green Route Option

Structure ID	Chainage (m)	Location	Structure	Structure Span (m)	Structure Width (m)	Deck Area (m2)
SP-GR-02	200-230	Ballinderry River	Underbridge	30	21	630
SP-GR-07	580	WwTW	Accommodation Underpass/ walkway	3 (h) x **3 (w)**	21	63
SP-GR-09	800	Castle Road	Overbridge	75	15	1125

Structure ID	Chainage (m)	Location	Structure	Structure Span (m)	Structure Width (m)	Deck Area (m2)
SP-GR-10	1140	Killymoon Road	Overbridge	100	15	1500
SP-GR-12	2550	B73 Coagh Road	Underbridge	20	22	440
SP-GR-13	2920	Old Coagh Road	Underbridge	18	22	396
SP-GR-16	3220	-	Accommodation Underpass/ Farm access	5.5 (h) x **6.5 (w)**	50	325

Notes:

1. Chainages are referenced from the mainline.
2. Structure Span is measured parallel to the 'Element Carried'.
3. 'Structure Width' does not include length of Wing Walls.
4. Additional structures may be required as accommodation works during development of the preferred route

Table 5-47 - Proposed Retaining Structures – Green Route Option

Structure ID	Chainage (m)	Location	Structure	Maximum Retained Height (m)	Average Retained Height (m)	Structure Length (m)	Area – Front Face (m2)
SP-GR-03	340-575	Ballinderry River	Retaining Structure RHS	8.4	5.5	235	1293
SP-GR-04	530-580	WwTW	Retaining Structure LHS	2.8	2	50	100
SP-GR-05	570-590	WwTW	Retaining Structure – Access LHS	7.2	3.6	24	86.4
SP-GR-06	565-580	WwTW	Retaining Structure – Access RHS	4.7	2.4	20	48
SP-GR-08	580-650	WwTW	Retaining Structure LHS	8.0	7.3	70	511

Notes:

1. Structure Length is measured parallel to the proposed carriageway.
2. Additional retaining structures may be required as accommodation works during development of the preferred route, when land constraints are better understood.

5.5.2.5. Sandholes Link Road

There are no proposed retaining structures on Sandholes Link Road. Retention measures to protect the Derryloran Church Wall (Monument in State Care) may be required as a result of the spatial constraints associated with close proximity of the highway improvement scheme to the wall. This will be considered further during the development of the specimen design at Stage 3 of the assessment process.

5.5.3. BUILDABILITY CONSTRAINTS

Under all four route options the existing culvert of the Fairy Burn beneath the Loughry Roundabout will be decommissioned with a new structure constructed adjacent to it. The construction of the new culvert would have to be staged to suit operational requirements of the roundabout during the construction period and the existing structure would likely require infilling to decommission it, as this will be less disruptive than excavating it from beneath the live junction.

5.5.3.1. Red Route

Buildability will be most constrained at the southern end of the proposed route. The topography and constrained corridor between the WwTW and the Ballinderry River mean working space in this area would be tight to construct the required retaining walls (up to 3.5m on the west and 4.5m to the east) to form the road cross section.

Construction of these retaining walls is more suited to reinforced soil techniques as it will allow the levels to the increased gradually with filling operations, without the requirement for large temporary props associated with concrete cantilever walls which could reduce working space even further. High bedrock in this area may also suit reinforced soil, rather than the potential for having to excavate rock to construct a concrete wall base. Depending on gradient of the rock, anchors could potentially be required to mitigate sliding.

The shortest route to accessing this area for construction of the walls is across the Balinderry River and so it is considered likely that the river crossing would be required to be constructed early in the programme to unlock access to this area from the south. Concurrent construction of these structures would be more difficult, requiring construction access from the north.

The two proposed underbridges associated with the B73 Coagh Road and Old Coagh Road would require temporary road closures of these routes during the critical stages of their construction (completion of abutment walls, lifting of bridge beams and casting of deck). Given the close siting of these two routes, it is considered that one of the routes would have to remain open at all times to accommodate traffic between Cookstown and the B73 to the east of the bypass route. This will therefore have an impact on the phasing of works in this area.

The new culvert at the junction of the Red Route and the A29 Moneymore Road would require phasing to ensure the continued operation of the existing route during the construction period.

5.5.3.2. Purple A Route

Construction of the Purple A Route option is constrained in a similar manner to the Red Route at the southern end, with the main structural difference being that the retaining walls are higher (up to 5m on the west side and 9.5m on the east side). This will require a larger plan footprint for bases / straps and so has the potential to further limit working space, or space for haul routes, during the construction phase, compared to the Red Route.

Construction of these retaining walls is more suited to reinforced soil techniques as it will allow the levels to the increased gradually with filling operations, without the requirement for large temporary props associated with concrete cantilever walls which would reduce working space even further. High bedrock in this area may also suit reinforced soil, rather than the potential for having to excavate rock to construct a concrete wall base. Depending on the gradient of the rock, anchors could potentially be required to mitigate sliding.

The Killymoon Overbridge is to be constructed on-line in an area constrained on the west side by private dwellings and where the proposed bypass route is in deep cutting. As such, creating a local bypass of the works area will not be feasible. This would sever access of the golf club at the end of Killymoon Road, which is only accessible from the west. As such, alternative access would be required to the golf club while Killymoon Road is blocked, with arrangements via Castle Road being explored.

The two proposed underbridges associated with the B73 Coagh Road and Old Coagh Road will require temporary road closures of these routes during the critical stages of their construction (completion of abutment walls, lifting of bridge beams and casting of deck). Given the close proximity of these two routes, it is considered that one of them would have to remain open at any one time to accommodate traffic between Cookstown and the B73 to the east of the bypass route. This will therefore impact the phasing of the works in this area.

The new culvert at the junction of the Purple A Route and the A29 Moneymore Road will require phasing to ensure the continued operation of the existing route during the construction period.

5.5.3.3. Purple B Route

The alignment and, hence, construction constraints of the Purple B route are the same as the Purple A Route between the Loughry Road roundabout and the proposed Cloghog Road roundabout (this includes the WwTW area and the Killymoon Overbridge.

The construction constraints in relation to the Coagh Road and Old Coagh Road Underbridges are the same for this route as for the Purple A Route. As above, one route would likely be required open at all times, so phasing of these two structures would be required.

As the junction of the Purple B Route and the A29 Moneymore Road is offline, the culvert to the watercourse in this area does not impact on the operation of the existing A29 in this area and so can be constructed in a single phase without disruption.

5.5.3.4. Green Route

The proposed alignment for the Green route positions the tie-in of the bypass at Loughry Roundabout further east than other proposed routes, creating an oval shaped roundabout that will require realignment of the existing Tullywiggan road arm. As a result, a slightly longer replacement culvert for the Fairy Burn will be required for this option.

Construction of the Green Route option is constrained in a similar manner to the Red Route at the southern end, with the main structural difference being that the retaining walls are higher than both the Red and Purple A and B Routes on the west side, adjacent to the WwTW and higher than the Red Route on the east side (up to 8.0m on the west side and 8.4m on the east side). This will require a larger plan footprint for bases / straps and so has the potential to further limit working space, or space for haul routes, during the construction phase, compared to the other route options.

Construction of the retaining walls on the east side is more suited to reinforced soil techniques as it will allow the levels to be the increased gradually with filling operations, without the requirement for large temporary props associated with concrete cantilever walls which could reduce working space even further. High bedrock in this area may also suit reinforced soil, rather than the potential for having to excavate rock to construct a concrete wall base. Depending on the gradient of the rock, anchors could potentially be required to mitigate sliding.

The retaining walls on the west side adjacent to the WwTW would be suited to either permanent sheet piling or temporary sheet piling to allow for a permanent concrete retaining wall, due to the extent of cut and the proximity to the boundary of the WwTW. However, the presence of outfalls running below ground from the WwTW across the alignment may pose some issues in terms of sheet piling, in which case a piled wall or king-post solution could be considered.

The shortest route to accessing this area for construction of the walls is across the Balinderry River and so it is considered likely that the river crossing would be required to be constructed early in the programme to unlock access to this area from the south. Concurrent construction of these structures would be more difficult, requiring construction access from the north.

The Castle Road Overbridge is to be constructed on-line in an area constrained on both sides by private dwellings and where the proposed bypass is in deep cutting. A local bypass of the area would not be feasible. To maintain access to the dwellings, alternative access routes would be required while Castle Road is closed for works.

Killymoon Road Overbridge is to be constructed with a minor realignment to the south of its existing location in an area constrained on the west side by private dwellings and where the proposed bypass route is in deep cutting (approximately 22.7m). As such, creating a local bypass of the works area will not be feasible. This would sever access of the golf club at the end of Killymoon Road, which is only accessible from the west and alternative access would be required to the golf club while Killymoon Road is closed, with arrangements via Castle Road being explored. As such, it is unlikely that both Castle Road Overbridge and Killymoon Road Overbridge could be constructed at the same time. This will therefore impact the phasing of the works in this area.

The two proposed underbridges associated with the B73 Coagh Road and Old Coagh Road will require temporary road closures during the critical stages of their construction (completion of abutment walls, lifting of bridge beams and casting of deck). Given the close proximity of these two routes, it is considered that one of them would have to remain open at any one time to accommodate traffic between Cookstown and the B73 to the east of the bypass route. This will therefore impact the phasing of the works in this area.

The new culvert at the junction of the Green Route and the A29 Moneymore Road would require phasing to ensure the continued operation of the existing route during the construction period, similar to that for the Purple A route.

5.5.3.5. Sandholes Link Road

The proposed replacement structure on the Fairy Burn is on the footprint of the existing structure. As such, a phased construction technique would be required here, and it is possible that single lane shuttle traffic only would be possible during this operation due to limited width in this area.

Temporary retaining structures may be required along the route to accommodate phased working to upgrade the alignment to limit impact on adjacent boundaries / structures.

5.6. PUBLIC UTILITIES ASSESSMENT

This assessment has assumed that if a Route Option crosses a utility line or a piece of existing plant lies within the indicative scheme boundary of a Route Option a diversion and/or protection measures will be required. In absence of detailed information such as levels this high-level assessment will not consider the cost or type of work(s) which may be required but will provide a comparison of the indicative length and type of plant affect by each Route Option.

As part of the "Scheme Identification and Preliminary Inquiries (C2)" process of "The Street Works (Northern Ireland) Order 1995 - Diversionary Works" the following service providers advised that they have plant in the Study Area:

- British Telecom (BT)
- Northern Ireland Electricity (NIE)
- Northern Ireland Water (NIW)
- SGN Natural Gas (SGN)
- Telefónica UK (O_2)
- Dept. for Infrastructure (DfI) – Road Lighting
- Clear Channel

Please refer to drawings 718314-WSP-B-D-0100-0002 to 718314-WSP-B-D-0100-0021 in Appendix A for details of the existing utilities within the study area.

This section provides a summary of public utilities which are likely to be affected by the route options, based on available records and may not be a definitive list.

NIW have foul water, storm water and clean water plant around Cookstown. It is assumed that the existing Overflow Pipes which exit the NIW Waste Water Treatment Works and outfall to the Ballinderry River will be affected by all Route Options.

SGN Natural Gas are currently installing both intermediate pressure line and medium/low pressure mains throughout Cookstown as part of the "Gas to the West" programme. "As-built" record have yet to be finalised and SGN have advised that future works are planned. For this assessment SGN plant is as per available as built records at the end of September 2020. SGN Design Proposals are indicative only but have been assumed to be along the line indicated in Drawings 718314-WSP-B-D-0100-0014 to 017 and 020.

Where approximate lengths are provided, the minimum length of plant affected has been assumed to be 20m with all other measurements assumed to be at 50m intervals.

5.6.1. RED ROUTE OPTION

NIE and BT cables are located both above and below ground at several locations along the Red Route Option. Table 5-48 and Table 5-49 below summarise the location where NIE and BT plant lies within the indicative Red Route Option boundary.

Table 5-48 – NIE Plant potentially affected – Red Route Option

Type	Location	Approx. Length (m)
NIE 11Kv Overhead (w/ poles)	CH210m, CH1475m, CH1920m, CH2170m, CH2670m, CH3470m, Castle Road, Clare Lane	50, 100, 50, 100, 100, 150, 200, 50
NIE 11kV Cable	CH720m, Loughry Rd Roundabout	50, 150
NIE MV Cables	CH1650m, CH2050m, Cloghog Rd, Clare Lane, B73 Coagh Rd, A29 Moneymore Rd, Tamlaghtmore Rd	350, 50, 20, 250, 20, 300, 20

Seventeen NIE lines may be affected by the proposed Red Route Option. Approximately 2km of the electricity network may require to be diverted should this be selected as the preferred route.

Table 5-49 - BT Plant potentially affected – Red Route Option

Type	Location	Approx. Length (m)
BT Underground Duct	Loughry Rd Roundabout, CH1150m + Killymoon Rd, CH1670m + Cloghog Rd, Clare Lane, CH2200m + B73 Coagh Rd, A29 Moneymore Rd, Tamlaghtmore Rd	150, 100, 250, 100, 100, 700, 500
BT Overhead Line	CH750m + Castle Rd, CH1670m + Cloghog Rd, Clare Lane, CH2650m + Old Coagh Rd, CH3250, Tamlaghtmore Rd	200, 250, 100, 150, 100, 50

Thirteen BT lines may be affected by the proposed Red Route Option. Approximately 2.75km of the telecommunication network may require to be diverted should this be selected as the preferred route.

The Red Route Option may impact an existing O_2 mast at Ch1675m. where none of the other route options will. Should this item plant need to be relocated the cost of doing so is likely to be significant.

The footprint of the proposed roundabout and realignment of the A29 Moneymore Road is the largest of the four route options and so could have greatest impact on SGN's Intermediate Pressure plant. The position of the Cloghog Road Roundabout on the Red Route OPtion is the only one which could have an interaction with the Intermediate Pressure plant along Cloghog Road.

Road Lighting columns, lanterns and associated cables along the Loughry Road Roundabout, Cloghog Road, Clare Lane, A29 Moneymore Road and Tamlaghtmore Road all lie within the proposed fence line of the Red Route Option and may be affected. The Red Route would have the greatest impact on existing DfI Road Lighting.

Table 5-50 (below) lists the locations where NIW plant lies within the indicative Red Route scheme boundary. NIW plant situated at locations where the bypass would be in cut are highlighted in red text.

Table 5-50 - NIW Plant potentially affected – Red Route Option

Type	Location	Approx. Length (m)
NIW Foul Sewer	Loughry Rd Roundabout, CH1670m + Cloghog Rd, Clare Lane, A29 Moneymore Rd	150, 250, 200, 700
NIW Combined Sewer	Loughry Rd Roundabout	150
NIW Over Flow Pipes (WwTW)	CH450m, CH500m, CH570m	100, 100, 100
NIW Watermain	CH800m + Castle Rd, CH1670m + Cloghog Rd, Clare Lane, CH2650m + Old Coagh Rd, Tamlaghtmore Rd	200, 250, 100, 150, 20
NIW Storm Sewer	Clare Lane	100
NIW Distribution Main	Clare Lane, CH2650m + Old Coagh Rd	100, 150
NIW Trunkmain	2800m	150

Nineteen NIW pipes may be affected by the proposed Red Route Option. Approximately 3.65km of the pipes may require to be diverted should the this be selected as the preferred route.

The Red Route is the only route option which would not affect the existing Trunk Main which crosses under the existing Cloghog Road. Each of the other route options would require either a diversion or protection measures to be put in place for this Trunk Main.

5.6.2. PURPLE A ROUTE OPTION

NIE and BT cables are located both above and below ground at several locations along the Purple A Route Option. Table 5-51 and Table 5-52 below summarise the locations where NIE and BT plant lies within the indicative Purple A Route Option boundary.

Table 5-51 – NIE Plant potentially affected – Purple A Route Option

Type	Location	Approx. Length (m)
NIE 11kV Cables	Loughry Rd Roundabout	150
NIE 11Kv Overhead (w/ poles)	CH210m, CH670m, CH1700m, CH1860m, CH2320m, CH2510m, CH2720m, CH3750m, Loughry Rd Roundabout, Castle Rd, Clare Lane, Cloghog Rd (West of RA), Old Coagh Rd, A29 Moneymore Rd	100, 50, 100, 250, 100, 200, 50, 50, 20, 100, 20, 50, 50, 50
NIE MV Cables	CH1000m + Killymoon Rd, Cloghog Road Acc. Works, Cloghog Rd (East of RA), Cloghog Rd (West of RA), A29 Moneymore Rd, Tamlaghtmore Rd	250, 50, 50, 50, 200, 50

Twenty-one NIE lines may be affected by the proposed Purple A Route Option. Approximately 2km of the electricity network may require to be be diverted should this be selected as the preferred route.

Table 5-52 – BT Plant potentially affected – Purple A Route Option

Type	Location	Approx. Length (m)
BT Underground Duct	Loughry Rd Roundabout, CH1100m + Killymoon Rd, CH1900m + Clare Lane, Cloghog Rd, CH2520 + B73 Coagh Rd, A29 Moneymore Rd, Tamlaghtmore Rd	150, 300, 350, 350, 250, 450, 250
BT Overhead Line	CH750m + Castle Rd, Killymoon Rd, CH1900m + Clare Lane, Cloghog Rd, B73 Coagh Rd	250, 100, 350, 350, 50

Twelve BT lines may be affected by the proposed Purple A Route Option. Approximately 3.2km of the telecommunication network may require to be diverted should this be selected as the preferred route.

The footprint of the proposed roundabout for the Purple A Route on the A29 Moneymore Road is smaller than that of the Red Route Option and the potential impact on SGN's Intermediate Pressure plant would likely be less than the Red Route Option.

Road Lighting columns, lanterns and associated cables along the Loughry Road Roundabout, Killymoon Road and Tamlaghtmore Road lie within the proposed fence line of the Purple A Route Option and may be affected to a lesser degree than the Red Routes Option.

NIW have both foul, storm and clean water plant in the area. Table 5-53 below lists the locations where NIW plant lies within the indicative Purple A Route Option boundary.

The Trunk Main at CH1840m and to the West of the proposed Cloghog Road Roundabout would have to be either protected but depending on the available cover or diverted as the proposed finished level at these locations is below the existing ground level. See entries highlighted in red text below.

Table 5-53 – NIW Plant potentially affected – Purple A Route Option

Type	Chainage	Approx. Length (m)
NIW Foul Sewer	Loughry Rd Roundabout, A29 Moneymore Rd	150, 400
NIW Combined Sewer	Loughry Rd Roundabout	150
NIW Over Flow Pipes	CH450m, CH500m, CH560m, CH1600m	50, 50, 100, 20
NIW Watermain	CH750m + Castle Rd, CH1900m + Cloghog Rd, CH2520m + B73 Coagh Rd, CH2850m + Old Coagh Rd, A29 Moneymore Rd	200, 300, 200, 250, 400
NIW Trunkmain	CH1840m, Cloghog Rd (West of RA), Cloghog Rd Acc. Works	50, 50, 50
NIW Distribution Watermain	CH2520m + B73 Coagh Rd, CH2850m + Old Coagh Rd	150, 250

Seventeen NIW pipes may be affected by the proposed Purple A Route Option. Approximately 2.8km of the pipes may require to be diverted should this be selected as the preferred route.

5.6.3. PURPLE B ROUTE OPTION

NIE and BT cables are located both above and below ground at several locations along the Purple B Route Option. Table 5-54 and Table 5-55 below summarise the location where NIE and BT plant lies within the indicative Purple B Route scheme boundary.

Table 5-54 – NIE Plant potentially affected – Purple B Route Option

Type	Chainage	Approx. Length (m)
NIE 11kV Cable	Loughry Rd Roundabout	150
NIE 11kV Overhead (w/ poles)	CH210m, CH670m, Castle Rd, CH1700m, CH1860m, CH1860m, Cloghog Rd (West of RA), CH2320m, CH2500m, CH2720m, Old Coagh Rd, CH4300m	100, 50, 100, 100, 250, 250, 50, 100, 200, 50, 50, 50, 150
NIE MV Cables	CH1000m, CH1000m + Killymoon Rd, Cloghog Rd Acc. Works, Cloghog Rd (East of RA), Cloghog Rd (West of RA), CH4300m, A29 Moneymore Rd	100, 250, 50, 50, 50, 100, 250

Twenty NIE lines may be affected by the proposed Purple B Route Option. Approximately 2.5km of the electricity network may require to be diverted should this be selected as the preferred route.

Table 5-55 – BT Plant potentially affected – Purple B Route Option

Type	Chainage	Approx. Length (m)
BT Underground Duct	Loughry Rd Roundabout, CH1100m + Killymoon Rd, CH1900m + Clare Lane, Cloghog Rd, B73 Coagh Rd, A29 Moneymore Rd	150, 300, 350, 350, 200, 600
BT Overhead Line	CH750m + Castle Rd, Killymoon Road, CH1900m + Clare Lane, Cloghog Rd, B73 Coagh Rd	250, 100, 350, 350, 50

Eleven BT lines may be affected by the proposed Purple B Route Option. Approximately 3.1km of the telecommunication network may require to be diverted should this be selected as the preferred route.

An offline roundabout is proposed for the Purple B Route Option on the A29 Moneymore Road which would have the least impact on existing utilities at the northern tie-in. Therefore, the potential impact on SGN's Intermediate Pressure plant would likely be the least of the four options.

Road Lighting columns, lanterns and associated cables along the Loughry Road Roundabout, Killymoon Road and the A29 Moneymore Road lie within the proposed fence line of the Purple B Route Option and may be affected. Therefore, the impact of the Purple B route on existing road lighting would be similar to Purple A Route Option but less than the Red Route Option.

Depending on the cover available the Purple B Route Option would also require either the diversion or protection of the Trunk Main at CH1840m and to the West of the proposed Cloghog Road Roundabout. See entries highlighted in red text below.

Table 5-56 – NIW Plant potentially affected – Purple B Route Option

Type	Location	Approx. Length (m)
NIW Foul Sewer	Loughry Rd Roundabout	150
NIW Combined Sewer	Loughry Rd Roundabout	150
NIW Over Flow Pipes (WwTW)	CH450m, CH500m, CH560m	50, 50, 100
NIW Watermain	CH750m + Castle Rd, CH1900m + Cloghog Rd, CH2520m + B73 Coagh Rd, Old Coagh Rd, A29 Moneymore Rd	200, 300, 200, 250, 450
NIW Over Flow Pipes	CH1600m	20
NIW Trunkmain	CH1840m, Cloghog Rd (West of RA), Cloghog Rd Accommodation Works	50, 50, 50
NIW Distribution Watermain	CH2520m + B73 Coagh Rd, Old Coagh Rd	150, 250
NIW Foul Sewer	A29 Moneymore Rd	600

Type	Location	Approx. Length (m)
NIW Abandoned Watermain	A29 Moneymore Rd	250

Eighteen NIW pipes may be affected by the proposed Purple B Route Option. Approximately 3.3km of the pipes may require to be diverted should this be selected as the preferred route.

5.6.4. GREEN ROUTE

NIE and BT cables are located both above and below ground at several locations along the Green Route Option. Table 5-57 and Table 5-58 below summarise the location where NIE and BT plant lies within the indicative Green Route Option boundary.

Table 5-57 – NIE Plant potentially affected – Green Route Option

Type	Location	Approx. Length (m)
NIE 11Kv Cable	Loughry Rd Roundabout	200
NIE 11Kv Overhead (w/ poles)	CH230m, CH710m, Castle Rd, CH1790m, CH1900m, Clare Lane, CH2350m, CH2870m, CH3740m, A29 Moneymore Rd	100, 100, 100, 100, 400, 20, 100, 100, 50, 50
NIE MV Cable	Castle Rd, Killymoon Rd, Clare Lane, A29 Moneymore Rd, Tamlaghtmore Rd	50, 100, 50, 150, 20

Sixteen NIE lines may be affected by the proposed Green Route Option. Approximately 1.7km of the electricity network may require to be diverted should this be selected as the preferred route.

Table 5-58 – BT Plant potentially affected – Green Route Option

Type	Location	Approx. Length (m)
BT Underground Duct	Loughry Rd Roundabout, CH1180 + Killymoon Rd, CH1940m + Cloghog Rd, CH2560m, A29 Moneymore Rd, Tamglaghtmore Rd	150, 400, 20, 100, 600, 150
BT Overhead Line	CH820m + Castle Rd, Killymoon Rd, CH1940m + Cloghog Rd	300, 50, 200

Nine BT lines may be affected by the proposed Green Route Option. Approximately 2km of the telecommunication network may require to be be diverted should this be selected as the preferred route.

The footprint of the proposed roundabout for the Green Route Option on the A29 Moneymore Road is broadly similar to that proposed for the Purple A Route Option. The footprint of this roundabout is smaller than that of the Red Route Option but would be larger than the offline roundabout proposed for the Purple B Route Option. Therefore, the potential impact on SGN's Intermediate Pressure plant would likely be greater than Purple B but less than the Red Route Options.

Road Lighting columns, lanterns and associated cables along the Loughry Road Roundabout, Castle Road, Killymoon Road and the A29 Moneymore Road lie within the proposed fence line of the Green

Route Option and may be affected. The impact of the Green Route Option on existing road lighting would be less than the Red Route but greater than the Purple A and Purple B Route Options.

The Trunk Main at CH1840m, would require either a diversion or the protection of depending on the cover available. See entries highlighted in red text below.

Table 5-59 – NIW Plant potentially affected – Green Route Option

Type	Location	Approx. Length (m)
NIW Combined Sewer	Loughry Rd Roundabout	150
NIW Foul Sewer	Loughry Rd Roundabout, A29 Moneymore Rd	200, 600
NIW Watermain	Loughry Rd Roundabout, CH820 + Castle Rd, Killymoon Rd, CH1930m + Cloghog Rd, CH2560m, CH2920m, A29 Moneymore Rd,	100, 250, 50, 250, 100, 100, 600
NIW Over Flow Pipes (WwTW)	CH500m, CH550m, CH600m	50, 50, 100
NIW Trunkmain	CH1860m, Cloghog Rd	50, 50
NIW Distribution Watermain	CH2560m, CH2920m	20, 100

Seventeen NIW pipes may be affected by the proposed Green Route Option. Approximately 2.9km of the pipes may require to be diverted should this be selected as the preferred route.

5.6.5. SUMMARY

Table 5-60 below shows the number of interactions each route option could have with plant controlled by each of the Statutory Authorities.

Table 5-60 – Number of Interactions between utilities and each Route Option

Statutory Authority	Type	Red Route	Purple A Route	Purple B Route	Green Route
BT	Underground	7	7	6	6
	Overhead	6	5	5	3
DfI - Road Lighting	Lighting Column, Luminaires and Cable runs	5	3	3	4
NIE	Underground	9	7	8	6
	Overhead	8	14	12	10
NIW	Watermains and Foul Water Sewers	16	13	14	14
O_2	Telecoms Mast	1	-	-	-
SGN	Proposed, Intermediate and Medium Pressure Gas Mains	3	1	1	1
Total		**55**	**50**	**49**	**44**

NB: * = Runs the length of Road

The Green Route Option would be the preferred route option from a utilities perspective for the following reasons:

- It has the fewest number of interactions with existing utilities
- It has the fewest number of interactions with BT and NIE plant over the shortest distance
- It is tied with the Purple A route in having the fewest interactions with NIW plant (17no.)
- It is more preferable to Purple A as its proposed roundabout at Cloghog Road would not interact with the existing NIW Trunk Main.

Purple B Route Option is preferable to Purple A Route Option for the following reasons:

- It would have the least impact on SGN Plant
- The offline roundabout at Moneymore Road would make utility switch-over easier to execute and programme
- It has fewer interactions with NIE and BT

The Red Route Option would be the least preferred for the following reasons:

- It has the largest number of interactions with existing utilities
- It is the only route option to impact on O2 plant
- It has the greatest potential impact on SGN Intermediate Pressure plant as it is the only route option which could have an interaction along Cloghog Road
- It has the greatest impact on existing Road Lighting.

5.6.6. SANDHOLES LINK ROAD

The Sandholes Link Road proposal has been designed to match or be above the existing road level where possible to minimise disturbance to existing equipment. However, the alteration of existing kerb lines can impact on services and the exposure of existing services can bring hidden deficiencies, for example leaking pipes and deficiencies in cover to light.

Table 5-61 and Table 5-62 below summarise the location where there are NIE and BT plant lines within the indicative Sandholes Link Road boundary.

Table 5-61 – NIE Plant potentially affected – Sandholes Link Road

Type	Location	Approx. Length (m)
NIE MV Cable	Drum Rd, CH0m, CH550m	150, 150, 50
NIE 11kV Cable	CH60m, CH440m, CH550m, Sandholes Rd	100, 50, 150, 100
NIE 11kV Overhead (w/ poles)	CH420m, CH530m	50, 50

Nine NIE lines could be affected by the proposed Sandholes Link Road. Approximately 0.85km of the electricity network may be affected by the Sandholes Link.

Table 5-62 – BT Plant potentially affected – Sandholes Link Road

Type	Location	Approx. Length (m)
BT Underground Duct	Drum Rd, CH0m, Sandholes Rd	150, 650, 100
BT Overhead Line	CH380m, CH640m, Sandholes Rd	50, 50, 50

Six lines of approximately 1.1km of the telecommunication network may be affected by the Sandholes Link Road.

NIW have both foul and clean water plant in the area. Table 5-63 below lists the locations where NIW plant lies within the indicative Sandholes Link Road boundary.

Table 5-63 – NIW Plant potentially affected – Sandholes Link Road

Type	Location	Approx. Length (m)
NIW Mainline	Drum Rd (Westbound), Drum Rd (Eastbound), CH0m – CH700m (Southbound), CH0m – CH450m (Northbound), Sandholes Rd (East of RA), Sandholes Rd (West of RA)	150, 150, 700, 450, 50, 100
NIW Foul Sewer	Drum Road RA, Drum Road (Westbound), CH150m, CH550m, Sandholes Rd	100, 100, 50, 100, 250
NIW Storm Sewer	Sandholes Rd	250

Twelve pipes (approximately2.45km) of the NIW network could be affected by the Sandholes Link Road. The existing watermains on both sides of the carriageway the proposed Fairy Burn culvert may create buildability issues and/or require diversionary works depending on levels.

Similar issues may arise with the existing Intermediate Pressure and the proposed Medium Pressure gas mains at the proposed Fairy Burn culvert. SGN currently have an Intermediate Pressure gas main along the southbound side of the existing Sandholes Road between Drum Road and Strifehill Road and have indicated their intention to lay a Medium Pressure main on the opposite side of the carriageway which would straddle the full extents of the proposed works.

Clear Channel have indicated that they have existing Bus Shelter at the northbound side of the carriageway at CH100m which could be affected by the proposed works.

The existing Sandholes Road is lit by DfI Road Lighting which would be re-designed as part of the stage 3 Specimen Design

5.7. ENGINEERING SUMMARY

5.7.1. HIGHWAYS

The Green Route would be the preferred route option from a highways perspective as it is the only route option which would have no Departures from Standard on the mainline and the only route option to provide direct access to Cookstown at all existing side roads. The absence of direct side access onto the mainline (ie. no LILOs) should lead to a lower collision rate when compared to the other routes as typically collisions occur more frequently at junctions than on links.

The Purple A Route Option and Purple B Route Option are as preferable as each other but less preferable to Green Route Option.

The Red Route would be the least preferred option as while it has the same number of Departures and Relaxations of Standard as the Purple A and Purple B route options the Departure relating Mainline SSD in the proximity of the Castle Road LILO junction and the >4Step Departure for visibility to the left for road users exiting from that Side Road would be considered as a significant road safety issue. The LILO junctions proposed at Castle Road and Killymoon Road would also lead to lengthy diversions for road users on both side road and may lead to a higher collision rate when compared to the other routes.

5.7.2. DRAINAGE

The key drainage constraint which is impacted upon by all the proposed route options would be the existing sewers at the Wastewater Treatment Works at approx. Ch500m.

The Green Route Option would be the preferred route option from an attenuation pond location perspective as there would not be a requirement to locate any ponds within a floodplain. It is anticipated that four ponds would be located within a floodplain for both the Purple A and Purple B Route Options, with five ponds anticipated should the Red Route Option be selected as the Preferred Route Option.

The Green Route Option (3,239m3) and the Red Route Option (3,371m3) would be preferable to the Purple A (6,187m3) and/or Purple B (6,496m3) Route Options from a pond storage perspective as volumetrically each would require significantly less capacity.

5.7.3. HYDROLOGY AND FLOODING

All four route options would impact on Fairy Burn, Ballinderry River, Fountain Road Stormwater Drain and undesignated Trib_2. The Red Route Option has one additional crossing however this would not have a material impact in terms of flooding.

Depending on the footprint area of a route option within a floodplain (greater area creates a greater impact) this may require additional lands to be vested to provide flood compensation areas. This has been provisionally assessed and can be managed for each of the route options.

The Green route would be the preferred option from a hydrology and flooding perspective as it would have the least impact on floodplain extents and watercourse diversions. Purple B would be the least preferred route option as it would have the most significant impact on floodplain, particularly along the northern section on the approach to A29 Moneymore Road.

The Green Route would also have the lowest impact on the alignment of existing watercourses as it is anticipated that approx. 580m (total) of diversionary works would be required. The Purple A Route Option would have highest impact on the alignment of existing watercourses with approx. 1,160m. (total) of diversionary works would be required.

5.7.4. GEOTECHNICS

GI data across the study area indicates that each of the four routes would encounter generally similar ground conditions with glacial till deposits predominant. These deposits will primarily be excavated in areas of cutting and reused for areas of embankment. Some of the deposits can be expected to be too wet for re-use as dug and may require some conditioning or mixing prior to be retained in the works where required.

Bedrock has not been widely proven across the study area to date, but it may be expected in some of the deeper cuttings on the route.

Significant deposits of contaminated land have not been identified within the study area. All routes are impacted to similar extent with no major significant differentiators between any of the routes.

5.7.5. STRUCTURES

A proposed underbridge for the Ballinderry River will be required with an expected span of approximately 30m common to all four route options. The Red Route Option would be the preferred route option from a structures perspective as it would require the fewest structures (two, both overbridges) to accommodate side road crossings. The Green route would be the least preferable of the route options at it would require four structures (all underbridges) to accommodate side road crossings and would pose the greatest buildability constraints near the WwTW.

5.7.6. UTILITIES

The Green Route Option would be the preferred route option from a utilities perspective with the fewest number of interactions with existing utilities. The Red Route Option would be the least preferred option with the largest number of interactions with existing utilities and is the only route option which could impact upon O2 plant and an SGN Intermediate Pressure gas main at Cloghog Road.

The Purple B Route Option would be preferable to the Purple A Route as the offline roundabout at Moneymore Road would make utility switch easier to execute and programme and has fewer interactions with both NIE and BT.

5.7.7. ENGINEERING ASSESSMENT SUMMARY TABLE

Table 5-64– Engineering Assessment Summary Table

Topic / Route Option Ranking	Red Route	Purple A Route	Purple B Route	Green Route
Highways	4th	2nd	2nd	1st
Drainage	2nd	2nd	2nd	1st
Flooding	2nd	3rd	4th	1st
Geotechnical	4th	1st	2nd	4th
Structures	1st	2nd	2nd	4th
Utilities	4th	3rd	2nd	1st
Overall	**4th**	**2nd**	**3rd**	**1st**

6. ENVIRONMENTAL ASSESSMENT

6.1. INTRODUCTION

The following section presents the findings of the Stage 2 environmental assessment, undertaken to identify and assess potential environmental effects that may result from construction of each of the Route Options, each inclusive of the Sandholes Link Road. It details mitigation measures to minimise these effects and provides relative scoring of post mitigation residual effects based on the predicted environmental outcomes, to help inform the overall preferred option selection process.

The four route options are assessed individually for each environmental topic against baseline conditions to identify sensitive receptors and likely significant residual environmental effects (beneficial or adverse). Effects that are classified as being of moderate or greater are considered to be 'significant' in environmental assessment terms. Effects classified as slight or below are considered to be 'non-significant'. Alternatives considered in previous reporting (but not assessed here) are detailed in Section 2.2 of this report.

6.1.1. ENVIRONMENTAL ASSESSMENT TOPICS

Sections 6.2 to 6.12 cover the following environmental topics in alignment with the Design Manual for Roads and Bridges (DMRB), Volume 11[2] as follows:

- Air Quality
- Cultural Heritage
- Landscape and Visual
- Biodiversity
- Geology and Soils
- Materials Assets and Waste
- Noise and Vibration
- Population and Human Health
- Climate
- Road Drainage and the Water Environment
- In-combination and Cumulative Effects

A summary of the Environmental Assessment findings is provided within Section 8.

6.1.2. MAJOR ACCIDENTS AND DISASTERS

Although there is potential for a wide range of major accidents and disasters (major events) to occur, the probability, likelihood and frequency is very low; often due to the management of a risk under the established legislative requirements or during the design process.

'Disaster risk' can be characterized as a hazard which has the potential to cause injury or losses to individuals or a community and potentially includes loss / detriment to life, health, assets and livelihoods. An 'Accident' can be defined as, an undesirable event resulting in damage or harm.

A high-level assessment is made as to the vulnerability of the proposed scheme to risks of major events; and any consequential changes in the predicted effects of that project on environmental

[2] DMRB (various years). DMRB Volume 11 – Environmental Assessment. [online] Available at: https://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/index.htm [Accessed 19/08/2020].

factors (see Table 6-1 below). This follows the scoping approach identified within DMRB “LA 104: Environmental assessment and monitoring”. This assessment will be further developed at Stage 3.

Any consequential changes in the predicted effects of the proposed scheme on individual environmental topics is made on a ‘topic by topic’ basis as identified within Table 6-1 below. An initial scoping exercise was undertaken to determine the types of major events likely to have a significant effect on the proposed scheme as summarised in Table 6-1.

Table 6-1 – Major Accident or Disaster Scoping Exercise

Major Event	Scoped In / Out	Comment
Earthquake / seismic	Out	There is a risk that an earthquake could occur in the locality of the proposed scheme and that impacts to the proposed scheme itself (and consequential adverse effects on the environment) could occur as a result. However, the design is not considered likely to increase the vulnerability of the proposed scheme to seismic events, as the proposed scheme will be designed in accordance with the relevant engineering standards and earthquake risk guidelines. The proposed scheme is not expected to have any effect that will increase the likelihood of an earthquake. On this basis, the vulnerability of the proposed scheme to earthquakes and the resultant effects on the environment have not been considered further within this report.
Volcanic activity	Out	There is a risk of volcanic eruption in Europe however it is unlikely that this could significantly impact the proposed scheme. The proposed scheme design will not increase its vulnerability to volcanic activity. The proposed scheme is not expected to have any effect that will increase the likelihood of volcanic activity. On this basis, the vulnerability of the proposed scheme to volcanic events and the resultant effects on the environment have not been considered further within this report.
Tsunami	Out	The design will not increase the vulnerability of the proposed scheme to tsunami. The proposed scheme is not expected to have any effect that will increase the likelihood of a tsunami. On this basis, the vulnerability of the proposed scheme to tsunami and the resultant effects on the environment have not been considered further within this report.
Fire	Out	The design will not increase the vulnerability of the proposed scheme to fire. Fires could be initiated by the proposed scheme (e.g. construction related activities); however, during construction standard control measures would be implemented by the appointed contractor to manage the risk of fire and during operation the risk is no different to similar roads. Specific measures are therefore not considered to be required as part of the proposed scheme. On this basis, the vulnerability of the proposed scheme to fire and the resultant effects on the environment have not been considered further within this report.
Ground related hazard (e.g. subsidence, landslide, release of hazardous ground gasses)	Out	The design will not increase the vulnerability of the proposed scheme to landslides, subsidence or release of hazardous ground gasses. In designing the proposed scheme to applicable standards, resources and receptors would not be put at a greater risk as a consequence of the proposed scheme. On this basis, the vulnerability of the proposed scheme to landslides, subsidence or release of hazardous ground gasses and the resultant effects on the environment have not been considered further within this report.
Extreme weather event (e.g.	Partial in / partial out	The design will not increase the vulnerability of the proposed scheme to cyclones, drought or heavy snow. The proposed scheme is not expected to have any effect that will increase the likelihood of a cyclone, drought or heavy

Major Event	Scoped In / Out	Comment
cyclone, drought, flooding, heavy snow)		snow. On this basis, the vulnerability of the scheme to the above extreme weather events and the resultant effects on the environment have not been considered further within this report. There is a risk that the design could increase the vulnerability of the proposed scheme to flooding and the potential for the proposed scheme to exacerbate flooding. This potential effect is considered further in Section 5.3.
Act of terrorism	Out	The design will not increase the vulnerability of the proposed scheme to acts of terrorism. The proposed scheme is not expected to have any effect that will increase the likelihood of an act of terrorism. On this basis, the vulnerability of the proposed scheme to acts of terrorism and the resultant effects on the environment have not been considered further within this report.
Major road accident	In	The design is expected to show overall improvements in road safety relative to the do-nothing scenario through a reduction in the overall number of road accidents within the network (as identified in Section 7.3). It will therefore not increase the vulnerability of the proposed scheme to road accidents, and the proposed scheme is not expected to have any effect that will increase the likelihood of road accidents. This is considered further in Section 7 (Traffic and Economics Assessment). Environmental risks of pollution during operation due to accidental spillages where spilled materials may drain from the road surface, polluting the receiving water bodies is considered in Section 6.11 Road Drainage and the Water Environment.
Major rail accident	Out	The nearest rail line to the proposed scheme is at Portadown approximately 29 km to the south east of the proposed scheme. On this basis, the proposed scheme design is not considered vulnerable to major rail accidents. The proposed scheme is not expected to have any effect that will increase the likelihood of a major rail accidents. On this basis, the vulnerability of the proposed scheme to major rail accidents and the resultant effects on the environment have not been considered further within this report.
Major aviation accident	Out	The nearest major airport to the proposed scheme is Belfast International Airport, which is located approximately 31 km to the east of the proposed scheme. The proposed scheme design will not increase the vulnerability of the proposed scheme to aviation accidents. The proposed scheme is not expected to have any effect that will increase the likelihood of a major aviation accidents. On this basis, the vulnerability of the scheme to aviation accidents and the resultant effects on the environment have not been considered further within this report.
Major industrial accident	Out	The proposed scheme is not located within close proximity to any existing heavy industrial sites. The design will not increase the vulnerability of the proposed scheme to major industrial accidents. The proposed scheme is not expected to have any effect that will increase the likelihood of a major industrial accident. On this basis, the proposed scheme is not considered vulnerable to major industrial accidents and as such, this has not been considered further within this report.
Major maritime accident	Out	The proposed scheme is located inland. On this basis, the proposed scheme is not considered vulnerable to major maritime accidents, and the proposed scheme is not expected to have any effect that will increase the likelihood of a major maritime accidents. As such, this has not been considered further within this report.
Nuclear accident	Out	The design will not increase the vulnerability of the proposed scheme to a nuclear accident relative to the do-nothing scenario. The proposed scheme is

Major Event	Scoped In / Out	Comment
		not expected to have any effect that will increase the likelihood of a nuclear accident. On this basis, the vulnerability of the proposed scheme to nuclear accidents and the resultant effects on the environment have not been considered further within this report.
Major water infrastructure accident (e.g. dam inundation, from reservoir)	Out	The proposed scheme passes a Northern Ireland Water Limited Wastewater Treatment Works (WwTW). The design, including a retaining structure, and carefully managed construction techniques will be such that impacts on this WwTW will be minimised. The design will not increase the vulnerability of the proposed scheme to major water infrastructure accidents. The proposed scheme is not expected to have any effect that will increase the likelihood of a major water infrastructure accident. On this basis, the vulnerability of the proposed scheme to dam inundation and/or inundation from reservoir and the resultant effects on the environment have not been considered further within this report.
Major construction accident	Partial in / partial out	The potential for construction related accidents is recognised; however, they are considered under existing legislation around safe working practices, environmental management and Construction Design Management (CDM) which will ensure that such risks are mitigated appropriately without the need for further assessment. During construction there may be an increase in risk of leaks and spillages of hazardous materials associated with construction activities. standard control measures would be implemented by the appointed contractor to manage the risk of spillages and leaks. The environmental risks posed by spillages accidental spillage of contaminants are considered in Section 6.6 Geology and Soils and Section 6.11 Road Drainage and the Water Environment.
Biological natural hazards – Disease epidemics	Out	The design will not increase the vulnerability of the proposed scheme to disease epidemics. The use of the proposed scheme is not expected to propagate or promote any disease epidemics; therefore, the proposed scheme is not expected to have any effect that will increase the likelihood of a disease epidemic. Public Health Agency (PHA) in Northern Ireland is responsible for protecting and improving the health and social wellbeing of the nation. The Health Protection Service in the PHA has a lead role in protecting the population from infection and environmental hazards through a range of core functions including surveillance and monitoring, operational support and advice, education, training and research. Any impact of disease epidemics that result in an effect of the environmental assessment of the proposed scheme are considered on a topic by topic basis within this report where relevant.

6.2. AIR QUALITY

6.2.1. ASSESSMENT SCOPE

A comparison of potential construction and operational road traffic impacts in regard to local air quality of the four route options in the proposed year of opening (2025), has been completed in line with the guidance in DMRB, LA 105, Air Quality[3], (LA 105).

A proportionate approach has been considered, focussing on the key elements that differentiate the route options, and based on the quality of data available and the risk of likely significant effects occurring.

This section presents the predicted road traffic impacts arising on local air quality from the route options on surrounding sensitive receptors. The four route options also consider Sandholes Link Road.

The assessments scoped in for this stage of the project lifecycle are:

- Construction dust risk assessment
- Operational road traffic assessment, considering the following elements
    - Compliance risk assessment
    - Designated habitats assessment
    - Local air quality assessment, in consideration of human health

Route Option drawings and traffic flow data for each route option have been generated to determine the construction dust risk potential to the receiving environment, which informs the appropriate level of mitigation and to predict annual mean pollutant concentrations of nitrogen dioxide (NO_2) and particulate matter (PM_{10}, $PM_{2.5}$) from road vehicle exhaust emissions at sensitive receptors, as a consequence of each route option in operation.

The LA 105 guidance has been followed to provide an initial determination whether each route option triggers a significant effect by assessing the following:

- effects on human health
- effects on designated habitats
- outcomes of the compliance risk assessment

A comparison of the impacts of each route option has then been made.

As the proposed scheme is at the options stage, a simple assessment has been considered. According to LA 105, "*A simple assessment provides sufficient information to confirm that the project does not result in any exceedance of the air quality thresholds*."

The assessments scoped out for this stage of the project lifecycle are:

- Construction road traffic assessment
- Detailed operational road traffic assessment

[3] Highways England, Transport Scotland, Welsh Government and the Department for Infrastructure Northern Ireland, (2020). DMRB, LA 105 revision 0. Air Quality [online] Available at: https://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/LA%20105%20Air%20quality-web.pdf [Accessed 04/05/2020].

The impact of construction activities on vehicle movements has not been considered at this stage of the project lifecycle. According to LA 105, "*The impact of construction activities on vehicle movements shall be assessed where construction activities are programmed to last for more than 2 years*." Initial discussions have indicated that the anticipated construction programme will last for approximately 18 months. As such, a construction road traffic assessment has not been completed at this stage. At the preferred option stage, a detailed assessment will be considered to provide a full determination on the significance of effect on local air quality.

A glossary of terms and acronyms used is provided in Appendix B-1 along with the references of information sources used in the production of this section.

6.2.1.1. Legislative and Policy Framework

Details of the relevant legislation and policy notes considered in the air quality assessment are provided in Environmental Appendix B-2.

6.2.1.2. Guidance

Details of the relevant guidance considered in the air quality assessment are provided in Environmental Appendix B.

6.2.1.3. Topic Study Area

Construction Study Area

For the construction dust assessment, the guidance within LA 105[3] has been followed. This states that, "*All sensitive receptors (human and designated habitats) within 200 m of all construction activity shall be identified on a constraints plan*."

At this stage, neither a construction programme nor details of the likely construction haul routes and equipment to be used are confirmed. As such, a construction study area of within 200 m from the road centreline of each route option including the Sandholes Link Road has been set to complete this assessment.

The construction study area for each of the four route options are presented in Figures 6.2.1 to 6.2.4 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0199 to 0202).

Operational Study Area

As per LA 105[3], an 'affected road network' (ARN) for each route option has been generated by applying the traffic scoping criteria to the respective traffic data supplied for the proposed scheme. The ARN derived for each route option is based on changes between the Do-Minimum (DM) and Do-Something (DS) scenarios, that would occur due to the implementation in the proposed year of opening (2025), which are as follows:

- Daily traffic flows will change by more than 1,000 Annual Average Daily Traffic (AADT)
- Heavy Duty Vehicle (HDV) flows will change by more than 200 AADT
- A change in speed band, or
- Horizontal road alignment will change by 5 m or more

Figures 6.2.5 to 6.2.8 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0203 to 0206) present the ARN for each route option, covering the respective proposed alignment, and road links situated within 200m of, or form part of, the ARN.

For this options appraisal, the operational stage assessment focuses on the Traffic Reliability Area (TRA) which encompasses all road links within the traffic model deemed as reliable for inclusion. As such, the operational stage study area has been based on the extents of the TRA which combines all four proposed route option ARNs.

The operational study area is shown in Figure 6.2.9 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0207).

6.2.1.4. Methodology

Specific guidance for the assessment of effects of road infrastructure schemes on air quality is provided in LA 105[3]. For more detail on methodology refer to Environmental Appendix B.

6.2.1.5. Consultation

Mid Ulster District Council Environmental Health Department were contacted during the assessment process and their responses summarised as follows:

- E-mail notification of baseline air quality monitoring survey, including survey locations; and
- E-mail correspondence to request the latest LAQM reporting and monitoring data held by Mid Ulster District Council.

Mid Ulster District Council were consulted to gain a broad agreement on the spatial extents of the baseline monitoring survey and to receive an update to any LAQM reporting and monitoring information to incorporate within this assessment.

6.2.1.6. Assumption and Limitations

Details of assumptions and limitations for air quality assessment are provided in Environmental Appendix B.

6.2.2. BASELINE CONDITIONS

This section presents a summary of baseline conditions, presented for the respective Local Authority which the proposed scheme is situated; Mid Ulster District Council.

6.2.2.1. Local Air Quality Management

A review of the latest LAQM review and assessment report[4] published by Mid Ulster District Council confirmed that there are no AQMAs declared within the Cookstown area.

The following narrative is presented from the 2017 Air Quality Progress Report[4]:

- "*Diffusion tube monitoring at 8 locations in the former Cookstown District Council area in Cookstown and Moneymore did not demonstrate any exceedances of the objective limit of 40ug/m^3*."

[4] Mid Ulster District Council, (2018). Mid Ulster District Council 2017 Air Quality Progress Report. [online] Available at: https://www.airqualityni.co.uk/assets/documents/dc-reports/Mid_Ulster_2017_Report.pdf [Accessed 06/07/2020].

Details of the Mid Ulster District Council AQAP are contained within the latest published LAQM report[4] and Mid Ulster District Council Area 2019 communication[5],. The AQAP outlines a series of measures that Mid Ulster District Council are aiming to deliver by 2023, in order to reduce concentrations of air pollutants and exposure to air pollution within the Mid Ulster area. These include:

- Ensuring potential air quality issues are assessed with new developments before problems arise through consultation with the Planning Department
- Investigation of the potential for a number of electric charging points to be included in certain developments, through consultation with the Planning Department
- Investigation of air quality nuisance complaints and inclusion of appropriate action to resolve issues
- Encouraging installation of bicycle stands at large supermarkets located in the District and promote the use of existing bicycle stands
- Investigation of fleet improvements of Council owned vehicles
- Investigating potential for marked walking and cycling routes within towns.

6.2.2.2. Air Quality Monitoring in Cookstown

Continuous Monitoring

There is no automatic (continuous) air quality monitoring carried out within Cookstown area.

Passive Monitoring

According to the 2017 Air Quality Progress Report[4] and the Air Quality in the Mid Ulster District Council Area 2019 communication[5], Mid Ulster District Council carried out non-automatic (passive) monitoring of NO_2 at four locations within Cookstown between 2015 and 2018. Monitoring was carried out at the following locations listed in Table 6-2 below.

Table 6-2 – Mid Ulster District Council NO_2 Annual Mean Diffusion Tube Data – 2015 to 2018

Tube Ref	Site Location	Site Type	OSNI Grid Reference		Annualised NO_2 ($\mu g/m^3$)			
			X	Y	2015	2016	2017	2018
C2	William Street	Roadside	281071	378445	28.8	21	22	25
C3	James Street	Kerbside	281053	378197	20.4	32	31	31
C4	Church Street	Roadside	281121	377537	28.3	29	26	26
C5	Killymoon Street	Kerbside	281225	376939	22.4	32	32	30

The results in Table 6-2 show during 2015 to 2018 the annual mean NO_2 concentrations from the identified monitoring sites did not exceed, or come within 10% ($36\mu g/m^3$) of the air quality objective of $40\mu g/m^3$ at any of the four identified locations in Cookstown.

[5] Mid Ulster District Council, (2019). Air Quality in the Mid Ulster District Council Area 2019 – Air Quality Action Plan. [online] Available at: https://mid-ulster.cmis-ni.org/midulster/Decisions/tabid/67/ctl/ViewCMIS_DecisionDetails/mid/391/Id/adc0469e-64fb-4e2c-a174-8cd719651abb/Default.aspx [Accessed 04/05/2020].

Proposed Scheme Specific Monitoring

As part of the proposed scheme, a baseline air quality monitoring programme for NO_2 concentrations was established across the Cookstown area. The location of monitoring points are shown in Figure 6.2.10 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0208).

The results have been annualised and bias adjusted for 2019 as per the guidance contained in LAQM.TG16 as the monitoring commenced in May 2019. The results from the monitoring survey are contained in Table 6-3 below.

Table 6-3 – WSP NO_2 Annual Mean Diffusion Tube Data – 2019

Tube Ref	Site Location	Classification	OSNI Grid Ref		2019 Annual NO_2 ($\mu g/m^3$)
			X	Y	
M1	LC 4405 – A505 Drum Road	Roadside	280470	376866	27.7
M2	LC 6379 – Sandholes Road	Roadside	280397	376766	20.7
M3	LC 6175 – Sandholes Road	Roadside	280718	376291	16.4
M4	LC 3427 – Tullywiggan Road	Roadside	281400	375862	19.0
M5	LC 1118.1 – A29 Church Street	Roadside	281236	376433	25.6
M6	LC 4717 – Killymoon Road	Roadside	281807	377131	10.5
M7	LC 6036.6 – Westlands Road South	Kerbside	280566	377358	27.6
M8	LC 4568 – Orritor Road	Roadside	280129	378499	14.2
M9	LC 4154 – Morgan's Hill Road	Roadside	280559	378920	17.2
M10	LC 4526 – Tullagh Road	Roadside	279934	377977	9.3
M11	LC 41474 – Lissan Close	Roadside	280762	379206	12.4
M12	LC 4863 – Lissan Road	Roadside	280967	379059	17.1
M13	LC 4992 – Coolreaghs Road	Roadside	280607	379811	7.7
M14	LC 1214.1 – A29 Moneymore Road	Roadside	281373	379121	30.5
M15	LC 108 – A29 Riverside	Roadside	282627	380268	18.1
M16	LC 5134 – Old Coagh Road	Kerbside	281626	378569	13.9
M17	LC 6432 – Molesworth Street	Roadside	281651	378156	22.6
M18	LC 4825 – Fountain Road	Roadside	282008	377636	16.4
M19	LC 1157 – A29 Chapel Street	Roadside	281106	377816	21.1
M20	LC 4384 – Convent Road	Urban background	280830	377844	10.4

The results in Table 6-3 show that in 2019 the annual mean NO_2 concentrations from the proposed scheme specific monitoring sites did not exceed, or come within 10% (36$\mu g/m^3$) of the air quality objective of 40$\mu g/m^3$ at any of the 20 locations.

Further details on the proposed scheme specific monitoring survey are contained in Appendix B-4.

6.2.2.3. Background Pollutant Concentrations

DEFRA provides mapped estimates of background pollution concentrations[6] for NO_X, NO_2, PM_{10} and $PM_{2.5}$ across the UK at a grid resolution of 1km x 1km, covering each year from 2017 to 2030.

Future year projections have been developed on the base year for the background maps, which is currently 2017. The maps include a breakdown of background concentrations by emission source, including road and industrial sources which have been calibrated against 2017 UK monitoring and meteorological data.

The total background NO_x, NO_2, PM_{10} and $PM_{2.5}$ average, maximum and minimum annual mean concentrations for the 1km x 1km grid squares encompassing the Cookstown area for a base year of 2019 and the operational year of 2025 are provided in Table 6-4.

Table 6-4 – DEFRA Annual Mean Background Pollutant Concentrations – 2019 to 2025

Statistic	Annual Mean (µg/m^3) - 2019				Annual Mean (µg/m^3) - 2025			
	NO_x	NO_2	PM_{10}	$PM_{2.5}$	NO_x	NO_2	PM_{10}	$PM_{2.5}$
Minimum	4.4	3.5	7.6	4.7	3.6	2.9	7.2	4.3
Average	6.1	4.8	8.7	5.2	5.1	4.0	8.2	4.8
Maximum	11.2	8.4	11.1	7.1	9.6	7.3	10.7	6.7

The reported background pollutant concentrations are observed to be below the respective annual mean Air Quality Objectives for NO_2, PM_{10} and $PM_{2.5}$. Further information is provided in Appendix B-6.

6.2.2.4. DEFRA PCM Model Links

Information on areas that are exceeding the EU limit value thresholds can be sourced from DEFRA's PCM model[7], where projections for concentrations of annual mean NO_2 have been calculated across the UK between 2018 and 2030 inclusive. This data is generated in support of DEFRA's UK Plan for tackling roadside NO_2 concentrations[8].

Predicted roadside NO_2 concentrations were obtained from DEFRA's PCM model[7] for the reference year of 2018. Years between 2019 to 2025 are presented in Table 6-5 for links contained within the TRA (see Figure 6.2.12 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0210)).

Table 6-5 – DEFRA PCM Model Results for Annual Mean Roadside NO_2 Concentrations (2018-2025)

Road	Census Point ID	Annual Mean Roadside NO_2 Concentration (µg/m^3)							
		2018	2019	2020	2021	2022	2023	2024	2025
A29	902630	18.6	17.7	16.7	15.8	15.0	14.2	13.5	12.8
A505	902664	9.6	9.0	8.3	7.8	7.2	6.8	6.4	6.0

[6] DEFRA, (2019). 2017-based background maps for NO_x, NO_2, PM_{10} and $PM_{2.5}$. [online] Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2017 [Accessed 06/07/2020].
[7] DEFRA, (2020). 2020 NO_2 projections data (2018 reference year). [online] Available at: https://uk-air.defra.gov.uk/library/no2ten/2020-no2-pm-projections-from-2018-data [Accessed 03/08/2020].
[8] DEFRA and Department for Transport (DfT), (2017). UK Plan for tackling roadside nitrogen dioxide concentrations. [online] Available at: https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017 [Accessed 04/05/2020].

EU Limit Value	40µg/m^3

In the Cookstown area, the national PCM model predicts two locations (the A505 Drum Road and A29) to be in compliance with the annual mean EU Limit Value by the operational year of 2025.

6.2.2.5. APIS Background Information

Background pollutant concentrations and deposition rates at Upper Ballinderry River ASSI / SAC were obtained from the APIS website[9] using the 'site relevant critical loads' function and are summarised in Table 6-6.

Table 6-6 – Upper Ballinderry River ASSI / SAC – Critical Lovel and Critical Load Ranges – APIS

Parameter	Minimum	Average	Maximum
NO_x Concentration (µg/m^3)	4.1	5.3	12.6
Critical Level (µg/m^3)	30		
N Deposition (kg N/ha/yr)	8.2	10.1	12.7
Critical Load Range	No comparable habitat with established critical load estimate available		

From APIS - the pollution concentration and deposition data in the Site Relevant Critical Load Tool has been updated to use the three-year mean for 2016-18.

It can be seen from Table 6-6 that the quoted background NO_x concentrations are below the critical level of 30µg/m^3. A critical load range has not been designated within APIS[27] for the Upper Ballinderry River ASSI / SAC however the feature is identified as being sensitive to N deposition.

6.2.2.6. Predicted Baseline Assessment

A baseline modelling exercise has been completed for each of the route options, accounting for the identified sensitive receptor locations included in the human health component of the operational stage assessment. The modelling was carried out for a base year of 2019, for which local and project specific monitoring data were available to facilitate model verification.

A summary of the baseline assessment results is provided below.

Annual Mean NO_2 concentrations

In the 2019 modelled baseline scenario, annual mean NO_2 concentrations are below the air quality objective at all modelled receptors with the exception of one. The modelled concentrations range from 4.0µg/m^3 to 40.2µg/m^3, with receptor UPRN 185692951 (12 Church Street) experiencing the highest modelled concentration.

Annual Mean PM_{10} concentrations

In the 2019 modelled baseline scenario, annual mean PM_{10} concentrations are below the air quality objective at all modelled receptors. The modelled concentrations range from 7.7µg/m^3 to 14.1µg/m^3,

[9] Centre for Ecology and Hydrology et al, (2020). Air Pollution Information System (APIS) Upper Ballinderry River ASSI / SAC. [online] Available at: http://www.apis.ac.uk/srcl/select-a-f.eature?site=UK0030296&SiteType=SAC&submit=Next [Accessed 03/08/2020].

with receptor UPRN 185694696 (Carebears Daycare Creche) experiencing the highest modelled concentration.

Annual Mean $PM_{2.5}$ concentrations

In the 2019 modelled baseline scenario, annual mean $PM_{2.5}$ concentrations are below the air quality objective at all modelled receptors. The modelled concentrations range from 4.7µg/m^3 to 8.9µg/m^3, with receptor UPRN 185694696 (Carebears Daycare Creche) experiencing the highest modelled concentration.

6.2.5.7 Future Baseline

Pollutant concentrations will vary in the future when compared to the baseline scenario, because of projected improvements in vehicle emissions and variations in traffic distribution across the road network. This is due to both implementation of new policies and strategies, potential new road schemes for the area, changing attitudes towards driving, and improvements in fuel and vehicle technology.

The DEFRA background pollutant concentration dataset for 2025 shows annual mean NO_2 concentrations (see Appendix B-6) below the respective objective, as well as both PM_{10} and $PM_{2.5}$ (see Appendix B-6).

6.2.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

6.2.3.1. Construction Stage

Construction Dust Assessment

Risk Potential

With reference to Table 1-1 of Appendix B, the proposed scheme is for the construction of a bypass to the east of Cookstown and includes upgrades to the Sandholes Link Road, to provide a better link between A505 Drum Road and the Loughry Roundabout on the A29. As such, all route options are considered to have a Large construction risk potential, as specified in LA 105[3].

Receiving Environment Sensitivity to Construction Dust

The number of sensitive receptors within the construction stage study area of each route option are presented in Table 1-5 of Appendix B and illustrated in Figure 6.2.1 (Appendix A: Drawing Reference 718314-WSP-B-D-3000-0199), Figure 6.2.2 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0200), Figure 6.2.3 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0201), and Figure 6.2.4 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0202) respectively.

Identified sensitive receptors within 100m are considered to experience a High level of dust risk potential whilst those receptors situated between 100-200m are considered to experience a Low level of dust risk potential. This is applicable for all four route options.

Construction Traffic Assessment

Section 6.2.1.4 states that "*Early indications of the construction programme is that construction-related activities are programmed to last for a timeframe of 18 months*".

As such, the impact of construction activities on vehicle movements has not been assessed as construction activities are programmed to last for less than two years, as per LA 105[3].

6.2.3.2. Operational Stage

Human Health Assessment

A total of 6,523 sensitive receptor locations (see Table 1-6 of Appendix B) were selected for the human health component of the operational stage assessment. The selected receptors are contained to the Cookstown area, within the designated TRA (see Figure 6.2.9 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0207)) and are in proximity to the DEFRA PCM model[7] road links that are considered as part of the compliance risk assessment.

Each proposed route option encompasses the Sandholes Link Road as well as the main route option component.

Red Route Option

The greatest decrease in annual mean NO_2 concentration between DM and DS for the Red Route Option is predicted at receptor UPRN 185692951 (12 Church Street), with a concentration change of -18.5µg/m^3, from 39.3µg/m^3 to 20.8µg/m^3. This impact equates to a large (improvement) magnitude of change.

Annual Mean PM_{10} Concentrations

The Air Quality Objective for annual mean PM_{10} is 40µg/m^3. The results of the human health air quality assessment for the Red Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Red Route Option in operation.

The maximum predicted PM_{10} annual mean concentration with the implementation of the Red Route Option is 14.3µg/m^3 at receptor UPRN 187638106 (39 Castle Road). This receptor is situated within the Red route site boundary and is predicted to experience a concentration change of 4.9µg/m^3, which equates to a large (deterioration) magnitude of change.

Annual Mean $PM_{2.5}$ Concentrations

The Air Quality Objective for annual mean $PM_{2.5}$ is 25µg/m^3. The results of the human health air quality assessment for the Red Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Red Route Option in operation.

The maximum predicted $PM_{2.5}$ annual mean concentration with the implementation of the Red Route Option is 8.2µg/m^3 at receptor UPRN 185696280 (41 Blackhill). This receptor is situated within the Sandholes Link Road site boundary.

A maximum concentration change of 2.7µg/m^3 is predicted at receptor UPRN 187638106 (39 Castle Road) with the Red Route Option in operation, from 5.7 µg/m^3 to 8.0 µg/m^3. This equates to a large (deterioration) magnitude of change.

A summary of the Red Route Option human health air quality assessment is presented in Table 6-7 below.

Table 6-7 – Human Health Air Quality Assessment – Opening Year (2025) – Red Route Option

Pollutant		NO_2	PM_{10}	$PM_{2.5}$
Annual Mean Air Quality Objective / Limit Value (µg/m^3)		40	40	25
Number of Considered Receptors greater than Limit Value / AQO	Base Year (2019) Exceedances	1	0	0
	DM (2025) Exceedances	0	0	0
	DS (2025) Exceedances	0	0	0
	Removed Exceedances	0	0	0
	New Exceedances	0	0	0
Total Number of Considered Receptors	Improvement in Concentration	5449	4659	3998
	No Change in Concentration	307	1181	2056
	Deterioration in Concentration	767	683	469
DS-DM Annual Mean Change (µg/m^3)	Maximum Improvement	-18.5	-1.7	-1.0
	Maximum Deterioration	14.0	4.9	2.7
Ratio (Improvement to Deteriorations)		7.1: 1	6.8: 1	8.5: 1
Total Number of Receptors		6523		
Results rounded to 1 decimal place				

In summary, there are no new or removed exceedances of the respective annual mean NO_2, PM_{10} and $PM_{2.5}$ Air Quality Objectives due to the Red Route Option in operation in 2025.

Approximately 83.5% of the considered receptor locations are predicted to experience an improvement in annual mean NO_2 concentrations with the Red Route Option in operation, with 11.8% predicted to experience a deterioration.

With regard to annual mean PM_{10}, approximately 61.3% of receptors are predicted to experience an improvement with the Red Route Option in place and 10.5% are predicted to experience a deterioration. Similarly, 71.4% of receptors are predicted to experience an improvement with the Red Route Option in place and 7.2% are predicted to experience a deterioration with respect to annual mean $PM_{2.5}$ concentrations.

Purple A Route Option

Annual Mean NO_2 Concentrations

The Air Quality Objective for annual mean NO_2 is 40µg/m^3. The results of the human health air quality assessment for the Purple A route show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Purple A Route Option in operation.

Receptor UPRN 187681414 (135 Church Street) is predicted to experience the maximum annual mean NO_2 value of 26.7µg/m^3 and is situated approximately 475m from the Purple A Route Option site boundary.

The greatest increase in annual mean NO_2 concentration between the DM and DS scenarios is predicted at receptor UPRN 185693174 (11 Golf View), with a concentration change of 3.3µg/m^3, from 9.3µg/m^3 to 12.6µg/m^3. This impact equates to a medium (deterioration) magnitude of change. However, the predicted annual mean NO_2 concentration remains below the respective Air Quality Objective in both the DM and DS scenarios.

The greatest decrease in annual mean NO_2 concentration between DM and DS for the Purple A Route Option is predicted at receptor UPRN 185692951 (12 Church Street), with a concentration change of -17.9µg/m^3, from 39.3µg/m^3 to 21.4µg/m^3. This impact equates to a large (improvement) magnitude of change.

Annual Mean PM_{10} Concentrations

The Air Quality Objective for annual mean PM_{10} is 40µg/m^3. The results of the human health air quality assessment for the Purple A Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Purple A Route Option in operation.

The maximum predicted PM_{10} annual mean concentration with the implementation of the Purple A Route Option is 13.3µg/m^3 at receptor UPRN 185696280 (41 Blackhill). This receptor is situated within the Sandholes Link Road site boundary and is predicted to experience a concentration change of 0.1µg/m^3, which equates to an imperceptible magnitude of change.

The maximum change of 1.2µg/m^3 in regard to annual mean PM_{10} concentrations with the Purple A Route Option in operation is predicted at receptor UPRN 185693174 (11 Golf View). Annual mean PM_{10} concentrations at this receptor are predicted to increase from 9.4µg/m^3 to 10.6µg/m^3 with the Purple A Route Option in operation.

Annual Mean $PM_{2.5}$ Concentrations

The Air Quality Objective for annual mean $PM_{2.5}$ is 25µg/m^3. The results of the human health air quality assessment for the Purple A Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Purple A Route Option in operation.

The maximum predicted $PM_{2.5}$ annual mean concentration with the implementation of the Purple A Route Option is 8.2µg/m^3 at receptor UPRN 185696280 (41 Blackhill). This receptor is situated within the Sandholes Link Road site boundary.

A maximum concentration change of 0.7µg/m^3 is predicted at receptor UPRN 185693174 (11 Golf View) with the Purple A Route Option in operation, from 5.7µg/m^3 to 6.4µg/m^3. This equates to a small (deterioration) magnitude of change.

A summary of the Purple A Route Option human health air quality assessment is presented in Table 6-8.

Table 6-8 – Human Health Air Quality Assessment – Opening Year (2025) – Purple A Route Option

Pollutant		NO_2	PM_{10}	$PM_{2.5}$
Annual Mean Air Quality Objective / Limit Value (µg/m^3)		40	40	25
Number of Considered Receptors greater than Limit Value / AQO	Base Year (2019) Exceedances	1	0	0
	DM (2025) Exceedances	0	0	0
	DS (2025) Exceedances	0	0	0
	Removed Exceedances	0	0	0
	New Exceedances	0	0	0
Total Number of Considered Receptors	Improvement in Concentration	5556	4745	3997
	No Change in Concentration	297	1192	2159
	Deterioration in Concentration	670	586	367
DS-DM Annual Mean Change (µg/m^3)	Maximum Improvement	-17.9	-1.7	-1.0
	Maximum Deterioration	3.2	1.2	0.7
Ratio (Improvement to Deteriorations)		8.3: 1	8.1: 1	10.9: 1
Total Number of Receptors		6523		
Results rounded to 1 decimal place				

In summary, there are no new or removed exceedances of the respective annual mean NO_2, PM_{10} and $PM_{2.5}$ Air Quality Objectives due to the Purple A Route Option in operation in 2025.

Approximately 85.2% of the considered receptor locations are predicted to experience an improvement in annual mean NO_2 concentrations with the Purple A Route Option in operation, with 10.3% predicted to experience a deterioration.

With regard to annual mean $PM_{10,}$ approximately 72.7% of receptors are predicted to experience an improvement with the Purple A route in place and 9.0% are predicted to experience a deterioration. Similarly, 61.3% of receptors are predicted to experience an improvement with the Purple A Route Option in place and 5.6% are predicted to experience a deterioration with respect to annual mean $PM_{2.5}$ concentrations.

Purple B Route Option

Annual Mean NO_2 Concentrations

The Air Quality Objective for annual mean NO_2 is 40µg/m^3. The results of the human health assessment for the Purple B Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Purple B Route Option in operation.

Receptor UPRN 187681414 (135 Church Street) is predicted to experience the maximum annual mean NO_2 value of 27.1 µg/m^3 and is situated approximately 475m from the Purple B Route Option site boundary.

The greatest increase in annual mean NO_2 concentration between the DM and DS scenarios is predicted at receptor UPRN 185693174 (11 Golf View), with a concentration change of 3.1µg/m^3, from 9.3µg/m^3 to 12.4µg/m^3. This impact equates to a medium (deterioration) magnitude of change. However, the predicted annual mean NO_2 concentration remains below the respective Air Quality Objective in both the DM and DS scenarios.

The greatest decrease in annual mean NO_2 concentration between DM and DS for the Purple B route is predicted at receptor UPRN 185692951 (12 Church Street), with a concentration change of -17.4µg/m^3, from 39.3µg/m^3 to 21.9µg/m^3. This impact equates to a large (improvement) magnitude of change.

Annual Mean PM_{10} Concentrations

The Air Quality Objective for annual mean PM_{10} is 40µg/m^3. The results of the human health assessment for the Purple B Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Purple B Route Option in operation.

The maximum predicted PM_{10} annual mean concentration with the implementation of the Purple B Route Option is 13.3µg/m^3 at receptor UPRN 185696280 (41 Blackhill). This receptor is situated within the Sandholes Link Road site boundary and is predicted to experience a concentration change of 0.1µg/m^3, which equates to an imperceptible magnitude of change.

The maximum change of 1.2µg/m^3 in regard to annual mean PM_{10} concentrations with the Purple B Route Option in operation is predicted at receptor UPRN 185693174 (11 Golf View). Annual mean PM_{10} concentrations at this receptor are predicted to increase from 9.4µg/m^3 to 10.6µg/m^3 with the Purple B Route Option in operation.

Annual Mean $PM_{2.5}$ Concentrations

The Air Quality Objective for annual mean $PM_{2.5}$ is 25µg/m^3. The results of the human health air quality assessment for the Purple B Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Purple B Route Option in operation.

The maximum predicted $PM_{2.5}$ annual mean concentration with the implementation of the Purple B Route Option is 8.2µg/m^3 at receptor UPRN 185696280 (41 Blackhill). This receptor is situated within the Sandholes Link Road site boundary.

A maximum concentration change of 0.7µg/m^3 is predicted at receptor UPRN 185693174 (11 Golf View) with the Purple B Route Option in operation, from 5.7µg/m^3 to 6.4µg/m^3. This equates to a small (deterioration) magnitude of change.

A summary of the Purple B Route Option human health air quality assessment is presented in Table 6-9 below.

Table 6-9 – Human Health Air Quality Assessment – Opening Year (2025) – Purple B Route Option

Pollutant		NO_2	PM_{10}	$PM_{2.5}$
Annual Mean Air Quality Objective / Limit Value (µg/m^3)		40	40	25
Number of Considered Receptors greater than Limit Value / AQO	Base Year (2019) Exceedances	1	0	0
	DM (2025) Exceedances	0	0	0
	DS (2025) Exceedances	0	0	0
	Removed Exceedances	0	0	0
	New Exceedances	0	0	0
Total Number of Considered Receptors	Improvement in Concentration	5504	4755	3873
	No Change in Concentration	291	1131	2258
	Deterioration in Concentration	728	637	392
DS-DM Annual Mean Change (µg/m^3)	Maximum Improvement	-17.4	-2.0	-1.1
	Maximum Deterioration	3.1	1.2	0.6
Ratio (Improvement to Deteriorations)		7.6: 1	7.5: 1	9.9: 1
Total Number of Receptors		6523		
Results rounded to 1 decimal place				

In summary, there are no new or removed exceedances of the respective annual mean NO_2, PM_{10} and $PM_{2.5}$ Air Quality Objectives due to the Purple B Route Option in operation in 2025.

Approximately 84.4% of the considered receptor locations are predicted to experience an improvement in annual mean NO_2 concentrations with the Purple B Route Option in operation, with 11.2% predicted to experience a deterioration.

With regard to annual mean PM_{10}, approximately 72.9% of receptors are predicted to experience an improvement with the Purple B route in place and 9.8% are predicted to experience a deterioration. Similarly, 59.4% of receptors are predicted to experience an improvement with the Purple B Route Option in place and 6.0% are predicted to experience a deterioration with respect to annual mean $PM_{2.5}$ concentrations.

Green Route Option

Annual Mean NO_2 Concentrations

The Air Quality Objective for annual mean NO_2 is 40µg/m^3. The results of the human health air quality assessment for the Green Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Green Route Option in operation.

Receptor UPRN 187681414 (135 Church Street) is predicted to experience the maximum annual mean NO_2 value of 26.8µg/m^3 and is situated approximately 475m from the Green Route Option site boundary.

The greatest increase in annual mean NO_2 concentration between the DM and DS scenarios is predicted at receptor UPRN 185695223 (1 Tullywiggan Road), with a concentration change of 3.0µg/m^3, from 15.5µg/m^3 to 18.5µg/m^3. This impact equates to a medium (deterioration) magnitude of change. However, the predicted annual mean NO_2 concentration remains below the respective Air Quality Objective in both the DM and DS scenarios.

The greatest decrease in annual mean NO_2 concentration between DM and DS for the Green Route Option is predicted at receptor UPRN 185692951 (12 Church Street), with a concentration change of -17.7µg/m^3, from 39.3µg/m^3 to 21.6µg/m^3. This impact equates to a large (improvement) magnitude of change.

Annual Mean PM_{10} Concentrations

The Air Quality Objective for annual mean PM_{10} is 40µg/m^3. The results of the human health air quality assessment for the Green Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Green Route Option in operation.

The maximum predicted PM_{10} annual mean concentration with the implementation of the Green Route Option is 13.3µg/m^3 at receptor UPRN 185696280 (41 Blackhill). This receptor is situated within the Sandholes Link Road site boundary and is predicted to experience a concentration change of 0.1µg/m^3, which equates to an imperceptible magnitude of change.

The maximum change of 0.8µg/m^3 in regard to annual mean PM_{10} concentrations with the Green Route Option in operation is predicted at receptor UPRN 187638106 (39 Castle Road). Annual mean PM_{10} concentrations at this receptor are predicted to increase from 9.4µg/m^3 to 10.2µg/m^3 with the Green Route Option in operation.

Annual Mean $PM_{2.5}$ Concentrations

The Air Quality Objective for annual mean $PM_{2.5}$ is 25µg/m^3. The results of the human health air quality assessment for the Green Route Option show that in the opening year of 2025, predicted concentrations at none of the considered receptors are above the Air Quality Objective both without and with the Green Route Option in operation.

The maximum predicted $PM_{2.5}$ annual mean concentration with the implementation of the Green Route Option is 8.2µg/m^3 at receptor UPRN 185696280 (41 Blackhill). This receptor is situated within the Sandholes Link Road site boundary.

A maximum concentration change of 0.5µg/m^3 is predicted at receptor UPRN 187638106 (39 Castle Road) with the Green Route Option in operation, from 5.3µg/m^3 to 5.8µg/m^3. This equates to a small (deterioration) magnitude of change.

A summary of the Green Route Option human health air quality assessment is presented in Table 6-10 below.

Table 6-10 – Human Health Air Quality Assessment – Opening Year (2025) – Green Route Option

Pollutant		NO_2	PM_{10}	$PM_{2.5}$
Annual Mean Air Quality Objective / Limit Value (µg/m^3)		40	40	25
Number of Considered Receptors greater than Limit Value / AQO	Base Year (2019) Exceedances	1	0	0
	DM (2025) Exceedances	0	0	0
	DS (2025) Exceedances	0	0	0
	Removed Exceedances	0	0	0
	New Exceedances	0	0	0
Total Number of Considered Receptors	Improvement in Concentration	5588	4782	4025
	No Change in Concentration	286	1188	2157
	Deterioration in Concentration	649	553	341
DS-DM Annual Mean Change (µg/m^3)	Maximum Improvement	-17.7	-1.7	-1.0
	Maximum Deterioration	3.0	0.8	0.5
Ratio (Improvement to Deteriorations)		8.6: 1	8.6: 1	11.8: 1
Total Number of Receptors		6523		
Results rounded to 1 decimal place				

In summary, there are no new or removed exceedances of the respective annual mean NO_2, PM_{10} and $PM_{2.5}$ Air Quality Objectives due to the Green Route Option in operation in 2025.

Approximately 85.7% of the considered receptor locations are predicted to experience an improvement in annual mean NO_2 concentrations with the Green Route Option in operation, with 9.9% predicted to experience a deterioration.

With regard to annual mean PM_{10}, approximately 73.3% of receptors are predicted to experience an improvement with the Green Route Option in place and 8.5% are predicted to experience a deterioration. Similarly, 61.7% of receptors are predicted to experience an improvement with the Green Route Option in place and 5.2% are predicted to experience a deterioration with respect to annual mean $PM_{2.5}$ concentrations.

Compliance Risk Assessment

Within the TRA, there are two road links that are contained within the DEFRA PCM Model (see Table 6-5, Figure 6.2.12 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0210). As such, a compliance risk assessment has been completed for each of the four route options.

Table B7-2 to Table B7-5 in Appendix B-7 presents the predicted annual mean total NO_2 concentrations obtained from the compliance risk assessment. A summary is provided below.

Red Route Option

The highest annual mean NO_2 concentration predicted in the DS scenario for the opening year is at receptor C 185694719, with a value of 25.0µg/m^3. This compliance receptor is situated along the A505 and experiences a decrease of 6.8µg/m^3 in annual mean NO_2 concentration with the Red Route Option in operation.

The maximum predicted change presented in the compliance assessment is 0.8µg/m^3, which corresponds to receptor C 185696294. This receptor is situated along the A505 and is predicted from 20.4µg/m^3 in the DM scenario to 21.2µg/m^3 with the Red Route Option in operation.

Although there are changes that are more than 0.4µg/m^3, or 1% of the annual mean NO_2 EU Limit value (see Table B7-2), none of the considered compliance receptors are predicted to be in exceedance of the annual mean EU Limit Value or cause the UK0043 Northern Ireland zone to become non-compliant with the EU Directive on ambient air quality[10]..

Furthermore, the A29 is predicted to experience an improvement in annual mean NO_2 concentrations, with all 29 of the modelled compliance receptor points predicting an overall reduction.

Purple A Route Option

The highest annual mean NO_2 concentration predicted in the DS scenario for the opening year is at receptor C 185694719, with a value of 25.1µg/m^3. This compliance receptor is situated along the A505 and experiences a decrease of 6.7µg/m^3 in annual mean NO_2 concentration with the Purple A Route Option in operation.

The maximum predicted change presented in the compliance assessment is 0.7µg/m^3, which corresponds to receptor C 185696294. This receptor is situated along the A505 and is predicted from 20.4µg/m^3 in the DM scenario to 21.1µg/m^3 with the Purple A Route Option in operation.

Although there are changes that are more than 0.4µg/m^3, or 1% of the annual mean NO_2 EU Limit value (see Table B7-3), none of the considered compliance receptors are predicted to be in exceedance of the annual mean EU Limit Value or cause the UK0043 Northern Ireland zone to become non-compliant with the EU Directive on ambient air quality[10].

Furthermore, the A29 is predicted to experience an improvement in annual mean NO_2 concentrations, with all 29 of the modelled compliance receptor points predicting an overall reduction.

Purple B Route Option

The highest annual mean NO_2 concentration predicted in the DS scenario for the opening year is at receptor C 185694524, with a value of 25.7µg/m^3. This compliance receptor is situated along the A27 and experiences a decrease of -17.9µg/m^3 in annual mean NO_2 concentration with the Purple B Route Option in operation.

The maximum predicted change presented in the compliance assessment is 0.7µg/m^3, which corresponds to receptor C 185696294. This receptor is situated along the A505 and is predicted from 20.4µg/m^3 in the DM scenario to 21.1µg/m^3 with the Purple B Route Option in operation.

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[10] European Parliament, Council of the European Union, (2008). Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. [online] Available at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32008L0050 [Accessed 04/05/2020].

Although there are changes that are more than 0.4µg/m^3, or 1% of the annual mean NO_2 EU Limit value (see Table B7-4), none of the considered compliance receptors are predicted to be in exceedance of the annual mean EU Limit Value or cause the UK0043 Northern Ireland zone to become non-compliant with the EU Directive on ambient air quality[10].

Furthermore, the A29 is predicted to experience an improvement in annual mean NO_2 concentrations, with all 29 of the modelled compliance receptor points predicting an overall reduction.

Green Route Option

The highest annual mean NO_2 concentration predicted in the DS scenario for the opening year is at receptor C 185692951, with a value of 25.2µg/m^3. This compliance receptor is situated along the A27 and experiences a decrease of -24.5µg/m^3 in annual mean NO_2 concentration with the Green Route Option in operation.

The maximum predicted change presented in the compliance assessment is 0.7µg/m^3, which corresponds to receptor C 185696294. This receptor is situated along the A505 and is predicted from 20.4µg/m^3 in the DM scenario to 21.1µg/m^3 with the Green route in operation.

Although there are changes that are more than 0.4µg/m^3, or 1% of the annual mean NO_2 EU Limit value (see Table B7-5), none of the considered compliance receptors are predicted to be in exceedance of the annual mean EU Limit Value or cause the UK0043 Northern Ireland zone to become non-compliant with the EU Directive on ambient air quality.

Furthermore, the A29 is predicted to experience an improvement in annual mean NO_2 concentrations, with all 29 of the modelled compliance receptor points predicting an overall reduction.

Ecological Assessment

An assessment of the impacts on the Upper Ballinderry River ASSI /SAC has been completed for the proposed scheme, whereby the calculation of the change in annual mean NO_x concentrations and the corresponding N deposition associated with each route option has been derived. The location of the Upper Ballinderry River ASSI / SAC in reference to the proposed scheme is presented in Figure 6.2.11 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0209).

For this assessment, the maximum NO_x concentration and N deposition values reported (see Table 6-6) has been selected for use in the ecological assessment to provide a conservative approach.

According to APIS[9], the Upper Ballinderry River ASSI / SAC has no comparable habitat with an established critical load estimate available. For the purposes of this assessment, an indicative critical load range of between 5kgN/ha/yr and 10kgN/ha/yr has been applied, to allow for a comparison.

A summary of each route option is provided below. Further information is provided in Appendix B-8.

Red Route Option

Annual Mean NO_x Concentrations

In the opening year of assessment (2025), total NOx concentrations are predicted to decrease along the Upper Ballinderry River ASSI / SAC with the Red Route Option in operation. Annual mean NO_x concentrations range between 16.0µg/m^3 and 41.1µg/m^3 in the DS scenario (See Table B8-1, Appendix B-8).

Two exceedances of the critical level of 30µg/m^3 are identified, at 0m and 10m along the modelled transect receptor points in the DM scenario. In the DS scenario, an exceedance is removed at the

10m transect receptor point, with a decrease of 7.1µg/m^3 predicted, from 34.6µg/m^3 in the DM scenario to 27.5µg/m^3 in the DS scenario.

A maximum decrease of 14.5µg/m^3 is predicted at the 0m transect receptor location, however this location is predicted to remain in exceedance of the critical level. Overall, all transect receptor location points, up to 200m are predicted to experience a decrease in annual mean NO_x concentrations as a consequence of the Red Route Option in operation.

N Deposition

In regard to N deposition, the maximum background N deposition critical load value is 12.7kgN/ha/yr (see Table 6-6), which is above the indicative assessment critical load range of between 5kgN/ha/yr and 10kgN/ha/yr.

In the DM scenario, predicted N deposition rates range between 13.3kgN/ha/yr and 19.1kgN/ha/yr. However, there is a maximum decrease of 2.0kgN/ha/yr predicted at the 0m transect receptor location point, with annual N deposition rates ranging between 13.2kgN/ha/yr and 17.1kgN/ha/yr (see Table B8-1, Appendix B-8).

All transect receptor locations are predicted to experience a reduction of N deposition with the Red Route Option in operation.

Purple A Route Option

Annual Mean NO_x Concentrations

In the opening year of assessment (2025), total NO_x concentrations are predicted to decrease along the Upper Ballinderry River ASSI / SAC with the Purple A Route Option in operation. Annual mean NO_x concentrations range between 16.0µg/m^3 and 41.4µg/m^3 in the DS scenario (See Table B8-2, Appendix B-8).

Two exceedances of the critical level of 30µg/m^3 are identified, at 0m and 10m along the modelled transect receptor points in the DM scenario. In the DS scenario, an exceedance is removed at the 10m transect receptor point, with a decrease of 6.9µg/m^3 predicted, from 34. µg/m^3 in the DM scenario to 27.7µg/m^3 in the DS scenario.

A maximum decrease of 14.2µg/m^3 is predicted at the 0m transect receptor location, however this location is predicted to remain in exceedance of the critical level. Overall, all transect receptor location points, up to 200m are predicted to experience a decrease in annual mean NO_x concentrations as a consequence of the Purple A Route Option in operation.

N Deposition

In regard to N deposition, the maximum background N deposition critical load value is 12.7kgN/ha/yr (see Table 6-6), which is above the indicative assessment critical load range of between 5kgN/ha/yr and 10kgN/ha/yr.

In the DM scenario, predicted N deposition rates range between 13.3kgN/ha/yr and 19.1kgN/ha/yr. However, there is a maximum decrease of 2.0kgN/ha/yr predicted at the 0m transect receptor location point, with annual N deposition rates ranging between 13.3kgN/ha/yr and 17.1kgN/ha/yr (see Table B8-6, Appendix B-8).

All transect receptor locations are predicted to experience a reduction of N deposition with the Purple A Route Option in operation.

Purple B Route Option

Annual Mean NO_x Concentrations

In the opening year of assessment (2025), total NO_x concentrations are predicted to decrease along the Upper Ballinderry River ASSI / SAC with the Purple B Route Option in operation. Annual mean NO_x concentrations range between 16.0µg/m^3 and 41.8µg/m^3 in the DS scenario (See Table B8-3, Appendix B-8).

Two exceedances of the critical level of 30µg/m^3 are identified, at 0m and 10m along the modelled transect receptor points in the DM scenario. In the DS scenario, an exceedance is removed at the 10m transect receptor point, with a decrease of 6.7µg/m^3 predicted, from 34.6µg/m^3 in the DM scenario to 27.9µg/m^3 in the DS scenario.

A maximum decrease of 13.8µg/m^3 is predicted at the 0m transect receptor location, however this location is predicted to remain in exceedance of the critical level. Overall, all transect receptor location points, up to 200m are predicted to experience a decrease in annual mean NO_x concentrations as a consequence of the Purple B Route Option in operation.

N Deposition

In regard to N deposition, the maximum background N deposition critical load value is 12.7kgN/ha/yr (see Table 6-6), which is above the indicative assessment critical load range of between 5kgN/ha/yr and 10kgN/ha/yr.

In the DM scenario, predicted N deposition rates range between 13.3kgN/ha/yr and 19.1kgN/ha/yr. However, there is a maximum decrease of 1.9kgN/ha/yr predicted at the 0m transect receptor location point, with annual N deposition rates ranging between 13.3kgN/ha/yr and 17.2kgN/ha/yr (see Table B8-7, Appendix B-8).

All transect receptor locations are predicted to experience a reduction of N deposition with the Purple B Route Option in operation.

Green Route Option

Annual Mean NO_x Concentrations

In the opening year of assessment (2025), total NO_x concentrations are predicted to decrease along the Upper Ballinderry River ASSI / SAC with the Green Route Option in operation. Annual mean NO_x concentrations range between 16.0µg/m^3 and 41.6µg/m^3 in the DS scenario (See Table B8-4, Appendix B-8).

Two exceedances of the critical level of 30µg/m^3 are identified, at 0m and 10m along the modelled transect receptor points in the DM scenario. In the DS scenario, an exceedance is removed at the 10m transect receptor point, with a decrease of 6.9µg/m^3 predicted, from 34.6µg/m^3 in the DM scenario to 27.7µg/m^3 in the DS scenario.

A maximum decrease of 14.0µg/m^3 is predicted at the 0m transect receptor location, however this location is predicted to remain in exceedance of the critical level. Overall, all transect receptor location points, up to 200m are predicted to experience a decrease in annual mean NO_x concentrations as a consequence of the Green Route Option in operation.

N Deposition

In regard to N deposition, the maximum background N deposition critical load value is 12.7kgN/ha/yr (see Table 6-6), which is above the indicative assessment critical load range of between 5kgN/ha/yr and 10kgN/ha/yr.

In the DM scenario, predicted N deposition rates range between 13.3kgN/ha/yr and 19.1kgN/ha/yr. However, there is a maximum decrease of 2.0kgN/ha/yr predicted at the 0m transect receptor location point, with annual N deposition rates ranging between 13.3kgN/ha/yr and 17.1kgN/ha/yr (see Table B8-8, Appendix B-8).

All transect receptor locations are predicted to experience a reduction of N deposition with the Green Route Option in operation.

6.2.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

6.2.4.1. Options Comparison

A combined route option comparison for each of the assessed environmental effects is presented in Table 6-11 below. The most and least preferred route option for each environmental parameter is given including a subjective overall appraisal for all the parameters in combination.

Table 6-11 – Option Comparison

Parameter	Preferred Route Option	Least Preferred Route Option
Construction Stage		
Dust Risk Potential	Red	Purple A
Operational Stage		
Human Health	Green	Red
Compliance	Red	Purple B
Ecological	Red	Purple B
Overall	**Green**	**Red**

With precedence given to the human health component of the operational stage assessment, overall the Green route alignment is the preferred route option with the least preferred being the Red route.

6.2.4.2. Mitigation

Construction Stage

The outcome of the construction dust risk assessment has determined that there is a high dust risk potential at sensitive receptors located within 100m of the proposed scheme and a low dust risk potential between 100m and 200m. According to LA 105[3], the following measures to monitor mitigation effectiveness for high and low construction dust risk are proposed as follows:

High

- Development of a Dust Management Plan (DMP) with measures to monitor effectiveness of mitigation as part of the Construction Environmental Management Plan (CEMP)

- Daily on-site and off-site inspections to be included in the CEMP
- Record of complaints/exceptional dust events to be included in the CEMP

Low

- Inspections on site to confirm no significant dust generation to be included in the CEMP
- Record of complaints, if received and problem identified development of the DMP to be included in the CEMP

A full, detailed breakdown of the proposed scheme specific mitigation measures should be included within the CEMP.

Operational Stage

As no overall significant effect in regard to local air quality has been determined for all route options, no mitigation is proposed for the operational stage of the proposed scheme.

6.3. CULTURAL HERITAGE

6.3.1. ASSESSMENT SCOPE

This section presents the findings of the assessment of the proposed scheme route options on cultural heritage. The DMRB[11] defines cultural heritage as historic monuments, historic groups of buildings and/or historic sites.

Historic monuments consider architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features. Historic groups of buildings incorporate groups of separate or connected buildings that are recognised for their architecture, homogeneity or their place in the landscape. Historic sites consider material remains resulting from the works of humans or the combined works of nature and humans, and areas including archaeological sites.

The cultural heritage resource consists of heritage assets that include an individual building, monument, site, place, area or landscape identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest.

6.3.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the cultural heritage assessment are provided in Environmental Appendix B.

6.3.1.2. Study Area

The nature and extent of any known or potential archaeological and historical resources has been examined to determine the potential impact of the proposed scheme within a study area encompassing the four route options, the Sandholes Link Road and a 500m assessment buffer around their boundaries. A 1km buffer was also examined around the proposed scheme for assets identified as Scheduled Monuments, Monuments in State Care, Listed Buildings and Historic Parks, Gardens

[11] Highways England et al, (2019). DMRB Volume 11, Section 3, Part 2 Sustainability & Environment Appraisal LA 106 Cultural heritage assessment (Revision 0). [online] Available at: https://www.standardsforhighways.co.uk/dmrb/search/8c51c51b-579b-405b-b583-9b584e996c80 [Accessed 03/08/2020].

and Demesnes. The study areas adopted are shown in Figure 6.3.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0166).

6.3.1.3. Methodology

The assessment was undertaken with respect to the guidance provided by Volume 11, Section 3, Part 2, LA 106 Cultural heritage assessment, which refers to the Chartered Institute for Archaeologists (CIfA) Standards and Guidance for Historic Environment Desk Based Assessments[12].

This guidance is supplemented by the DEM 156/15 Management of Archaeological Investigations on Major Road Improvement Schemes, which details the steps to be taken during the implementation and reporting phases of archaeological investigations.

For more detail on methodology refer to Environmental Appendix B.

6.3.1.4. Consultation

The following statutory bodies have been consulted:

- DfC HED; and
- Mid Ulster Council

The response from Mid Ulster Council reiterated the known constraints with special regard given to the Area of Archaeological Potential (AAP) around Derryloran Church and mention of the Area of Archaeological Interest at the southern tip of the study area. They also stated that a more detailed response on cultural heritage would be provided by HED.

Further consultation will all relevant statutory bodies will be undertaken at Stage 3.

6.3.1.5. Assumption and Limitations

Details of assumptions and limitations for cultural heritage assessment are provided in Environmental Appendix B.

6.3.2. BASELINE CONDITIONS

The following sources of information have been consulted in order to establish the baseline:

- Information on heritage assets from the Historic Environment Record of Northern Ireland (HERoNI), which includes the Northern Ireland Sites and Monuments Record (NISMR), the Northern Ireland Buildings Database (NIBD), the Heritage Gardens Inventory (HGI), a list of Defence Heritage Sites, a list of Battlefields, and the Industrial Heritage Record (IHR);
- Details of previous archaeological investigations taken from the Database of Irish Excavation Reports (DIER) and the HERoNI;
- Identification of conservation areas, areas of townscape character, and ASAI from the local development plan;
- Historic maps of Ireland dating from the 17th century onward from https://www.oldmapsonline.org/en/Ireland; and
- Ordnance Survey maps of the study area from http://map.geohive.ie/.

[12] Chartered Institute for Archaeologists, (2017). Standard and Guidance for Historic Environment Desk Based Assessments. [online] Available at: https://www.archaeologists.net/sites/default/files/CIfAS%26GDBA_3.pdf [Accessed 03/08/2020].

A walkover survey was conducted between 15 July and 18 July 2019 where the sites of known heritage assets were visited to confirm their location and condition, and areas which would be disturbed by the proposed scheme were assessed for the presence of previously unknown heritage assets.

The recorded sites and features and others identified during the desktop survey and walkover survey are described below. In reviewing sites within the study area, it is important to recognise that the passage of time has resulted in only fragmentary remains of human settlement/occupation, economy and funerary and ritual practices surviving. It should also be noted that whilst most archaeological sites survive visibly above ground level, it is likely that archaeological sites may survive as sub-surface remains.

6.3.2.1. Historical background

The heritage assets located within the study area for the proposed scheme are described in detail within the Gazetteer in Appendix B-9, and are depicted upon Figure 6.3.1 – 6.3.6 (Appendix A Figure 6.3.1: Drawing Reference 718314-WSP-B-D-3000-0166; Figure 6.3.2: Drawing Reference 718314-WSP-B-D-3000-0179; Figure 6.3.3: Drawing Reference 718314-WSP-B-D-3000-0180; Figure 6.3.4: Drawing Reference 718314-WSP-B-D-3000-0178; Figure 6.3.5: Drawing Reference 718314-WSP-B-D-3000-0177; Figure 6.3.6: Drawing Reference 718314-WSP-B-D-3000-0176). The assets comprise three Scheduled Monuments, 56 Listed Buildings (two Grade A, six Grade B+, 21 Grade B1, and 27 Grade B2), two Historic Parks, Gardens and Demesnes, an AAP, and an ASAI. In addition to these assets, there are a further 178 heritage assets identified within the study area.

The assets are discussed below following a chronological framework from Prehistory to the present day. It should be noted that the time periods discussed are fluid and regional differences and/or overlaps exist between them. The time periods listed for Northern Ireland are broadly listed below:

- Prehistoric;

  Palaeolithic (c. 12500 – 7000 BCE);
  Mesolithic (c. 7000 – 4000 BCE);
  Neolithic (c. 4000 – c. 2400 BCE);
  Bronze Age (c. 2400 – 500 BCE); and
  Iron Age (c. 500 BCE – CE 400).

- Early Medieval (c. CE 400 – 1100);
- Medieval (c. CE 1100 – 1550);
- Post-Medieval (c. CE 1550 – 1900); and
- Modern (c. CE 1900 to Present).

6.3.2.2. Palaeolithic and Mesolithic Period

Evidence for human activity during the Palaeolithic period in Ireland is scarce, with only occasional flint artefacts and a cave site in County Clare identified as containing evidence for activity dating to this period. Evidence purporting to the later Mesolithic period becomes more prevalent within the cultural heritage resource and is characterised through the increase in recovery of lithic assemblages and the identification of sporadic and temporary structures and dwellings. Evidence supports the theory that the population during this period exploited the natural resources present, adopting hunting, fishing and gathering practices. Current indications highlight an association with coastal areas and rivers allowing for the exploitation and navigational uses of these available natural resources. Later

Mesolithic lithic technology and raw material procurement patterns reinforce the scenario of this generalised forager adaptation, characterised by low population, high mobility, and egalitarian social organisation.

The perceived transient lifestyle of Mesolithic communities and the temporary nature of their dwellings contribute to the difficulty in detecting the remains. There is currently no confirmed evidence of Mesolithic activity located within the study area.

6.3.2.3. Neolithic Period

The Neolithic Period represents the establishment of agriculture as the principal form of economic subsistence when successive generations of hunter-gatherer populations adapted and adopted new types of economy. During the Neolithic a characteristic feature of farming communities in Ireland, and over much of Western Europe, was the practice of collective burial in large funerary monuments including dolmens and cairns, with other ritual stone monuments associated with them such as stone circles and standing stones. These large funerary and ritual monuments remain as enduring characteristics of the Neolithic period, dominant within the landscape, but the associated settlements remain sporadic. There are three sites identified within the study area which appear to date to the Neolithic period.

The Scheduled Monument of Killymoon Demesnes Court Tomb ***(Site 49)*** is located within the grounds of Killymoon Golf Course (Plate 6-1). The remains of the monument are located on a limestone outcrop, formed by an area of large, dispersed boulders creating a horseshoe-shaped chamber measuring 10 m long by 4 m wide. Some suspicion has been cast on the validity of the site, with investigations suggesting that the remains may in fact be a Victorian folly, mimicking a Prehistoric monument. No datable artefacts have been recovered from the site and evidence of modern boreholes in surrounding stones, the construction design, which is not typical of monuments from this period, and the lack of similar archaeological discoveries of this type within the immediate landscape, may reinforce the concerns surrounding the validity of the monument.

A standing stone ***(Site 104)***, located to the south-east of Kidd's Bridge, was identified during an archaeological survey on the west-facing side of a valley, commanding expansive views to the north and south. A review of historic mapping identifies a lack of depiction of the standing stone with its presence only noted on the Ordnance Survey map of 1854[13]. On the previous mapping, a farmstead is present across an access track to the east[14]. This may indicate that the stone actually functioned as a Post-Medieval marker post. The site was visited during the walkover survey, showing the stone now sits within a private carpark.

A similar but smaller standing stone ***(Site 53)*** was known to the south-east of Cookstown. The standing stone was originally situated on a south-facing slope, with open views to the south. Development across the area and the subsequent construction of houses, have likely removed any trace of this monument. Like the previous standing stone, it is not depicted until the 20th century Ordnance Survey map of 1906[15], suggesting that the stone may have been a Post-Medieval marker stone.

[13] Ordnance Survey, (1854). Tyrone Sheet 29.
[14] Ordnance Survey, (1833). Tyrone Sheet 29.
[15] Ordnance Survey, (1906-07). Tyrone, Sheet 38.

Three further standing stones are located to the south of the proposed scheme, out with the study area but contained within the Tullyhogue ASAI ***(Site 2)***, providing further evidence of a vibrant, ritual Neolithic landscape along the south-eastern side of Cookstown.

Plate 6-1 - Killymoon Desmesne Court Tomb (Site 49)

6.3.2.4. Bronze Age

The Bronze Age represents the introduction and arrival of metallurgy and the transition to sophisticated practices associated with the production and manipulation of this resource. It resulted in the production of weapons and tools and introduced the expansion of complex trading networks with Britain and continental Europe. Funerary and ritual monuments extend into the Bronze Age with the presence of henges, wedge tombs and pit complexes and are supplemented with an increase in sedentary occupation and associated activities, e.g. fulacht fiadh. There are four sites identified within the study area that appear to relate to the Bronze Age.

A site of Bronze Age occupation and industrial activity was discovered within Killymoon Demesnes ***(Site 67)*** and is located within the Killymoon Golf Course. A series of archaeological excavations in 1995 revealed three large mounds containing evidence for barley production, with quern stones, charcoal, and a number of high status finds discovered, including a bronze socketed axe and a gold dress and sleeve fastener.

Archaeological investigations at Castle Road, Cookstown ***(Site 52)*** were carried out in 2008, revealing a number of small pits and post holes containing Bronze Age pottery. Two ditches were also revealed within one of the trenches that have subsequently been interpreted as the remains of two possible ring barrows.

Another archaeological excavation prior to development at Kilcronagh Business Park ***(Site 8)***, near the southern end of the study area, also revealed Bronze Age activity in the form of an arc of pits, with one of these containing Bronze Age corded ware. To the south-east of these pits there is also a

Scheduled Monument at Loughry related to a Bronze Age settlement within the Tullyhogue ASAI ***(Site 2)***.

6.3.2.5. Iron Age

Following on from the wealth of evidence for Bronze Age activity in Ireland, the Iron Age is far more enigmatic, with a lack of settlement evidence known from this period. The small number of sites known to date to the Iron Age consist of large forts or smaller funerary monuments or settlements that are of a similar style to their Bronze Age predecessors. The main evidence for the Iron Age in Ireland comes from discoveries of artefacts and rare bog bodies from the bogs and marshes of the island. There is no recorded evidence for known Iron Age activity within the study area.

6.3.2.6. Medieval

Early Medieval Ireland remained predominantly rural, with its inhabitants depending on the exploitation of crops, livestock and woodland. A common feature which coincided with this agriculturally based settlement, is the construction and use of the rath. These small ring or circular defensive embankments and enclosures (which may have origins in the Iron Age), consisted of a central area enclosed by up to three banks with ditches outside. Small round-houses and enclosures were located within this defensive boundary and it is believed over 40,000 of these sites have been identified across Ireland[16].

Outwith the study area, but contained within the Tullyhogue ASAI ***(Site 2)*** to the south of the proposed scheme, is a hilltop ring fort that has dominant views across the eastern and southern areas of Cookstown. This early Medieval rath was later utilised as the inauguration site of the O'Neill's in the 10^{th} century and was known as the capital of Tyrone until the 14^{th} century. Within the study area there are a further five raths, two of which are Scheduled Monuments.

Terressan Rath ***(Site 100)*** is a Scheduled Monument located directly to the east of Clare Road, on the summit of a localised hill with ground sloping down on all sides. The rath is roughly circular, with a defined perimeter bank that has been eroded and slightly cut into along its eastern extent by farm buildings. Pools of water have been noted in several places around the bank which are likely the location of the infilled ditch. The rath now lies within a wooded area surrounded by a former farmstead.

Gortalowry Platform Rath ***(Site 83)*** is another Scheduled Monument within the study area, located on top of a drumlin within the south-west extent of Cookstown. The interior is surrounded by a bank, which has now been planted with trees. An investigation of the rath found that the ditch was very difficult to trace, particularly along the western and southern extents, where the ground is level. Topsoil stripping to the north and north-east of the rath encountered several features of archaeological interest, including a small linear feature and two circular pits. The site now lies within a wooded area, which is set between a residential estate to the east and a cemetery to the west.

Remains of a rath to the east of Cookstown ***(Site 124)***, were recorded during a survey in 1990. The rath appears circular in plan and is located on the summit of a steep knoll with a ditch noted surrounding the southern half, with no evidence for any internal structures. The rath is first depicted in detail on the Ordnance Survey map of 1833, annotated as a 'Fort' and is displayed as a circular enclosure[14]. It is depicted on all subsequent historical mapping.

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[16] Ó Cróinín, D., (2008). A New History of Ireland: Prehistoric and Early Ireland.

A further rath is located to the south-west of Cookstown ***(Site 76)***, on the summit of a steep sided glacial knoll. The rath is only discernible by its enclosure, with a bow like interior but no evidence of internal features or an entrance. Two other platform raths are clearly visible from the summit, which may suggest an association between the groups that lived within each. The rath is also depicted on the Ordnance Survey map of 1833 and annotated as a 'Fort'[14]. An archaeological evaluation carried out in 2009, discovered pits and post-holes in the area around the rath, and confirmed the line of a ditch enclosing the site, with several internal features also uncovered, including a possible kiln.

Lastly, an enclosure to the east of Cookstown ***(Site 90)***, is first depicted and annotated as a 'fort' on the Ordnance Survey map of 1833 and is shown as a circular site that has been cut through its centre by an access track[14]. It is assumed that this site is the remains of a rath due to the similarity of the map annotation and other features of this type on historical mapping. On the Ordnance Survey map of 1854, the site is shown in the same location but has been partially dispersed by a bend in the road line[13]. No upstanding remains exist of the site with the area now occupied by agricultural fields.

The abundance of raths throughout the study area and in the local vicinity are indications of the degree of Medieval activity that took place around Cookstown during this period. This is further evidenced by the Derryloran Church ***(Site 42)*** located to the south-west of Cookstown. From the 5th century onwards Ireland began to convert to Christianity, through early interactions with Romano-Britain and the founding of monasteries throughout the island. The development of these ecclesiastical centres led to the creation of the first towns, schools, and churches. Derryloran Church ***(Site 42)*** would have been one of these centres, with the current site comprising a ruined church that was first occupied during the early Medieval period (Plate 6-2). An archaeological investigation carried out at the Church, determined that an earlier Medieval church, with a battered foundation at the eastern extent was later replaced by an early 17th century church.

Later archaeological investigations to the west of the church in 2003 ***(Site 39)*** and 2007 ***(Site 44)***, found evidence for an early Medieval enclosure and other features from this period. These features have been interpreted as being part of an early Medieval monastic complex centred around the church, and the area has been identified in the Cookstown Area Plan 2010 as an AAP ***(Site 41)***. The presence of this ecclesiastical centre may have been one of the reasons why the rath at Tullyhogue was selected as an inauguration site by the O'Neill's in the 10th century.

Plate 6-2 - General view of Derryloran Church (Site 42)

6.3.2.7. Post-Medieval

During the Post-Medieval period, the current town of Cookstown was created. The town takes its name from Dr Allen Cooke, who was an English ecclesiastical lawyer who leased a small portion of land previously seized by King James 1 in 1607. He constructed ten houses on the land around 1620 and received permission from King Charles I in 1628 to hold a twice weekly market. The town was mostly destroyed during the rebellion in 1641 with only two of the original houses still upstanding after the estate was acquired by William Stewart of Killymoon Estate in 1671. It is not until the late 18th century that the Stewarts began rebuilding the town, embarking on one of the boldest attempts at town building in Ulster's history, sparing no expense to make the place attractive to settlers. The main street was laid out to connect the Killymoon Demesne with Oldtown (the original settlement of Cookstown), and the remaining portions of the original Cookstown were all removed. This layout is still intact to the present day and forms the centre of the Cookstown Nucleated Settlement ***(Site 118)***.

There are two 17th century Historic Parks, Gardens and Demesnes to the south of Cookstown: Killymoon Castle ***(Site 15)*** and Loughry ***(Site 1)***; with another possible 17th century castle to the north-west of the town: Ballymenagh Castle ***(Site 212)***. The Castle at Killymoon formed the centre of the Killymoon Estate in the 19th century, with the park and garden landscaped in 1802 at the same time as the construction of the new Grade A Listed Killymoon Castle ***(Site 28)*** and outbuildings ***(Site 33)***. The new castle and outbuildings were constructed after the original castle was destroyed by fire in the 18th century. One other building within the estate is the Grade B1 Listed Sawmill ***(Site 30)*** dating from the 18th century. Alongside these assets, there are also five further assets within the Historic Park, Garden and Demesnes including gates and a lodge ***(Site 70)***, the western lodge ***(Site 46)***, and the remains of the original Killymoon Estate boundary walls, which were noted in three locations during the walkover survey ***(Site 34, 43, and 80)***.

Similar to the Killymoon Estate, the Loughry Historic Park, Garden and Demesnes ***(Site 1)*** was a 17th century estate that underwent a period of construction to build the current house at the beginning of the 19th century. The park and garden is now part of the college campus but the ice house, gate lodge and summer house are all still upstanding within the park and garden boundary. Unlike the previous estates that have surviving remains of the original buildings, Ballymenagh Castle ***(Site 212)*** was ruinous by the early 19th century and the only remains are a 3 m length of wall.

From the Ordnance Survey map of 1833-34, the new settlement at Cookstown may have been constructed close to an existing village at Ballyreagh ***(Site 5)***. Ballyreagh is south-west of Cookstown and consisted of 16 rectangular houses and a well, with later maps showing the largest of these houses named Ballyreagh House. Another village closer to Cookstown was Blackhill village ***(Site 48)***, which is constructed in the late 19th century and is much smaller. It consisted of five houses on Drum Road, to the immediate north-west of Derryloran Church. Neither of these villages survives fully intact, but some of the houses from Ballyreagh are still upstanding.

Within Cookstown and to the south-west at Derryloran, a large number of the houses, churches, halls, and other buildings are listed as Historic Buildings, with 38 of these buildings dated to the 19th century ***(Site 63, 75, 91, 92, 102, 106, 108-110, 119, 121, 123, 125, 129, 131, 138, 139, 141-143, 145, 146, 149, 156-160, 162-164, 166, 167, 169, 170, 185, 191, and 192)*** (Plate 6-3) and one, the Central Bar on William Street ***(Site 189)***, dating to the 18th century. A further 37 buildings from the 19th century within Cookstown are noted as Record Only within the NIBD, and were previously listed as Historic Buildings ***(Site 35, 68, 69, 71, 77, 79, 85, 88, 89, 93, 122, 126, 128, 130, 133, 135, 136, 151-153, 168, 171, 172, 174, 182, 186, 187, 190, 194-196, 198, 199, 201, and 204-206)***. They have been removed from the list due to demolition or inappropriate renovations making them unworthy of statutory protection.

Alongside the Historic Buildings, there were also a further six assets within the study area that relate to the residential expansion of the town and the surrounding area. These include three large manor houses at Dunman ***(Site 232)***, Ballymenagh ***(Site 223)***, and Brookmount ***(Site 32)***, cottages on Moneymore Road ***(Site 210)***, a rectory at Derryloran ***(Site 36)***, and housing at Gortalowry ***(Site 72)***. There were also four other assets related to community amenities, including a school ***(Site 78)***, two religious meeting houses ***(Site 18 and 73)***, and a golf course with clubhouse ***(Site 59)***.

It is clear from these Historic Buildings and from the other assets from this period that the late 18th and 19th centuries saw a growth in residential and community buildings within and around Cookstown. It is during this period that the town moved away from an existence as a rural centre and became an industrial hub. Several industrial buildings and other features are located within the study area that can attest to this industrialisation including saw mills, flax mills, corn mills and associated features ***(Site 22, 29, 31, 45, 60, 74, 161, and 234)***; bleach works and a spinning mill ***(Site 62)***; limekilns and associated quarries ***(Site 58, 101, 178, and 188)***; and flax pools ***(Site 181 and 114)***. The main industry in the area was linen production, and with the industrialisation also came the need for better infrastructure in the form of new roads and bridges ***(Site 27, 50, 140, 184, and 239)*** and the introduction of the railway line from Cookstown to Randallstown ***(Site 207)***, with platforms ***(Site 177)***, a station ***(Site 179)***, and a goods shed ***(Site 175)*** at Molesworth Street.

Out with the nucleus of the town there are six further Historic Buildings within the study area, three of which have been previously mentioned within the Killymoon Estate. Of the other three, the Lissan Rectory ***(Site 241)*** and the house at 20 Lismoney Road ***(Site 216)*** are located to the north and west of the proposed scheme. The Rectory is an early 19th century house built for the Reverend John

Staples of Lissan House, and the house at Lismoney Road is a Grade B1 farmstead that likely dates from the 18th century or early 19th century, having been established prior to the Ordnance Survey map of 1832. The final Historic Building is to the south of the proposed scheme, at the northern edge of the Loughry park and garden and consists of a house at 27 Ardcumber Road ***(Site 3)***.

The landscape within the study area was dominated by agricultural activity throughout the Post-Medieval period. The archaeological evidence for this activity is still visible today in the field systems that still remain relatively unchanged. However, the majority of the former farm houses and farmsteads that use to exist amongst the field systems have now been demolished with modern agricultural practices creating larger farms with more intensive production. Within the study area, cartographic research discovered 66 farmsteads ***(Site 4, 6, 7, 9-11, 13, 14, 16, 17, 19, 21, 23, 25, 26, 37, 38, 47, 51, 54, 55, 65, 81, 82, 84, 86, 94, 96, 97, 99, 103, 113, 117, 120, 134, 137, 144, 147, 148, 150, 165, 176, 183, 197, 200, 202, 203, 209, 211, 215, 217-221, 224-228, 231, 235-238, and 240)*** several of which are accompanied with wells and out buildings. Three other wells ***(Site 229, 214, and 61)***, and two other buildings denoted as ruins ***(Site 222 and 20)*** that are not associated with specific farms, but are likely related to agricultural activity, were also noted. Of these agricultural sites, only 18 are still in existence ***(Site 11, 19, 25, 47, 54, 65, 96, 103, 137, 183, 200, 203, 218, 221, 224, 225, 231, 238)***, with the majority of these renovated and modernised.

Plate 6-3 - 51-53 Molesworth Street (Site 170)

6.3.2.8. Modern

From the early 20th century onwards, Cookstown continued to be defined by growth and industrialisation, with further expansion of residential housing and community buildings. As before, several of these buildings were previously listed as Historic Buildings and include five houses ***(Site 87, 95, 115, 180, and 208)***, the former railway station ***(Site 173)***, the Cookstown cenotaph ***(Site 193)***, the Post Office building ***(Site 154)***, the Foresters Hall ***(Site 98)***, and two hotels ***(Site 56 and 64)***. There are also seven Grade B1 and Grade B2 Historic Buildings dating from the 20th century within the town, including a telephone exchange ***(Site 155)***, social security office ***(Site 127)***, masonic lodge ***(Site 132)***, a technical college building ***(Site 116)***, a rectory ***(Site 111)***, chapel ***(Site 105)***, and a court house ***(Site 107)***. The architectural style attributed to these mainly municipal buildings is testament to the investment being made in the town during this period of growth.

Further industrial sites are also present from the 20th century, with the Tape and Webbing Factory ***(Site 40)***, and the Cookstown Gasometer ***(Site 57)*** both noted as important sites related to the industrial heritage of the area. The other assets from this period include a bridge ***(Site 24)***, two orange halls ***(Site 12 and 233)***, a pavilion ***(Site 66)***, and tennis courts ***(Site 112)***.

6.3.2.9. Unassigned

There are three sites identified within the study area that remain unassigned to a particular time period. All of these sites are enclosures that were depicted and annotated on the Ordnance Survey maps of 1833-34. The first of these was depicted as a circular enclosure and annotated as a fort ***(Site 12)*** that latterly contained an orange hall built in the 20th century. The second is the remains of Dunman enclosure ***(Site 230)***, the location of which were confirmed by an archaeological investigation in 2017, but there was no dating evidence to indicate whether the enclosure is Prehistoric or Medieval. A large dairy factory is located on part of the enclosure and has likely removed part of it. The final enclosure ***(Site 213)*** is to the immediate south of Moneymore Road and was depicted containing trees in the centre suggesting some antiquity.

It is likely that all of these sites were Medieval raths, being similar in size and shape to others in the area. However, without dating evidence and due to the lack of annotation on the Ordnance Survey maps or notes in the SMR, this cannot be assumed.

6.3.2.10. Previous Archaeological Investigations

There have been a number of previous archaeological investigations carried out that overlap or fall within the study area (see Appendix A Figure 6.3.1: Drawing Reference 718314-WSP-B-D-3000-0166; Figure 6.3.2: Drawing Reference 718314-WSP-B-D-3000-0179; Figure 6.3.3: Drawing Reference 718314-WSP-B-D-3000-0180; Figure 6.3.4: Drawing Reference 718314-WSP-B-D-3000-0178; Figure 6.3.5: Drawing Reference 718314-WSP-B-D-3000-0177; Figure 6.3.6: Drawing Reference 718314-WSP-B-D-3000-0176). The investigations are summarised below, and where they encountered archaeological remains the site reference number has been provided:

- Event 1 - 1980-84:0184 Derryloran ***(Site 42)*** – Archaeological excavations were carried out between 1980 and 1984, on the Derryloran Church. The excavations demonstrated that the Medieval church, with a battered foundation at the eastern extent was later replaced by an early 17th century church;
- Event 2 - 1995:264 - SMR 29:66 Killymoon Demesne ***(Site 67)*** – An area within the Killymoon Golf course, was investigated in 1995. An excavation revealed three mounds composed of alternating layers of baked clay and charcoal. Surrounding the mounds, a layer of ashy soil, charcoal and charred barley was also present. Notable finds recovered during the excavations included two gold objects (a ‘dress-fastener’ and a ‘sleeve-fastener’) as well as a bronze socketed axe, a stone bead, saddle querns, spindle-whorls, woollen twine and cloth, hair (some of it human), and considerable quantities of coarse pottery;
- Event 3 - 2003:1843 Derryloran ***(Site 39)*** – A phase of archaeological monitoring was undertaken during topsoil stripping in 2003 as part of a factory expansion for Keylite Windows. The work

encountered the existence of at least three large ditches and a number of further archaeological features. The features have been interpreted as relating to the remains of an early Medieval enclosure, probably linked to an earlier monastic enclosure reputed to have existed within this area of Cookstown;

- Event 4 - 2004:1651 Castle Road, Killymoon Demesne – Archaeological monitoring was undertaken in 2004, during topsoil removal on the line of a new water pipe at Castle Road wastewater treatment plant. Nothing of archaeological significance was observed or noted during the monitoring works;
- Event 5 – 2006:1940 Kilcronagh Business Park ***(Site 8)*** – An archaeological evaluation followed by excavation works were undertaken in 2005 and 2006 prior to construction of industrial units at Kilcronagh Business Park. The investigations uncovered a series of features ranging in date from the Prehistoric to the Medieval periods with artefacts consisting of a large number of worked flint Bronze Age pottery, and souterrain ware that dates to the 10^{th} century;
- Event 6 - 2007:1762 Derryloran ***(Site 44)*** – A phase of archaeological monitoring was undertaken in 2007 during the initial stages of construction of a new warehouse in Derryloran Industrial Estate. A small pit was encountered, located near the centre of the site. No artefacts or dating evidence were encountered within the pit;
- Event 7 - 2007:1758 Sandholes Road – An archaeological evaluation was carried out in 2007 prior to construction of a residential development. The trenches revealed that the site has been extensively disturbed in the recent past and was used to dump large quantities of building rubble. Nothing of archaeological significance was observed or noted during the monitoring works;
- Event 8 - 2008:1188 Castle Road ***(Site 52)*** – An archaeological evaluation was carried out on Castle Road in 2008, prior to the proposed construction of a nursing home and retirement properties. The evaluation revealed a number of small pits and post-holes within eight of the trenches, with Bronze Age pottery identified within a number of the features. Two linear features were also encountered, interpreted as the remains of two ring-barrows, indicating the presence of Bronze Age funerary activity;
- Event 9 - 2009:783 Westbury Hill, Westland Road South ***(Site 76)*** – An archaeological evaluation was carried out in 2009 prior to a proposed residential development. The development boundary was known to be the site of a possible rath, and 14 of the 21 trenches excavated, encountered archaeological features consisting of pits, post-holes, and a ditch, which enclosed an area some 34 m in diameter. A number of internal features were also uncovered, including a possible kiln;
- Event 10 – AE/11/101 Derryloran Bridge ***(Site 42)*** – A phase of archaeological works was undertaken in 2011 prior to and during the widening of the Derryloran Bridge structure, consisting of a geophysical survey, building survey on the bridge, archaeological monitoring, excavation, and reburial of human remains;
- Event 11 - 2016:276 31 Castle Road, Killymoon Demesne – An archaeological investigation was carried out at this location in 2016. Nothing of archaeological significance was observed or noted during the monitoring works; and
- Event 12 - 2017:452 Dale Farm Ltd, Moneymore Road ***(Site 230)*** – An archaeological evaluation was carried out in 2017, prior to the construction and extension to an existing dairy factory at Dale Farm. The development area contained the remains of an enclosure of uncertain date, encountered within an evaluation trench. Subsequent mitigation included the open excavation of a larger area to define the ditch extents before recording and covering for preservation in situ.

6.3.2.11. Future baseline

The current baseline as described above will continue to evolve without the introduction of the proposed scheme. In the areas surrounding the Sandholes Link Road, the changes to the baseline are likely to be minimal as the area is mainly developed. Future development in the two small areas that currently lie vacant is inevitable with the northern field already having been evaluated for the presence of archaeological features as part of a proposed residential development. The southern field is also likely to be developed in the near future as it is the only vacant area surrounded by industrial warehouses and small business units. No known assets described in the baseline would be affected by these developments, but there is a possibility of previously unknown archaeological sites being discovered in the field to the south.

The baseline within the buffer for the route options to the east of Cookstown will also evolve without the introduction of the proposed scheme. However, this evolution will be more gradual as development in these areas will be restricted. The area is denoted as a vulnerable landscape within the Draft Mid Ulster Council Local Development Plan and will benefit from protection against inappropriate and over dominant development. Therefore, the future impacts on the known cultural heritage assets are likely to come from agricultural activity, through continued ploughing of the subsoil interface, and continued growth of vegetation over assets that are at the edges of field systems.

6.3.3. ASSESSMENT OF ROUTE OPTIONS

The majority of impacts upon the cultural heritage resource will occur during the construction phase. Development activities such as groundworks, topsoil stripping, landscaping, ground compaction, access, service installation, drainage, stockpiling, and storage may all have a direct adverse effect on cultural heritage assets. These construction related impacts could lead to the following effects:

- Permanent complete or partial loss of a cultural heritage resource as a result of ground excavation;
- Permanent or temporary loss of the physical and/or visual integrity of a historic monument, historic group of buildings or historic site;
- Damage to the cultural heritage resource as a result of ground excavation;
- Damage to the cultural heritage resource due to compaction, desiccation or waterlogging; and
- Damage to the cultural heritage resource as a result of ground vibration caused by construction.

Operational impacts would relate to indirect setting impacts due to the visual intrusion of new road infrastructure within the landscape, and the increased noise from traffic using the road. All route options are likely to impact upon the setting of a number of sites. Several of the visual impacts would occur due to the likely removal of existing tree cover during construction, or when existing tree cover is less dense during the winter months. Adopting a preventative approach at this stage, the effects associated with the design, construction, operation and maintenance of the proposed scheme, which may result in potentially significant impacts, are described below.

6.3.3.1. Construction

Red Route

Potential exists for direct physical impacts on five assets: an estate boundary wall ***(Site 34)***; potential Bronze Age features ***(Site 52)***; a standing stone ***(Site 104)***; a railway embankment ***(Site 207)***; and an undated enclosure ***(Site 213)***.

The junction with Old Coagh Road (Ch2650 m) would likely impact the north-east to south-west aligned former railway line ***(Site 207)***.

The remains of the Killymoon estate boundary wall ***(Site 34)*** to the immediate south of the Castle Road waste water treatment works has the potential to be directly impacted upon at Ch450 m. Similarly, a standing stone ***(Site 104)*** at the rear of the Cookstown Meat Factory will be directly impacted upon by the road cutting at Ch1850 m, resulting in the complete removal of the asset.

The potential sub-surface remains of a circular enclosure ***(Site 213)*** has the potential for direct impacts as the route progresses south from the new roundabout with Moneymore Road (Ch3400 m). The location of the enclosure has been identified from map regression. With the agricultural activities prevalent across the area, the exact nature and survival of remains relating to the enclosure is unknown. Similarly, the Bronze Age features ***(Site 52)*** to the north of Castle Road (between Ch800 m and Ch900 m) may extend beyond the previous investigative works that identified their presence, with any excavations in this area likely to impact on surviving elements.

Purple A Route

The Purple A route has the potential to impact on a number of assets including: an estate boundary wall ***(Site 34)***; potential Bronze Age features ***(Site 52)***; a pavilion ***(Site 66)***; a gate pier ***(Site 70)***; a farmstead ***(Site 84)***; a Medieval rath ***(Site 124)***; a farm building ***(Site 183)***; and a railway embankment ***(Site 207)***.

To the south of the Castle Road waste water treatment plant at approximate Ch450 m, a remnant of the Killymoon estate boundary wall ***(Site 34)*** has the potential to receive direct impacts. On the north side of Castle Road (between Ch800 m and Ch900 m) the Bronze Age features ***(Site 52)*** discovered in this area may extend beyond the investigative works that located these remains, with the large cutting in this area likely to cause direct impacts on any surviving elements.

Between Killymoon Road and Castle Road, there is the potential for direct impacts on any sub-surface remains of a pavilion ***(Site 66)*** at Ch1000 m, and a gate pier ***(Site 70)*** at Ch1050 m due to the large road cutting in this area.

There are likely to be direct impacts on any sub-surface remains of a farmstead ***(Site 84)*** at Ch1500 m, and there are likely to be direct impacts on a Medieval rath ***(Site 124)*** that is situated on the edge of the Purple A route at Ch2200 m (approximately), with the edge of the earthwork and sub-surface remains having the potential to be impacted upon during any construction works.

On the northern side of Coagh Road (Between Ch2550 m and Ch2600 m) an agricultural building ***(Site 183)*** has the potential for direct impacts, and construction works to the north of Old Coagh Road (Ch3100 m) have the potential to impact upon the former railway embankment ***(Site 207)***.

Purple B Route

The Purple B route has the potential for direct physical impacts on a number of assets including: an estate boundary wall ***(Site 34)***; potential Bronze Age features ***(Site 52)***; a pavilion ***(Site 66)***; a gate pier ***(Site 70)***; a farmstead ***(Site 84)***; a Medieval rath ***(Site 124)***; two farm buildings ***(Site 183 and 218)***; and a railway embankment ***(Site 207)***.

To the south of the Castle Road waste water treatment plant at approximate Ch450 m, a remnant of the Killymoon estate boundary wall ***(Site 34)*** has the potential to receive direct impacts. On the north side of Castle Road (between Ch800 m and Ch900 m) the Bronze Age features ***(Site 52)*** discovered in this area may extend beyond the investigative works that located these remains, with the large cutting in this area causing direct impacts on any surviving elements.

Between Killymoon Road and Castle Road, there is the potential for direct impacts on any sub-surface remains of a pavilion ***(Site 66)*** at Ch1000 m, and a gate pier ***(Site 70)*** at Ch1050 m due to the large road cutting in this area.

There are likely to be direct impacts on any sub-surface remains of a farmstead ***(Site 84)*** at Ch1500 m, and there are likely to be direct impacts on a Medieval rath ***(Site 124)*** that is situated on the edge of the Purple B route at Ch2200 m (approximately), with the edge of the earthwork and sub-surface remains having the potential to be impacted upon during any construction works.

On the northern side of Coagh Road (Between Ch2550 m and Ch2600 m) an agricultural building ***(Site 183)*** has the potential for direct impacts, and construction works to the north of Old Coagh Road (Ch3100 m) have the potential to impact upon the former railway embankment ***(Site 207)***.

A farm building ***(Site 218)*** has the potential for direct impacts during any construction works to the south of the roundabout at the A29 Moneymore Road (Ch3700 m), with the potential for complete removal of the structure.

Green Route

The Green route has the potential to impact on a number of assets including: an estate boundary wall ***(Site 34)***; potential Bronze Age features ***(Site 52)***; a pavilion ***(Site 66)***; a gate pier ***(Site 70)***; a former lodge ***(Site 71)***; an old meeting house ***(Site 73)***; a farmstead ***(Site 84)***; a Medieval rath ***(Site 124)***; and a railway embankment ***(Site 207)***.

To the south of Castle Road there are two sections of estate boundary wall remnants ***(Site 34 and Site 43)*** that have the potential to receive direct impacts (Ch500 m and Ch800 m respectively). On the north side of Castle Road (between Ch900 m and Ch1000 m) the Bronze Age features ***(Site 52)*** discovered in this area may extend beyond the investigative works that located these remains, with the large cutting in this area causing direct impacts on any surviving elements.

Between Killymoon Road and Castle Road, there is the potential for direct impacts on any sub-surface remains of a pavilion ***(Site 66)*** at Ch1050 m, and a gate pier ***(Site 70)*** at Ch1100 m due to the large road cutting in this area. To the immediate north of Killymoon Road there is the potential for direct impacts on the sub-surface remains of a former lodge ***(Site 71)*** and the sub-surface remains of an old meeting house ***(Site 73)***, both at approximate Ch1200 m.

There are likely to be direct impacts on any sub-surface remains of a farmstead ***(Site 84)*** at Ch1500 m, and there are likely to be direct impacts on a Medieval rath ***(Site 124)*** that is situated on the edge of the Green route at Ch2250 m (approximately), with the edge of the earthwork and sub-surface remains having the potential to be impacted upon during any construction works.

Construction works to the north of Old Coagh Road (Ch3100 m) have the potential to impact upon the former railway embankment ***(Site 207)***.

Sandholes Link Road

The Sandholes Link Road has the potential to directly impact on the Fairy Burn bridge ***(Site 24)*** and the Derryloran Church AAP ***(Site 41)***.

Widening of the existing road on its western side between Ch50 m and Ch150 m, has the potential for direct impacts on the Derryloran AAP ***(Site 41)*** that is likely to contain further elements of the Medieval activity associated with the early church. The current proposals avoid the Derryloran Church and graveyard to the east, with the majority of the widening taking place within previously developed ground.

Further south at approximate Ch400 m, the proposed scheme has the potential for direct impacts on the Fairy Burn Bridge ***(Site 24)***. The current designs suggest a new larger culvert/bridge will replace the current bridge to allow for road widening.

6.3.3.2. Operation

Red Route

The introduction of the Red route has the potential to result in indirect impacts on the setting of the Killymoon Castle Historic Park, Garden and Demesne ***(Site 15)***, and the Grade A Listed Killymoon Castle and outbuildings ***(Site 28 and 33)***. It also has the potential for indirect impacts on the setting of a further 10 assets along the length of the Red route.

The introduction of infrastructure on the slopes between Killymoon Road and Castle Road (between Ch800 m to Ch1200 m), has the potential to be visible from the Killymoon Castle Historic Park, Garden and Demesne ***(Site 15)***, as well as the Grade A Listed Killymoon Castle and outbuildings ***(Site 28 and 33)***, which are located within the park. The inclusion of this new infrastructure within views across the current rural landscape has the potential for impact on the setting of these assets.

The new bridge over the Ballinderry River between Ch50 m and Ch100 m, and the connecting road with the current A29 roundabout (Ch0 m) may result in visual impacts on a weir ***(Site 22)***, and on a farmstead to the west ***(Site 25)***.

The introduction of the junction at Castle Road (Ch800 m) may also increase visual and noise impacts for the Tape and Webbing Factory ***(Site 40)***, and a section of the former estate boundary wall ***(Site 43)***.

Further north, the introduction of the junction with Coagh Road between Ch2150 m to Ch2250 m has the potential to impact the setting of the Medieval rath ***(Site 124)***. The new infrastructure of the Red route will be visible from the rath, with further potential impacts by the roundabout at Clare Lane (Ch1700 m) to the south as well.

The introduction of the new infrastructure around Old Coagh Road (Ch2650 m to Ch2850 m) including the junction embankments have the potential to impact on the setting of the farmstead ***(Site 203)*** as well as the railway embankment remains ***(Site 207)*** to the north-east and south-west.

The introduction of infrastructure at the roundabout with Moneymore Road and the road leading south (between Ch3250 m to Ch3550 m) may impact on the setting of the remains of Ballymenagh Castle ***(Site 212)***, as well as two farmsteads ***(Site 221 and 224)***. These upstanding structures will likely have views of the new infrastructure, with impacts from noise also a potential on Ballymenagh Castle due to the proximity of the Red route.

Purple A Route

The introduction of the Purple A route has the potential for indirect impacts on the setting of: the Killymoon Castle Historic Park, Garden and Demesne ***(Site 15)***; the Grade A Listed Killymoon Castle and outbuildings ***(Site 28 and 33)***; and the Terressan Rath Scheduled Monument ***(Site 100)***. There may also be a number of indirect impacts on the setting of a further 10 assets along the length of the Purple A route.

The introduction of infrastructure on the slopes between Killymoon Road and Castle Road (between Ch800 m to Ch1200 m), has the potential to be visible from the Killymoon Castle Historic Park, Garden and Demesne ***(Site 15)***, as well as the Grade A Listed Killymoon Castle and outbuildings ***(Site 28 and 33)***, which are located within the park. The inclusion of this new infrastructure within views across the current rural landscape has the potential for impact on the setting of these assets.

The introduction of the new roundabout works at Clare Lane and the embankments to the south (between Ch1550 m to Ch1900 m) may be visible from the Terressan Rath ***(Site 100)***, impacting on the setting of the Scheduled Monument.

The inclusion of a new bridge over the Ballinderry River between Ch150 m and Ch200 m, and the other connecting road with the current A29 roundabout at Ch0 m may result in visual impacts on a weir ***(Site 22)***, and farmstead to the west ***(Site 25)***.

The junction at Castle Road (Ch750 m) may also create visual and noise impacts for the Tape and Webbing Factory ***(Site 40)***, and a section of the former estate boundary wall ***(Site 43)***.

To the north, the Clare Lane roundabout (Ch1900 m) may introduce indirect impacts on the site of a Medieval rath ***(Site 90)***, along with a farmstead ***(Site 96)***. There is also the potential for noise and visual impacts on the setting of another Medieval rath ***(Site 124)***, which will have direct views across the road at Ch2200 m and fall within close proximity to the roundabout at Clare Lane.

The new road between Ch2400 m to Ch2800 m is likely to be visible from two farmsteads ***(Site 144 and 197)*** to the east of the Purple A route, impacting on the setting from both these assets. The new road between Ch2900 m and Ch3300 m, to the north of Old Coagh Road and the junction at Old Coagh Road may result in further impacts on the setting of railway embankment ***(Site 207)***.

Purple B Route

The introduction of the Purple B route has the potential for indirect impacts on the setting of: the Killymoon Castle Historic Park, Garden and Demesne ***(Site 15)***; the Grade A Listed Killymoon Castle and outbuildings ***(Site 28 and 33)***; and the Terressan Rath Scheduled Monument ***(Site 100)***. The possibility also exists for indirect impacts on the setting of a further 15 assets identified along the length of the Purple B route.

The introduction of infrastructure on the slopes between Killymoon Road and Castle Road (between Ch800 m to Ch1200 m), has the potential to be visible from the Killymoon Castle Historic Park, Garden and Demesne ***(Site 15)***, as well as the Grade A Listed Killymoon Castle and outbuildings ***(Site 28 and 33)***, which are located within the park. The inclusion of this new infrastructure within views across the current rural landscape has the potential for impact on the setting of these assets.

The introduction of the new roundabout works at Clare Lane and the embankments to the south (between Ch1550 m to Ch1900 m) may be visible from the Terresan Rath ***(Site 100)***, impacting on the setting of the Scheduled Monument.

The inclusion of a new bridge over the Ballinderry River between Ch150 m and Ch200 m, and the other connecting road with the current A29 roundabout at Ch0 m may result in visual impacts on a weir ***(Site 22)***, and farmstead to the west ***(Site 25)***.

The junction at Castle Road (Ch750 m) may also create visual and noise impacts for the Tape and Webbing Factory ***(Site 40)***, and a section of the former estate boundary wall ***(Site 43)***.

To the north, the Clare Lane roundabout (Ch1900 m) may introduce indirect impacts on the site of a Medieval rath ***(Site 90)***, along with a farmstead ***(Site 96)***. There is also the potential for noise and visual impacts on the setting of another Medieval rath ***(Site 124)***, which will have direct views across the road at Ch2200 m and fall within close proximity to the roundabout at Clare Lane.

The new road between Ch2400 m to Ch2800 m is likely to be visible from two farmsteads ***(Site 144 and 197)*** to the east of the Purple B route, impacting on the setting from both these assets. The new road between Ch2900 m and Ch3300 m, to the north of Old Coagh Road and the junction at Old Coagh Road may result in further impacts on the setting of railway embankment ***(Site 207)***.

The proximity of the road to the south of the roundabout at Ch3700 m may introduce noise and visual impacts on the ruins of a farmstead ***(Site 217)***. The new roundabout with Moneymore Road (Ch4300 m) may also result in visual impacts on the houses at Ballymenagh ***(Site 223)*** and Dunman ***(Site 232)***, as well as the two farmsteads ***(Site 231 and 238)***.

Green Route

The introduction of the Green route has the potential for indirect impacts on the setting of: the Killymoon Castle Historic Park, Garden and Demesne ***(Site 15)***; the Grade A Listed Killymoon Castle and outbuildings ***(Site 28 and 33)***; and the Terressan Rath Scheduled Monument ***(Site 100)***. There is also the potential for indirect impacts on the setting of a further 12 assets along the length of the Green route.

The introduction of infrastructure on the slopes between Killymoon Road and Castle Road (between Ch800 m to Ch1200 m), has the potential to be visible from the Killymoon Castle Historic Park, Garden and Demesne ***(Site 15)***, as well as the Grade A Listed Killymoon Castle and outbuildings ***(Site 28 and 33)***, which are located within the park. The inclusion of this new infrastructure within views across the current rural landscape has the potential for impact on the setting of these assets.

The introduction of the new roundabout works at Clare Lane and the embankments to the south (between Ch1550 m to Ch1900 m) may be visible from the Terresan Rath ***(Site 100)***, impacting on the setting of the Scheduled Monument.

The inclusion of a new bridge over the Ballinderry River at Ch200 m, and the other connecting road with the current A29 roundabout at Ch0 m may result in visual impacts on a weir ***(Site 22)***, and farmstead to the west ***(Site 25)***.

The junction at Castle Road (Ch800 m) may also create visual and noise impacts for the Tape and Webbing Factory ***(Site 40)***, and a section of the former estate boundary wall ***(Site 43)***.

To the north, the Clare Lane roundabout (Ch1950 m) may introduce indirect impacts on the site of a Medieval rath ***(Site 90)***, along with a farmstead ***(Site 96)***. There is also the potential for noise and visual impacts on the setting of another Medieval rath ***(Site 124)***, which will have direct views across the road at Ch2300 m and fall within close proximity to the roundabout at Clare Lane.

The new road between Ch2450 m to Ch2700 m is likely to be visible from the barn structure ***(Site 176)***, a farm building ***(Site 183)***, and a farmstead ***(Site 197)*** to the east of the Green route, impacting on the setting of these assets.

The new junction at Old Coagh Road, and to the north of it between Ch2900 m and Ch3300 m may result in further impacts on the setting of the railway embankment ***(Site 207)***. The introduction of the new infrastructure between Ch3500 m and Ch3800 m has the potential to result in setting impacts on the Ballymenagh castle remains ***(Site 212)***.

Sandholes Link Road

The works to the Sandholes Link Road may introduce visual impacts on the setting of Derryloran Church ***(Site 42)***. The upgrade and widening work of the road between Ch0 m and Ch150 m will be visible from the church as there is currently no screening between the church and existing road.

The introduction of the new road alignment and roundabout between Ch550 m and Ch650 m, has the potential to introduce visual impacts on the setting of the remaining buildings of Coolkeeghan Junction South-West Farmstead ***(Site 19)***.

6.3.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

6.3.4.1. Comparison of effects

All Route Options

The assessment indicates that all route options have the potential to introduce both direct and indirect impacts upon the cultural heritage resource. The impacts associated with the Sandholes Link road (common to all route options) would be identical. Comparison of the route options is provided within Table 6-12, and indicates that the potential for direct physical impacts from all of the route options have the possibility of removing or impacting on four assets: an estate boundary wall ***(Site 34)***, the Derryloran Church AAP ***(Site 41)***, Bronze Age features ***(Site 52)***, and the Randallstown to Cookstown Railway line ***(Site 207)***.

In terms of the potential for setting impacts across all route options, these mainly relate to the possibility of minor impacts throughout, with the main factor in the determination of the true impact related to the proximity of the individual asset and its exposure to the proposed scheme. It should be noted that the Historic Park, Garden and Demesne of Killymoon Castle ***(Site 15)*** has the potential to experience Moderate Adverse impacts from all route options, that would be deemed significant in environmental assessment terms.

Red Route Option

Further to the direct impacts referenced for all route options, the assessment highlights that the Red route has the potential to have direct impacts on two additional assets including a potential Prehistoric standing stone ***(Site 104)***, as well as impacting on any sub-surface remains of an enclosure ***(Site 213)***.

Purple A Route Option

Further to the direct impacts referenced for all route options, the Purple A route has the potential to have direct impacts on five further assets including a pavilion ***(Site 66)***, a gate pier ***(Site 70)***, a farmstead ***(Site 84)***, a Medieval rath ***(Site 124)***, and a farm building ***(Site 183)***.

Purple B Route Option

Further to the direct impacts referenced for all route options, the Purple B route has the potential to have direct impacts on six further assets including a pavilion ***(Site 66)***, a gate pier ***(Site 70)***, a farmstead ***(Site 84)***, a Medieval rath ***(Site 124)***, a farm building ***(Site 183)***, and a farmstead building ***(Site 218)***.

Green Route Option

Further to the direct impacts referenced for all route options, the Green route has the potential to have direct impacts on six further assets including a pavilion ***(Site 66)***, a gate pier ***(Site 70)***, a former lodge ***(Site 71)***, an old meeting house ***(Site 73)***, a farmstead ***(Site 84)***, and a Medieval rath ***(Site 124)***.

Summary

Taking into account the importance of the assets and sites, a comparison of the route options indicates that the potential for significant adverse impacts (moderate or greater) on the cultural heritage resource is lesser with the Red route. The comparison also highlights that the Purple B route and Green route will have a greater number of direct impacts on the cultural heritage resource compared with the Purple A route and Red route.

In terms of indirect impacts related to the setting of assets, the comparison highlights that the Purple B route has the potential for a greater number of impacts than the Purple A route, which in turn has the potential for a greater number of impacts than the Green route, and the least number of indirect impacts from the Red route.

All options have the potential for significant adverse impacts (moderate or greater) on the cultural heritage resource.

Table 6-12 – Overall summary of effects for cultural heritage

Asset Ref.	Receptor	Value	Type of Impact	Impact Significance (Residual Impacts)* Significant impacts (Moderate or greater) are highlighted in **bold**				Comparative Appraisal
				Red route	Purple A route	Purple B route	Green route	
Site 15	Killymoon Castle Historic park, Garden and Demesnes	High	Setting	Slight or **Moderate** Adverse				No differentiators Identified
Site 19	Farmstead	Low	Setting	Neutral or Slight Adverse				No differentiators Identified
Site 22	Weir	Low	Setting	Neutral or Slight Adverse				No differentiators Identified
Site 24	Fairy Burn Bridge	Negligible	Direct	Neutral				No differentiators Identified
Site 25	Farmstead	Low	Setting	Neutral or Slight Adverse				No differentiators Identified
Site 28	Killymoon Castle	High	Setting	Slight Adverse				No differentiators Identified
Site 33	Outbuildings at Killymoon Castle	High	Setting	Slight Adverse				No differentiators Identified
Site 34	Estate Boundary Wall	Low	Direct	Slight or **Moderate** Adverse				No differentiators Identified
Site 40	Tape and Webbing Factory	Low	Setting	Neutral or Slight Adverse				No differentiators Identified
Site 41	Derryloran Church AAP	Medium	Direct	**Moderate** Adverse				No differentiators Identified
Site 42	Derryloran Church	Medium	Setting	Slight Adverse				No differentiators Identified
Site 43	Estate Boundary Wall	Low	Setting	Neutral or Slight Adverse				No differentiators Identified

Asset Ref.	Receptor	Value	Type of Impact	Impact Significance (Residual Impacts)* Significant impacts (Moderate or greater) are highlighted in **bold**				Comparative Appraisal
				Red route	Purple A route	Purple B route	Green route	
Site 52	Bronze Age Features	Medium	Direct	**Moderate** Adverse				No differentiators Identified
Site 66	Pavilion	Negligible	Direct	Neutral	Slight Adverse			Differentiator – greater impact of Purple A, Purple B & Green route
Site 70	Gate Pier and Lodge	Negligible	Direct	Neutral	Slight Adverse			Differentiator – greater impact of Purple A, Purple B & Green route
Site 71	Lodge	Negligible	Direct	Neutral			Slight Adverse	Differentiator – greater impact of Green route
Site 73	Meeting House	Negligible	Direct	Neutral			Slight Adverse	Differentiator – greater impact of Green route
Site 84	Farmstead	Negligible	Direct	Neutral	Slight Adverse			Differentiator – greater impact of Purple A, Purple B & Green route
Site 90	Rath	Low	Setting	Neutral	Neutral or Slight Adverse			Differentiator – greater impact of Purple A, Purple B & Green route
Site 96	Farmstead	Low	Setting	Neutral	Neutral or Slight Adverse			Differentiator – greater impact of Purple A, Purple B & Green route

Asset Ref.	Receptor	Value	Type of Impact	Impact Significance (Residual Impacts)* Significant impacts (Moderate or greater) are highlighted in **bold**				Comparative Appraisal
				Red route	Purple A route	Purple B route	Green route	
Site 100	Terressan Rath	High	Setting	Neutral	Slight Adverse			Differentiator – greater impact of Purple A, Purple B & Green route
Site 104	Standing Stone	Low	Direct	**Moderate** Adverse	Neutral			Differentiator – greater impact of Red route
Site 124	Rath	Medium	Direct	Neutral	**Moderate** Adverse			Differentiator – greater impact of Purple A, Purple B & Green route
Site 144	Farmstead and Well	Low	Setting	Neutral	Neutral or Slight Adverse		Neutral	Differentiator – greater impact of Purple A & Purple B route
Site 176	Farmstead / Barn	Negligible	Setting	Neutral			Neutral or Slight Adverse	Differentiator – greater impact of Green route
Site 183	Building	Low	Direct	Neutral	Slight Adverse		Neutral or Slight Adverse	Differentiator – greater impact of Purple A & Purple B route
Site 197	Farmstead	Low	Setting	Neutral	Neutral or Slight Adverse		Neutral	Differentiator – greater impact of Purple A & Purple B route
Site 203	Farmstead	Low	Setting	Neutral				No differentiators Identified

Asset Ref.	Receptor	Value	Type of Impact	Impact Significance (Residual Impacts)* Significant impacts (Moderate or greater) are highlighted in **bold**				Comparative Appraisal
				Red route	Purple A route	Purple B route	Green route	
Site 207	Cookstown and Randallstown Railway	Low	Direct & Setting	Neutral or Slight Adverse	Slight Adverse			Differentiator – greater impact of Purple A, Purple B & Green routes
Site 212	Ballymenagh Castle	Low	Setting	Neutral or Slight Adverse		Neutral	Neutral or Slight Adverse	Differentiator – greater impact of Red, Purple A & Green route
Site 213	Enclosure	Low	Direct	Slight Adverse	Neutral			Differentiator – greater impact of Red route
Site 217	Farmstead	Low	Setting	Neutral		Neutral or Slight Adverse	Neutral	Differentiator – greater impact of Purple B route
Site 218	Farmstead	Low	Direct	Neutral		Slight Adverse	Neutral	Differentiator – greater impact of Purple B route
Site 221	Farmstead	Low	Setting	Neutral or Slight Adverse		Neutral	Neutral or Slight Adverse	Differentiator – greater impact of Red, Purple A & Green route
Site 223	Ballymenagh House	Low	Setting	Neutral or Slight Adverse				No differentiators identified
Site 224	Farmstead	Low	Setting	Neutral or Slight Adverse		Neutral	Neutral or Slight Adverse	Differentiator – greater impact of Red, Purple A & Green route

Asset Ref.	Receptor	Value	Type of Impact	Impact Significance (Residual Impacts)* Significant impacts (Moderate or greater) are highlighted in **bold**				Comparative Appraisal
				Red route	Purple A route	Purple B route	Green route	
Site 231	Farmstead and Well	Low	Setting	Neutral		Neutral or Slight Adverse	Neutral	Differentiator – greater impact of Purple B route
Site 232	Dunman House	Low	Setting	Neutral		Neutral or Slight Adverse	Neutral	Differentiator – greater impact of Purple B route
Site 238	Farmstead and Well	Low	Setting	Neutral		Neutral or Slight Adverse	Neutral	Differentiator – greater impact of Purple B route

*Significance of impact includes Sandholes Link Road for each route

6.3.4.2. Mitigation against construction related impacts

The assessment indicates there is the potential for direct physical impacts upon 15 cultural heritage assets from all route options, including an APP. For highly significant assets of regional importance, the preferred mitigation measures would be to avoid any direct physical impacts. For regionally significant assets or less significant assets, the DMRB states: "*Programmes of investigation should be undertaken to mitigate the impact on cultural heritage resource where it cannot be avoided*."

The programmes of investigation that will be required to mitigate the direct impacts from construction of the proposed scheme scheme will be agreed with HED in accordance with DEM 156/15 Management of Archaeological Investigations on Major Road Improvement Schemes. The type of investigations utilised can include, but are not limited to, photographic surveys of historic buildings, geophysical surveys, targeted trial trenching, excavations, and watching briefs. The objectives of the investigations will be to further our understanding of the site affected prior to its destruction or alteration. Any programme of investigation will require cultural heritage design objectives to be produced for the proposed scheme, set out within a Written Scheme of Investigation (WSI) to be agreed with HED.

To ensure that the impact of the proposed scheme can be appropriately mitigated it will be necessary to evaluate the preferred route option to locate and determine the significance and extent of those known and currently unknown archaeological assets present. The evaluation strategy will be agreed with HED in accordance with DEM 156/15, enabling archaeological investigations in an efficient and quality manner. It is likely to comprise a scheme of geophysical survey (if appropriate) followed by trial trenching. This evaluation may be followed by open area excavation prior to construction works. A watching brief during construction may also be required for areas not subject to evaluation or excavation. These works would be carried out to an agreed methodology prepared in consultation with HED.

Should archaeological remains of potentially national significance be encountered during the trial trenching or excavations, it is likely that these remains would require avoidance and may result in the proposed scheme design being amended to do so. In this instance, consultation with HED would be undertaken.

6.3.4.3. Mitigation against operational related impacts

The route options may result in impacts to the setting of 25 assets, including visual impacts on at least one Scheduled Monument, two Grade A Listed Buildings, and an Historic Park, Garden and Demesne. Other assets will have their settings affected by visual, or visual and noise impacts from the operation of the proposed scheme. Appropriate mitigation for these assets is likely to include screening or landscaping, and once a preferred route option has been identified, consultation would be undertaken with HED to discuss appropriate mitigation options that would reduce the setting impacts upon the assets.

6.4. LANDSCAPE AND VISUAL

6.4.1. ASSESSMENT SCOPE

This section sets out a simple landscape and visual assessment for Stage 2 options selection.

A simple assessment is appropriate at this stage in order to understand the likely effects on landscape character and visual amenity from the proposed scheme and inform the need for further detailed assessment on the final design.

The assessment of landscape character and visual amenity are two distinct but related areas:

- Landscape Character Assessment is the process whereby the different elements that form the landscape are recorded and assessed. DMRB LA 107[17] describes the process as "*the assessment of a combination of physical (e.g. landform, vegetation, buildings), aesthetic/perceptual (e.g. scale, appearance, tranquillity) and cultural/social (e.g. human interaction, land use, heritage) aspects which together make up the character of the area. An assessment is also made as to the quality, or condition, of the landscape, which involves consideration of the physical state of the landscape and of the features and elements which make up landscape character*".
- Visual amenity assessment is the assessment of the impact to receptors from locations inhabited and frequented by people. Effects upon the visual amenity, which is defined in LA 107 as "*the value of a particular area or view in terms of what is seen*", are also considered and assessed.

Development of highways can, by their nature, have significant impacts on individual landscape elements, landscape character and the nature and quality of views.

6.4.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the landscape and visual assessment are provided in Environmental Appendix B.

6.4.1.2. Study Area

In accordance with DMRB LA 107 the landscape assessment study area should be proportionate to the following factors:

- The project boundary/construction activity;
- The wider landscape setting within which the project/its works has the potential to influence;
- The extent of the area visible by the project; and
- The full extent of adjacent or affected landscape receptors of special value.

For the purposes of this assessment, the study area has been formed by an amalgamation of the individual 1 km buffers taken from either side of the centre line of each route option and the Sandholes Link Road. This has been used for both landscape and visual impacts, extending to the same extent at the junctions and assumes that the likelihood of significant effects beyond this buffer would be low. Whilst distant views may be possible beyond 1 km, within which there may be potential for awareness of each route option, the likelihood of significant effects is substantially reduced.

Refer to Figure 6.4.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0128) for the extent of the study area.

[17] Highways England, (2019). DMRB LA 107 Landscape and Visual Effects. [online] Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/LA%20107%20Landscape%20and%20visual%20effects-web.pdf [Accessed 04/11/2019].

6.4.1.3. Methodology

The assessment was undertaken in accordance with the DMRB guidance LA 107 Landscape and Visual Effects. For more detail on methodology refer to Environmental Appendix B.

6.4.1.4. Consultation

Consultation of relevance to the landscape and visual assessment with stakeholders has been described below:

- The location of TPO's was confirmed through consultation with Mid Ulster District Council in August 2019 and can be found on Figure 6.4.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0128);
- The Woodland Trust responded to consultation in October 2019 with concerns raised over the impact on woodland within Cabin Wood due to the proximity of the proposed scheme. All four route options would have the same impact through this location. Cabin Wood can be found on Figure 6.4.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0128);
- Mid Ulster District Council responded to consultation in October 2019 and confirmed the presence of the Northern Ireland Landscape Character Assessment 2000, the Northern Ireland Regional Landscape Assessment and the Killymoon Historic Park, Garden and Demesne. Mid Ulster District Council confirmed that with regard to the methodology and study area for landscape and visual considerations, that it would be a matter for WSP to determine and
- The Department for Agriculture, Environment and Rural Affairs (DAERA) responded to consultation in October 2019 with the following requests of relevance to this assessment:
    - A follow up consultation to the Natural Environment Division's (NED) Protected Landscapes Team was undertaken in November 2019 in regard to scoping out viewpoints from within The Sperrins AONB. To date no formal response has been received, and the assessment has progressed based on the anticipation that, due to the distance, no significant effects are anticipated, and viewpoints from within the Sperrins AONB have therefore been scoped out;
    - The Environmental Impact Assessment Report EIAR shall include a description of any proposed measures to avoid, prevent, reduce and, if possible, offset any significant adverse effects on the environment (i.e. Avoidance, Mitigation, Compensation, and Enhancement);
    - The principle of 'no net loss of biodiversity' should be applied to the EIA process;
    - The mitigation proposed should be clearly described and its effect on the magnitude and significance of these impacts should be assessed and clearly explained;
    - Any uncertainty in the effectiveness of proposed mitigation measures should be explained and, where appropriate, evidence should be provided of successes from other similar projects; and
    - The implementation of proposed mitigation should be clearly described and, if necessary, any arrangements for monitoring the implementation and success of mitigation measures should be stated.

6.4.1.5. Assumption and Limitations

Details of assumptions and limitations for landscape and visual assessment are provided in Environmental Appendix B.

6.4.2. BASELINE CONDITIONS

The baseline information provided below describes existing conditions within the study area for the route options. Existing baseline features are shown on Figure 6.4.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0128) and Figure 6.4.2 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0129).

6.4.2.1. Designated sites

There are no national landscape designations within the study area or that would be potentially impacted by the proposed scheme.

Within the setting of the local landscape through the Ballinderry River valley and lying within the south-eastern extent of the study area is the following designation:

- Killymoon Castle Historic Park, Garden and Demesne, situated within LLCA5 and LLCA6.

There are two LLPA's designated within the Cookstown Area Plan 2010:

- LLPA1 Ballinderry River, which broadly follows the course of the River Ballinderry, and extends from a large area incorporating the landscape associated with Killymoon Castle to the east of Cookstown and extends into the south and west of Cookstown. LLPA1 is situated within LLCA5, LLCA6 and LLCA7; and
- LLPA4 Coolnafranky, on the eastern margin of the town, bounded by Molesworth Road to the north and east and backing onto the development along Loy Street, the area comprises schools and playing fields. LLPA4 is situated within LLCA3.

Ancient woodland has been identified within the study area. No ancient woodland is within close proximity to the proposed scheme and is therefore not at risk of a direct impact, however key locations within the study area are outlined below:

- East and north of Sandholes Road adjacent to the Ballinderry River (approximately 100 m east and 200 m north);
- within the Ballinderry River valley within Cabin Wood (approximately 200 m east of all route options); and
- within the Killymoon Castle Historic Park, Garden and Demesne (approximately 300 m east of all route options).

There are no TPOs that would be affected by the Red route, Purple A route, Purple B route or Green route. However, there is one area TPO adjacent to the Sandholes Link Road northern roundabout connection that would potentially be affected by construction works. There is a further area TPO approximately 150 m north of Sandholes Road that would not be affected. The location and extent of designations listed above are provided on Figure 6.4.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0128).

6.4.2.2. Landscape Context

The landscape of the study area can be broadly defined as contrasting between the fragmented urban eastern edge of Cookstown to the west and the rolling Cookstown farmland to the east. Increasingly pronounced drumlin landforms are prominent in the north and east of the study area while the broad Ballinderry River valley complex offers a more expansive appreciation of the local landscape to the south.

Following a desk-based study and site survey LLCA's have been identified at an appropriate scale from which to assess the potential for significant effects. Sensitive LLCA's subject to potentially significant landscape effects as a result of the adoption of any of the route options are listed in Table 6-13 with a brief description below and are located on Figure 6.4.1 (Appendix A 718314-WSP-B-D-3000-0128).

Table 6-13 – LLCA's potentially subject to significant effects

LLCA	Value	Sensitivity to change
LLCA1 - Cookstown Market Street and Business Zone	Medium	Medium
LLCA2 - Cookstown Suburbs	Low	Medium
LLCA3 - Cookstown Urban Fringe	Low	Medium
LLCA4 - Cookstown Settled Farmland	Medium	High
LLCA5 - Heavily Managed Recreation	Medium	Medium
LLCA6 - Rural River Corridor	Medium	High
LLCA7 - Urban River Corridor	Low	Medium

LLCA1 - Cookstown Market Street and Business Zone

This LLCA comprises the northern extents of Cookstown's distinctive wide, well-lit and tree-lined high street and adjacent side streets. There is a mix of retail and commercial activity, communal facilities and light industry. There are occasional views from the high street and side streets into the surrounding farmland.

LLCA2 - Cookstown Suburbs

This LLCA is situated on and defines the western margins of the study area and incorporates a mix of older and new well-lit residential developments. Groupings of detached properties and townhouses extend beyond the older established edge of the town, where there is terraced and semi-detached housing arranged on a grid pattern.

LLCA3 - Cookstown Urban Fringe

This LLCA occupies land on the east and north-eastern periphery of the town and is visually enclosed by a combination of landform, buildings, mature roadside vegetation and trees. The attractive Kidds Bridge on Coagh Road is located on the eastern boundary of the area. Other, less attractive features include a factory and a waste water treatment works. Land use is mixed and includes pastoral fields enclosed by managed hedgerows in between urban development. There is an area of modern residential development along the eastern margin and a small number of local parks and occasional areas of open space. A generally well-lit area contrasting with the edge of the darker rural landscape adjacent. The open space and playing fields are designated as a LLPA in the Cookstown Area Plan 2010.

LLCA4 - Cookstown Settled Farmland

This LLCA occupies the largest proportion of the study area and is an area of pastoral agriculture with irregularly shaped medium-sized fields, typically enclosed by a network of dense mature hedgerows and interspersed with hedgerow trees. It is a rolling drumlin landscape, where views vary depending on elevation but are typically local and enclosed. On higher ground however, views can extend to Cookstown, the surrounding farmland and the Sperrins AONB in the distance to the north. There is a network of local roads that extend eastwards from the town and of small watercourses which have etched local valleys within the landscape. Other linear features include the disused railway line. It is typically a dark landscape with dispersed settlement, comprising large farmsteads set back from the local roads on long driveways, cottages adjacent to the roads, and more recently sporadic residential development on large roadside plots.

LLCA5 - Heavily Managed Recreation

This LLCA predominantly comprises the Killymoon golf course set within a framework of mature woodland to the north and enclosed by drumlin landforms immediately south. Local landform has been extensively shaped to accommodate the course layout. Specimen tree planting defines the fairways. Distinctive avenues of poplars line Killymoon Road and mark the southern boundary of the LLCA. While typically a dark landscape there is a degree of light spill from adjacent residential areas. The golf course forms part of the Ballinderry River LLPA1 designated in the Cookstown Area Plan 2010.

LLCA6 - Rural River Corridor

This LLCA comprises the river valley landscape of the Ballinderry and Killymoon Rivers. It is a particularly attractive area, defined by a sequence of woodlands and small-scale riverside pastures, as well as the historic grounds of Killymoon Castle. Away from the fringes of Cookstown it is a predominantly dark landscape with development limited to scattered farmsteads, set within a diverse patchwork of fields, hedgerows, woodland belts and local lanes. The river corridor forms the focus of the Ballinderry River LLPA1.

There are views to the periphery of Cookstown and to industrial areas on the banks of the river. The wastewater treatment works on higher ground in the north-west of the LLCA is well screened by local mounding and dense woodland.

LLCA7 - Urban River Corridor

This LLCA comprises a well-lit area of residential and industrial development substantially located to the south of the River Ballinderry as it flows west to east through the south-eastern periphery of the town. Woodland along the margins of the river corridor frame and integrate hotel and residential development in the northern and eastern portion of the LLCA and establishes a local area of good quality which is included within the Ballinderry River LLPA1. Industrial development south of the A505, Drum Road, and west of Sandholes Road constitute an area of ordinary landscape.

LLCA1, LLCA2, LLCA3 and LLCA7 are predominantly well-lit landscapes within an urban or urban fringe environment while LLCA5 experiences a degree of light spill associated with nearby housing areas. LLCA4 and LLCA6 are set within predominantly dark landscapes with minimal road lighting or residential properties although there is an appreciation of sky glow from Cookstown to the north west.

There are notable trees that contribute to the local character, these are highlighted below:

- A belt of mature woodland within the Ballinderry River corridor following the path of the river;
- Along Castle Road and within the vicinity of the Killymoon Castle Historic Park; and
- Within the vicinity of Killymoon golf course including a distinctive row of Poplars along Killymoon Road, amenity trees within the golf course and a large mature Oak tree on the western boundary of the golf course.

Landscape character photographs are shown on Figures 6.4.9 and 6.4.10 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0136 and 718314-WSP-B-D-3000-0137).

6.4.2.3. Visual Context

Visual amenity within the study area is predominantly experienced from residential properties and local roads with limited opportunities to experience views of the surrounding landscape from local footpaths. Broader views are more typically experienced to the south of Cookstown in the context of the broad Ballinderry River valley. Within the northern extents of the study area drumlin landforms and overgrown hedgerows contain views locally, although distant views to the Sperrin AONB to the north are occasionally afforded between drumlin landforms and field boundary vegetation.

Viewpoints have been identified to represent the visual receptors most likely to be subject to significant effects as a result of the construction and operation of the proposed scheme and are typically representative of residential properties.

The location of key sensitive visual receptors and the representative viewpoint and photograph locations are shown on Figure 6.4.2 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0129) and key viewpoint photographs on Figures 6.4.3 to 6.4.8 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0130, 718314-WSP-B-D-3000-0131, 718314-WSP-B-D-3000-0132, 718314-WSP-B-D-3000-0133, 718314-WSP-B-D-3000-0134 and 718314-WSP-B-D-3000-0135).

The location of key sensitive visual receptors which would be subject to potentially significant visual effects from the route options are outlined in Table 6-14 below:

Table 6-14 – Sensitive Visual Receptors

Visual Receptor (Representative viewpoint number)	Value of View	Sensitivity
Viewpoint (VP) 1 - Residential properties and local businesses on Sandholes Road (associated with Sandholes Link Road only)	High	Moderate (Due to outlook onto an existing busy road)
VP2 - Residential properties on Old Rectory Park and Old Rectory Court (associated with Sandholes Link Road only)	High	High
VP3 - Residential properties on A505 Drum Road and Riverside Drive (associated with Sandholes Link Road only)	High	High
VP4 - Residential properties on Tullywiggan Road	High	High
VP5 - Cabin Wood Public Walk	High	High
VP6 - Residential properties and businesses along Castle Road	High	High
VP7 - Residential properties within Castle Villas	High	High
VP8 - Users of Killymoon golf course	High	High
VP9 - Residential properties within Golf View	High	High
VP10 - Residential properties within Coolnafranky Park	High	High
VP11 - Residential properties within Festival Park	High	High
VP12 - Sustrans Route 95 and informal footways to the east of Cookstown	High	High
VP13 - Residential properties and local businesses in settled farmland along Fountain Road, Cloghog Road and Clare Lane	High	High
VP14 - Residential properties in settled farmland along Old Coagh Road	High	High
VP15 - Residential properties within The Dales	High	High

Visual Receptor (Representative viewpoint number)	Value of View	Sensitivity
VP16 - Residential properties and businesses on the A29 Moneymore Road	High	Moderate (Due to outlook onto an existing busy road)
VP17 – Residential properties in settled farmland on Lismoney Road	High	High

6.4.2.4. Future baseline

The future baseline is unlikely to significantly change in the short term with regards to the addition or alteration of sensitive landscape and visual receptors and the likely impacts upon them as a result of any one of the route options.

There are a number of sites allocated for Housing within Phase 1 of the Cookstown Area Plan 2010, to the north east of Cookstown, between Old Coagh Road and the A29. Within the 2010 Plan are several sites allocated for potential industrial development, extending to the east of the existing development between Old Coagh Road and Cloghog Road. There are also a number of potential housing developments proposed with planning applications for 40 to 70 dwellings between Cloghog Road and The Dales. This future development is likely to extend the eastern urban edge of Cookstown and change the immediate local character and marginally reduce the extent of the Cookstown Farmland LLCA.

6.4.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

6.4.3.1. Legislation and Policy summary and implications

The implications of all four route options are all broadly similar with regards to policies and are summarised below:

The development of any of the route options within Green Belt land may be in contradiction of policy GB/CPA 2 of the Planning Strategy Rural NI. The policy could constrain the proposed scheme and the Purple A route, Purple B route and Green route would have a marginally greater direct impact upon the Green Belt, than the Red route, due to a greater permanent land take within designated land.

Proposed landscaping designed with biodiversity in mind (as well as providing visual screening) would enable the proposed scheme to align with SPPS policy regarding the restoration of and halting the loss of biodiversity and The Wildlife and Natural Environment Act (Northern Ireland) 2011 with regards to furthering the conservation of biodiversity through restoration or enhancement of flora and habitats.

For all four route options, the possible removal of vegetation within Killymoon Historic Park, Garden and Demesne and Ballinderry River LLPA1 would need to be carefully mitigated by replacement planting to ensure compliance with The Wildlife and Natural Environment Act (Northern Ireland) 2011 and the SPPS over time.

The proposed scheme would conflict with Policy CON 2 of the Cookstown Area Plan 2010 relating to the protection of LLPAs. The proposed scheme would conflict with the Ballinderry River LLPA1 at the crossing of the Ballinderry River to the north east of the Loughry roundabout and where they pass through the Killymoon golf course to the east of Golf View.

The proposed scheme would conflict with Policy CON 6 relating to Killymoon Castle Historic Park, Garden and Demesne. All route options would conflict with the Historic Park through the Killymoon golf course.

The proposed scheme would conflict with Policy AGRI 1 relating to community woodland. All route options would conflict with the proposed community woodland and riverside walk.

Refer to Figure 6.4.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000) for the location of Green Belt, LLPAs, Historic Park, Garden and Demesne and Community Woodland.

6.4.3.2. Construction

Any predicted effect ratings noted below are the worst-case scenario and may reduce as a result of the mitigation planting establishing (refer to Section 6.4.4.1 for mitigation measures) and integrating the proposed scheme into the local landscape.

All routes

The below impacts and consequential effects are common to all four route options. Impacts from Sandholes Link Road, which is common to all route options, have been considered separately below under the Sandholes Link Road heading.

Landscape

- The construction of all four route options is expected to introduce temporary adverse residual effects on the following LLCA's:

  LLCA4 Cookstown Settled Farmland;
  LLCA5 Heavily Managed Recreation; and
  LLCA6 Rural River Corridor.

Construction would be perceived outside or on the edge of the remaining LLCA's but would not directly impact highly sensitive features of those landscapes or result in significant residual effects.

- Impacts on landscape character associated with the construction of all four route options would be similar between the southern Loughry roundabout connection (Ch0 m) and Castle Road (Ch800 m) through the highly sensitive Ballinderry River valley (LLCA6) and Ballinderry River LLPA1 (Ch150-250 m). These common impacts and consequential effects would relate to highly visible construction activity, landform modifications and vegetation loss in proximity to the river. The magnitude of effect (change) on the landscape would not substantially differ between the four route options and the perception and character of the local river valley is likely to substantially change resulting in a locally significant effect due to highly visible construction activity and clearance of mature trees.
- Impacts related to construction activity between Castle Road (Ch800 m) and Killymoon golf course (Ch1150 m) (within LLCA4) would not differ substantially between the four route options although construction activity associated with the Red route would be set marginally further away from the adjacent urban edge of Cookstown than the other routes. Construction activity would be visible from the south beyond Castle Road, from Killymoon Road and residential properties on the urban edge of Cookstown, introducing a localised short-term significant effect within the LLCA4 Cookstown Settled Farmland.
- Localised short-term impacts would be introduced for all four route options within LLCA5 through the Killymoon golf course, Killymoon Historic Park, Garden and Demesne and the Ballinderry

River LLPA1 (Ch1150-1350 m). On the western limits of the designations, construction activity would be highly visible and involve clearance of distinctive trees along Killymoon Road and adjacent to Golf View with all route options bisecting a belt of woodland that frames the northern boundary of the golf course. This would constitute noticeable damage and result in significant effects on the local composition of landform and parkland-styled landscape associated with the golf course.
- Whilst construction activity may be perceptible in proximity to the proposed scheme or of taller construction plant, there will be no significant effects on LLCA1, LLCA2 or LLCA3 for all route options during construction.

Common residual significance of effects on landscape receptors during construction are likely to be:

- Moderate adverse (significant) on LLCA4 Cookstown Settled Farmland
- Slight adverse on LLCA5 Heavily Managed Recreation.
- Major adverse (significant) on LLCA6 Rural River Corridor
- Major adverse (significant) on the Ballinderry River LLPA1
- Moderate adverse (significant) on the Killymoon Historic Park, Garden and Demesne

Visual

- Likely Moderate to Major adverse residual significant effects on four residential properties on Tullywiggan Road (Viewpoint (VP) 4);
- Mid distant appreciation of construction activity from Cabin Wood Woodland Walk (VP5). Effects are anticipated to be no more than Slight adverse (non-significant);
- Likely Moderate to Major adverse residual significant effects on 15 residential properties and businesses along Castle Road (VP6) as a result of highly visible construction activity through the Ballinderry River valley and crossing Castle Road with loss of mature vegetation;
- Likely Moderate to Major adverse residual significant effects on 16 residential properties within Castle Villas and Killymoon Road (VP7) due to construction activity and plant associated with large cutting formation through the drumlin landform immediately to the east; and
- Likely Moderate to Major adverse residual significant effects for users of Killymoon golf course (VP8) as a result of severance of the golf course and clearance of prominent trees on the north western boundary of the golf course.

Sandholes Link Road

Landscape

The implementation of the Sandholes Link Road would result in a minor alteration on the relationship or perception between key components of residential development, existing road corridor and industrial development which determine the existing landscape character within the south western extents of Cookstown (LLCA7). The impact during construction would be common to all options and the effects are anticipated to be no more the Slight adverse (non-significant) in the context of an existing urban environment.

Visual

Impacts would be primarily related to the construction stage and would involve disturbance for residents adjoining the existing road. Views to construction from residential properties adjacent to Sandholes Road and Drum Road (VP2 and VP3) would be set within the context of an existing busy road with surrounding detracting commercial buildings. Residual effects are anticipated to be no more than Slight adverse (non-significant) for the majority of receptors.

Two residential properties at the southern end of Sandholes Road (VP1), contained by surrounding business units, are likely to be subject to Moderate adverse (significant) effects as a result of construction of the short length of offline alignment and the roundabout junction adjacent to their front gardens.

The following summaries outline construction impacts specific to each route option and are additional to the above common impacts and consequential effects:

Red route

Landscape

To the north of the Killymoon golf course the Red route follows a more westerly alignment than the other route options with construction in closer proximity to the residential edge of Cookstown. A slight loss or damage to the perception of the broader landscape of LLCA4 is likely (Ch1350-1700 m).

In between Cloghog Road and Old Coagh Road, Red route construction activity would initially be perceived within LLCA3 Cookstown Urban Fringe adjacent to the pork factory, then would be well contained between two drumlins. However, construction of the elevated section of road would introduce a noticeable change through hedgerow loss and formation of engineered earthworks in proximity to the rolling drumlin landforms within LLCA4. Approaching Old Coagh Road construction activity related to the bridging of the local road and formation of tall earthworks are likely to introduce noticeable uncharacteristic features and damage on the perception of the rolling Cookstown farmland (Ch1700-2700 m).

North of The Dales, construction is anticipated to be prominent to the west of Inverton House on the eastern slopes of a large drumlin landform and include the formation of a large cutting and mature tree loss resulting in a change to the local skyline profile. Construction of earthworks would be noticeable through the low-lying local valley together with vegetation clearance to accommodate a new, large roundabout junction tying into the A29. This is likely to introduce a noticeable change on the perception of local landform and pattern of the Cookstown farmlands in proximity to the existing A29 corridor through the loss of prominent roadside mature trees on either side of the A29 (Ch2700-3550 m).

The significance of effects during construction on Landscape receptors that are additional to the common effects of all route options are likely to be:

- Slight adverse effect (non-significant) on LLCA3 Cookstown Urban Fringe.

Visual

The sensitive visual receptors which would be subject to significant visual effects during construction comprise:

- A group of 10 residential properties on Golf View (VP9) with near distance views onto construction through Killymoon golf course. Effects are anticipated to be Major adverse;
- A group of five residential properties on the western side of Festival Park (VP11). Views would comprise construction activity and vegetation clearance in close proximity, and through pastoral

fields to the west, including a roundabout junction tie in with Cloghog Road. Effects are anticipated to be Major adverse.

- Four Scattered residential properties on Coagh Road (VP13). Views would comprise highly visible construction activity associated with the elevated Red route on tall embankments to the north and south of Coagh Road. Effects are anticipated to be Moderate to Major adverse.
- A group of three residential properties on Old Coagh Road (VP14). The elevated Red route bridging the Old Coagh Road would be particularly intrusive in relation to these receptors. Effects are anticipated to be Moderate to Major adverse.
- Eight residential properties on the edge of The Dales (VP15). Construction activity highly visible through adjacent fields including overgrown hedgerow removal. Effects are anticipated to be Moderate to Major adverse.
- Nine Residential properties adjacent to or off the existing A29 (VP16). Inverton House would experience intrusive views as a result of adjacent construction and formation of large cutting slopes, mature tree loss and views to a large footprint of construction activity and vegetation loss through foreground fields and the roundabout junction on the A29. Effects are anticipated to be Moderate to Major adverse.

Purple A route

Landscape

To the north of the Killymoon golf course the Purple A route (together with the Purple B route and Green route) follows a more eastern alignment than the Red route, extending further into the settled farmland landscape (LLCA4). Construction activity would extend into a more rural environment and would include substantial loss of hedgerows and hedgerow trees. The deep cutting to the north of Cloghog Road would require a large construction footprint and would disrupt the locally prominent and important drumlin landforms and would likely introduce a highly noticeable change (Ch1350-2400 m).

Construction activity associated with the elevated alignment as it bridges Coagh Road and Old Coagh Road would temporarily change the perception of the rolling farmland landscape (Ch2400-3500 m).

It is expected that there will be no material difference to the effects that are common to all route options (as identified in Section 6.4.3.3) during construction on the landscape receptors listed above as a result of the Purple A route.

Visual

The sensitive visual receptors which would be subject to significant visual effects during construction comprise:

- A group of 10 residential properties on Golf View (VP9) as described above for the Red route. Effects are anticipated to be Major adverse.
- A group of six residential properties on the eastern side of Festival Park (VP11). Views would comprise vegetation clearance and construction activity in close proximity across pastoral fields to the south and east. Effects are anticipated to be Moderate to Major adverse.
- Three residential properties on Cloghog Road (VP12) as a result of construction activity associated with the roundabout tie in to Cloghog Road, and vegetation clearance opening views to construction. Effects are anticipated to be Moderate to Major adverse.
- Four scattered residential properties off Coagh Road (VP13). Views would comprise highly visible construction activity associated with formation of the elevated Purple A route. Effects are anticipated to be Moderate to Major adverse.

- Four scattered residential properties on Old Coagh Road (VP14). The elevated Purple A route crossing the Old Coagh Road and local valley on embankment would be particularly intrusive in relation to one low lying bungalow adjacent to the Purple A route extents. Effects are anticipated to be Major adverse.
- Nine residential properties adjacent to or off the existing A29 (VP16). Inverton House would experience particularly intrusive views as a result of adjacent construction and formation of large cutting slopes, mature tree loss and views to a large footprint of construction activity and vegetation loss in the foreground fields and the roundabout junction tie in to the A29. Effects are anticipated to be Moderate to Major adverse.

Purple B route

Landscape

Impacts on landscape character associated with the Purple B route would be the same as those described for the Purple A route between the Loughry roundabout and the disused railway line (Ch0-3300 m).

To the north of the disused railway (Ch3300 m), the route follows a more easterly alignment than all other route options, on embankment before crossing the crest of a drumlin in cutting and turning north to tie into the A29 Moneymore Road at a large roundabout junction. Construction activity would be a prominent new feature within the farmed local valley. The impact on the pattern, landform and landcover of the local landscape is likely to represent a noticeable change (Ch3300-4400 m).

It is expected that there will be no material difference to the effects common to all route options (as identified in Section 6.4.3.3) during construction on the landscape receptors listed above as a result of the Purple B route.

Visual

The sensitive visual receptors which would be subject to significant visual effects during construction are the same between the Loughry roundabout and the disused railway line (Ch0-3300 m). To the north of the disused railway line (Ch3300-4400 m) those receptors specific to the Purple B route comprise:

- Two residential properties on Lismoney Road (VP17). Impacts would be associated with construction activity and vegetation clearance through fields to the west and the formation of a long length of the road on tall earthworks. Effects are anticipated to be Moderate to Major adverse.
- Three individual residential properties at elevated positions overlooking the existing A29 corridor and surrounding farmland (VP16). Impacts would be associated with construction of the elevated alignment on tall earthworks and the roundabout junction tie in to the A29 with a large construction footprint within their field of view. Effects are anticipated to be Moderate to Major adverse.

Green route

Landscape

Impacts on landscape character associated with the Green route are broadly the same as the Purple A route between the Loughry roundabout (Ch0 m) and Castle Road (Ch600 m).

On approaching The Castle Road underpass from the south (Ch600-1100 m) there will be a large construction footprint with the creation of a deep cutting and Castle Road tie in works extending to the east and west. This will represent a highly noticeable change in landform and landcover to the north and south of Castle Road and prominent construction activity from the Ballinderry River valley.

To the north of Ch2200 m the Green route follows a slightly more westerly alignment than the Purple A route up until the roundabout tie in with the A29 Moneymore Road. To the north of Old Coagh Road there would be mature vegetation loss on field boundaries due to the creation of the Green route on tall embankment slopes as well as a large construction footprint in order to cross over the disused railway.

The impacts of construction activity from Ch3200 m will be similar to the impacts associated with the Purple A route up to the tie in with the A29 Moneymore Road.

It is expected that there will be no material difference to the effects common to all route options (as identified in Section 6.4.3.3) during construction on the landscape receptors listed above as a result of the Green route.

Visual

The sensitive visual receptors which would be subject to significant visual effects during construction are predominantly the same as for the Purple A route. Those receptors where impacts and the consequential effects are likely to differ comprise:

- A group of eight residential properties on Golf View (VP9) with near distant views onto construction through Killymoon golf course. Effects are anticipated to be Major adverse;
- A group of three properties off Coagh Road (VP13) and to the east of the Green Route where it deviates west from the Purple A alignment (Ch2200-2800 m) are likely to be subject to Moderate adverse effects.
- A group of three properties off Coagh Road and to the west of the Green route (VP13) are likely to be subject to Major adverse effects.
- A group of properties off Old Coagh Road (VP14). One low lying detached bungalow and three other properties will have awareness of construction through hill to the west. Effects are anticipated to be Minor adverse. Nine residential properties adjacent to or off the existing A29 (VP16). Inverton House would experience particularly intrusive views as a result of adjacent construction and formation of large cutting slopes, mature tree loss and views to a large footprint of construction activity and vegetation loss in the foreground fields and the roundabout junction tie in to the A29. Effects are anticipated to be Moderate to Major adverse.

6.4.3.3. Operation

Any predicted effect ratings noted below are the worst-case scenario and may reduce as a result of the mitigation planting establishing (refer to Section 6.4.4.1 for mitigation measures) and integrating the proposed scheme into the local landscape.

All routes

The below impacts and consequential effects are common to all four route options. Impacts from Sandholes Link Road, which are common to all route options, have been considered separately below under the Sandholes Link Road heading.

Landscape

- The operation of all four route options would introduce permanent adverse effects on the following LLCA's:

  LLCA4 Cookstown Settled Farmland;
  LLCA5 Heavily Managed Recreation; and
  LLCA6 Rural River Corridor.

The proposed scheme would be perceived outside or on the edge of LLCA1, LLCA2 and LLCA3 and would not directly impact any highly sensitive features of those landscapes or result in significant effects.

The impacts below are common to all four route options:

- Between the southern Loughry roundabout connection (Ch0 m) and Castle Road (Ch800 m) impacts would be similar through the highly sensitive Ballinderry River valley (LLCA6) and Ballinderry River LLPA1 (Ch150-250 m). These impacts would relate to the introduction of a highly visible road corridor through the river valley, and a noticeable change in vegetation cover. The magnitude of effect would not differ between the four route options and the perception and character of the local river valley is likely to be permanently damaged resulting in a significant effect. The inclusion of linear belts of mitigation planting would help to integrate the proposed scheme within the valley in the long term.
- Impacts between Castle Road and Killymoon golf course (within LLCA4) (Ch800-1150 m) would not differ substantially between the four route options despite the Red route being set marginally further east from the urban edge of Cookstown. The deep cutting required for all four route options would alter the hill profile and the engineered slopes would be visible from the south. The loss and change to existing features would be noticeable and result in significant effects, although there would be the opportunity to introduce mitigation planting to reduce the long-term impacts.
- Localised significant effects are likely for all four route options within LLCA5 through the Killymoon golf course, Killymoon Historic Park, Garden and Demesne and the Ballinderry River LLPA1 (Ch1150-1350 m). On the western limits of the designations and in deep cutting, the proposed scheme would be highly visible and the change to the vegetation cover along Killymoon Road would represent a noticeable change within a landscape of high value. This would constitute a locally substantial impact on the local composition of landform and parkland-styled landscape associated with the golf course and result in a significant effect.
- There will be no significant effects on LLCA1, LLCA2 or LLCA3 for all route options during operation.

Common effects on landscape receptors during operation are likely to be:

- Moderate adverse effect (significant) on LLCA4;
- Slight adverse (non-significant) on LLCA5;
- Moderate adverse effect (significant) on LLCA6;
- Moderate adverse effect (significant) on the Ballinderry River LLPA1; and
- Moderate adverse (significant) on the Killymoon Historic Park, Garden and Demesne.

Visual

The below likely effects are common to all four route options:

- Likely Moderate to Major adverse effects (significant) on residential properties on Tullywiggan Road (VP4);
- Mid distant appreciation of new road corridor from Cabin Wood Woodland Walk (VP5). Effects are anticipated to be no more than Slight adverse (non-significant);
- Likely Moderate to Major adverse effects (significant) on residential properties and businesses along Castle Road (VP6) as a result of highly visible new road corridor through the Ballinderry River valley; and
- Likely Moderate adverse effects (significant) for users of Killymoon golf course (VP8) as a result of severance of the golf course and clearance of prominent trees on the boundary. There is a minor alignment difference between the route options although resulting impacts would be similar.

Sandholes Link Road

Landscape

During operation, effects associated with the Sandholes Link Road would be negligible and represent a very minor loss or alteration to the existing townscape character. Impacts would be common to all route options and the changes would not be significant in the long term due to the context of an existing urban environment. The significance of effects is anticipated to be Neutral on LLCA7.

Visual

During operation, the majority of effects associated with the Sandholes Link Road would be negligible, and while changes would be perceptible the elements within the existing view would not substantially change and they would still be overlooking a local road. Impacts would be common to all route options and the changes would not be significant in the long term. The significance of effect is anticipated to be no more than Slight adverse (non-significant).

Two residential properties at the southern end of Sandholes Road, contained by surrounding business units, are likely to be subject to Slight adverse (non-significant) effects as a result of the short length of offline alignment and the roundabout junction in close proximity.

The following summaries outline operational impacts specific to each route option and additional to the above common impacts and consequential effects:

Red route

Landscape

The following landscape impacts have been identified as likely to arise as a result of the Red route:

- A total of approximately 20 hedgerows would be truncated by the route and a substantial number of mature hedgerow trees and four significant areas of woodland would be directly impacted;
- The route would cross six local tree lined watercourses resulting in noticeable changes to the existing landscape pattern;
- Changes to the profile of local drumlin form adjacent to Inverton House; and
- Substantial mature vegetation loss on the A29 and a large permanent footprint for the roundabout junction.

To the north of the Killymoon golf course the Red route follows a more westerly alignment than the other three route options, in closer proximity to the residential edge of Cookstown. The route is on low embankment as it crosses the Cloghog Road west of Festival Park and would be a noticeable new feature, although in closer association to the town than the other three route options (Ch1350-1700 m).

North of Cloghog Road the proposed scheme would be relatively contained between two drumlins although it would introduce a noticeable change in proximity to the rolling drumlin landforms perceptible from local roads within LLCA4. The long section of elevated new road, including two local road crossings over Coagh Road and Old Coagh Road, is likely to introduce a noticeable change on the perception, pattern and landform of the rolling Cookstown farmland. There would be the opportunity to reconnect field boundary hedgerows and introduce belts of woodland on embankments, however the proposed scheme would remain a highly visible new man-made feature uncharacteristic with the rolling drumlin farmland (Ch1700-2700 m).

North of The Dales the deep cutting to the west of Inverton House would noticeably damage the profile of the eastern slopes of the landform and result in the loss of a stand of mature trees on higher ground, modifying the profile of the immediate skyline. Emerging out of the cutting to the north the route would cross a local valley on low embankment and on a gentle curve to the north, tying into the A29 Moneymore Road at a new, large roundabout junction. This is likely to introduce a locally noticeable change on the perception of local landcover and pattern of the Cookstown farmlands in the vicinity of the existing A29 corridor, although mitigation planting would be introduced around the roundabout and severed hedgerows reconnected where possible to integrate the junction into the local landscape in the long term (Ch2700-3550 m).

The significance of effects during construction on Landscape receptors that are additional to the common effects of all route options are likely to be:

- Neutral effect on LLCA3 Cookstown Urban Fringe.

Visual

The principal sensitive visual receptors which would be subject to significant visual effects during operation comprise:

- A group of 10 residential properties on Golf View (VP9). Effects are anticipated to be Major adverse (significant);
- A group of five residential properties on the western side of Festival Park (VP11). Impacts would comprise open views to the new road and roundabout in close proximity, interrupting their existing rural view. Effects are anticipated to be Moderate to Major adverse (significant);
- Four scattered residential properties on Coagh Road (VP13). Impacts would comprise a new elevated road in close proximity interrupting views to surrounding farmland to the north and south of Coagh Road. Effects are anticipated to be Moderate to Major adverse (significant);
- A group of three residential properties on Old Coagh Road (VP14). The elevated Red route bridging the Old Coagh Road would be particularly intrusive in relation to these receptors. Established mitigation planting would soften the appearance of embankments and filter views to traffic in the long term, but the new road would still be a noticeable new feature within a rural view. Effects are anticipated to be Moderate to Major adverse (significant);

- Eight residential properties on the edge of The Dales (VP15). Views to the elevated route in close proximity in fields to the east. Effects are anticipated to be Moderate to Major adverse (significant); and
- Nine residential properties adjacent to or off the existing A29 (VP16). Inverton House would experience particularly intrusive views as a result of the adjacent new road, tree loss and disruption to the distinctive drumlin form. There would also be open views to the large roundabout junction on the A29. Effects are anticipated to be Moderate to Major adverse (significant).

Purple A route

Landscape

The following landscape impacts have been identified as likely to arise as a result of the Purple A route:

- A total of approximately 27 hedgerows would be truncated by the route along with a substantial number of mature hedgerow trees;
- Two significant areas of woodland would be directly impacted; and
- The route would cross seven local tree lined watercourses resulting in noticeable changes to the existing landscape pattern.

Substantial cutting slopes to the north of Cloghog Road within LLCA4 (Ch1900-2400 m) would alter the profile of locally prominent and important drumlin landforms and noticeably change the landcover and land use, introducing a new linear feature into the rolling farmland.

There would be a noticeable change as a result of the elevated alignment as it bridges Coagh Road, Old Coagh Road and the dismantled railway (Ch2400-3500 m) with the highly visible new road on embankment impacting the perception and pattern of the rolling farmland landscape. The engineered earthworks would stand out as a significant new feature within the localised valleys created by the drumlin forms.

It is expected that there will be no material difference to the effects common to all route options (as identified in Section 6.4.3.3) during operation on the landscape receptors listed above as a result of the Purple A route.

Visual

The sensitive visual receptors which would be subject to significant visual effects during operation comprise:

- A group of 10 residential properties on Golf View (VP9). Substantial impacts would be associated with a noticeable change in their outlook across the golf course and a substantial loss of vegetation within the field of view. Effects are anticipated to be Major adverse (significant);
- A group of six residential properties on the eastern side of Festival Park (VP11). Views would comprise a new road in closer proximity than the Red route, within a rural outlook and resulting in a noticeable change through pastoral fields to the south and east. Effects are anticipated to be Moderate to Major adverse (significant);
- Three residential properties on Cloghog Road and Clare Lane (VP12). Impacts would be associated with the roundabout junction with Cloghog Road, and vegetation clearance opening further views to the new road and roundabout. Effects are anticipated to be Moderate to Major adverse (significant);

- Four scattered residential properties on Coagh Road (VP13). Views would comprise a highly visible new road with the elevated Purple A route bridging Old Coagh Road and local valley on embankment. This would be particularly intrusive in relation to one low lying bungalow adjacent to the route alignment. Effects are anticipated to be Moderate to Major adverse (significant);
- Four scattered residential properties on Old Coagh Road (VP14). Effects are anticipated to range from Moderate to Major adverse (significant); and
- Nine residential properties adjacent to or off the existing A29 (VP16). Effects are anticipated to be Moderate to Major adverse (significant).

Purple B route

Landscape

The following landscape impacts have been identified as likely to arise as a result of the Purple B route:

- A total of approximately 29 hedgerows would be truncated by the route along with a substantial number of mature hedgerow trees;
- Two significant areas of woodland would be directly impacted; and
- The Purple B route would cross seven local tree lined watercourses resulting in noticeable changes to the existing landscape pattern.

Impacts on landscape character associated with the Purple B route would be the same as those described for the Purple A route between the Loughry roundabout and Old Coagh Road (Ch0-3500 m) during operation.

On crossing the disused railway beyond Ch3500 m, the route follows a more easterly alignment than the Purple A route and Green route on embankment before crossing the crest of a drumlin and turning north to tie into the A29 Moneymore Road via a large roundabout junction. This would represent a prominent new feature within the farmland that would conflict with and be uncharacteristic within the existing valley form. The noticeable new man-made elements would impact on the pattern, landform and landcover of the local landscape (Ch3500-40000 m).

It is expected that there will be no material difference to the effects common to all route options (as identified in Section 6.4.3.3) during operation on the landscape receptors listed above as a result of the Purple B route.

Visual

The sensitive visual receptors which would be subject to significant visual impacts during operation are predominantly the same as for the Purple A route. To the north of Old Coagh Road those receptors specific to the Purple B route comprise:

- Two residential properties off Lismoney Road (VP17). Impacts would be associated with mid-distant views to a long length of elevated road and a noticeable loss of vegetation. Mitigation through planting of belts of trees and shrubs would integrate the road within the view but it would remain visible. Effects are anticipated to be Moderate to Major adverse (significant); and
- Three individual residential properties at elevated positions overlooking the existing A29 corridor (VP16) and surrounding farmland. Impacts would be associated with views to a long section of elevated road on embankment through fields to the south and a roundabout junction with the A29. Effects are anticipated to be Moderate (significant).

Green route

Landscape

The following landscape impacts have been identified as likely to arise as a result of the Green route:

- A total of approximately 27 hedgerows would be truncated by the route along with a substantial number of mature hedgerow trees;
- Two significant areas of woodland would be directly impacted; and
- The route would cross seven local tree lined watercourses resulting in noticeable changes to the existing landscape pattern.

Impacts on landscape character associated with the Green route would broadly be the same as those described for the Purple A route during operation and locations where the magnitude of effect is likely to differ are outlined below:

- The Green route passes underneath Castle Road in deep cutting (Ch600-1000 m), substantially altering the profile of a locally prominent landform within LLCA4 which would be highly visible from within the Ballinderry River valley and urban edge of Cookstown, and result in a highly noticeable change in tree cover along Castle Road.

It is expected that there will be no material difference to the effects common to all route options (as identified in Section 6.4.3.3) during operation on the landscape receptors listed above as a result of the Green route.

Visual

The sensitive visual receptors which would be subject to significant visual effects during operation are predominantly the same as for the Purple A route. Those receptors where impacts are likely to differ comprise:

- Two residential properties on Castle Road and one detached property adjacent and immediately west of the alignment would be subject to open views to the proposed scheme and mature tree loss on the property boundary opening up views to the south east, along the line of the Green route. Effects are anticipated to be Major adverse;
- A group of eight residential properties on Golf View (VP9) with near distant views towards the Green route, passing through Killymoon golf course. Effects are anticipated to be Moderate adverse;
- A group of three properties off Coagh Road and to the east of the Green route (VP13) where it deviates west from the Purple A alignment (Ch2200-2800 m), are likely to be subject to Moderate adverse effects;
- A group of three properties off Coagh Road and to the west of the Green route (VP13) are likely to be subject to Major adverse effects; and
- A group of four properties off Old Coagh Road (VP14). One low lying detached bungalow and three other detached properties would have awareness of the alignment to the west. Effects are anticipated to be Minor adverse.

6.4.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

Any predicted significance of effect ratings noted below are the worst-case scenario and may reduce as a result of the mitigation planting establishing (refer to Section 6.4.4 for mitigation measures) and integrating the proposed scheme into the local landscape.

All route options

Common impacts resulting from all four route options can be summarised as:

Policy and Legislation

- Proposed landscaping designed with biodiversity in mind to align with SPPS policy regarding the restoration of and halting the loss of biodiversity and The Wildlife and Natural Environment Act (Northern Ireland) 2011;
- Careful mitigation within Killymoon Historic Park, Garden and Demesne and Ballinderry River LLPA1 to ensure compliance with The Wildlife and Natural Environment Act (Northern Ireland) 2011 and the SPPS over time;
- The proposed scheme would conflict with Policy CON 2 of the Cookstown Area Plan 2010 relating to the protection of LLPAs;
- The proposed scheme would conflict with Policy CON 6 relating to Killymoon Castle Historic Park, Garden and Demesne; and
- The proposed scheme would conflict with Policy AGRI 1 relating to community woodland.

Landscape

- Major adverse effect (significant) on LLCA6, Moderate adverse (significant) on LLCA4 and slight adverse on LLCA5 during construction.
- Moderate adverse effect (significant) on LLCA4 and on LLCA6 and slight adverse on LLCA5 during operation.
- Neutral effect on LLCA7 Urban River Corridor for all route options.
- Effects anticipated to be Major adverse (significant) on the Ballinderry River LLPA1 during construction and Moderate adverse during operation;
- Effects anticipated to be Moderate adverse (significant) on the Killymoon Castle Historic Park, Garden and Demesne during both construction and operation;
- Impacts on the relationship between the existing landscape fabric between the town and the Killymoon golf course;
- The introduction of a new road through farmland to the east of Cookstown (LLCA4), valued by local residents, would result in impacts on the perception, pattern, landcover and landform of that landscape;
- Whilst all route options would involve points of significant local landscape effects, all could be appropriately integrated within the urban and rural context, to a large degree, through a carefully considered mitigation strategy (see Section 6.4.4.1). Although the residual effect is likely to reduce in the long term as mitigation planting matures and the proposed scheme becomes more integrated into the local landscape, it is likely that significant effects will remain on LLCA4 and LLCA6 by the design year (year 15); and
- Whilst construction activity may be perceptible in proximity to the proposed scheme or of taller construction plant, there will be no significant effects on LLCA1, LLCA2 or LLCA3 for all route options during construction or operation.

Visual

- Likely Moderate to Major adverse effects (significant) are anticipated to residential properties on Tullywiggan Road (VP4);
- Mid distant appreciation of new road corridor from Cabin Wood Woodland Walk (VP5). Effects are anticipated to be no more than Slight adverse (non-significant);

- Likely Moderate to Major adverse effects (significant) are anticipated to residential properties and businesses along Castle Road (VP6);
- Likely Moderate effects (significant) are anticipated for users of Killymoon golf course (VP8). There is a minor alignment difference between the four route options although residual effects would be similar;
- Visual impacts between the Loughry roundabout and the northern boundary of Killymoon golf course (Ch0-1900 m); and
- The introduction of a new road through a rural landscape, distinctive drumlin forms and running across the existing pattern of radial local roads extending to the east of the town; and
- All route options would involve points of significant local visual effects, all could be appropriately integrated in the urban and rural context through a carefully considered mitigation strategy (see Section 6.4.4.1).

The principal differences between the four route options are summarised below:

Red route

Policy and Legislation

- The development of any of the route options within Green Belt land may be in contradiction of policy GB/CPA 2 of the Planning Strategy Rural NI. The Red route would have slightly less of a direct impact on the Green Belt, due to a lower permanent land take within designated land.

Landscape

- The Red route is the only route that would result in adverse effects (non-significant) on LLCA2 Cookstown Suburbs during construction;
- The Red route constitutes an option which, whilst initially located within the agricultural landscape east of the town, would become an integral part of the urban fabric as areas of future housing and industrial/mixed business use are developed, as envisaged in the Cookstown Area Plan 2010. As such, the section of the Red route between the northern boundary of the Killymoon golf course and the A29 (Ch1350-3550 m) would become a component which would be marginally more in keeping with the urban context to the east of Cookstown when compared to the other three route options, resulting in a marginally lower order of effect during construction and operation; and
- While the Purple A route and Green route tie into the A29 at the same location, the footprint of the Red route roundabout and slip roads would be greater and would result in marginally greater hedgerow and roadside tree loss compared to the Purple A route and Green route (Ch2700-3550 m).

Visual

- The Red route would adversely affect the largest number of receptors whilst the other three route options would impact approximately 20% fewer receptors. The quantity of receptors subject to a significant effect is anticipated to be similar to the Purple A route and marginally greater than the Purple B route and Green route;
- The Red route would be a slightly more easterly alignment, further away from residential receptors through Killymoon golf course, effects during construction are expected to be similar and substantial for all route options and anticipated to be Major adverse (significant);
- For properties on Golf view (VP9) the magnitude of effect would be marginally lower with the Red route than the Purple A route and Purple B route by virtue of the greater distance between the receptors and the more easterly alignment of the Red route through the golf course. There is also

greater opportunity to introduce mitigation measures in order to reduce the impacts. The Green route offers the opportunity to retain some screening vegetation and is likely to impact less receptors here than the Red route, although the magnitude of effect will be the same on the remaining receptors; and

- The Red route would not come into as close proximity as the other three route options to a group of five residential properties on the western side of Festival Park (VP11) resulting in effects anticipated to be of a lower order on the residential receptors.

Purple A route

Policy and Legislation

- The Purple A route would have a marginally greater direct impact on the Green Belt than the Red route, due to a greater permanent land take in designated land. The Purple A route would have broadly the same impact as the Purple B route and Green route.

Landscape

- Greater likelihood of locally significant effects within LLCA4 Cookstown Farmlands compared to the Red route as a result of the route being introduced in a marginally more rural context and effects anticipated to be in the higher order of Moderate adverse (significant) during construction. Impacts within LLCA4 would be broadly the same as the Purple B route and Green route;
- The Purple A route is expected to have a marginally higher order of moderate adverse residual effect than the Red route during operation on LLCA4 due to being set further into the Cookstown Settled Farmland landscape;
- The Purple A route, together with the Purple B route and Green route, would include a substantial loss of hedgerow and hedgerow trees as well as substantial cutting slopes to the north of Cloghog Road within LLCA4 (Ch1900-2400 m); and
- To the north of Old Coagh Road the Purple A route diverts west from the Purple B route to connect with the A29 at the same point as the Red route and Green route with similar associated impacts (Ch3500-39950 m).

Visual

- Approximately 20% fewer residential receptors would be subject to visual impacts in comparison to the Red route although a similar number subject to a significant effect anticipated. The quantity of receptors subject to a significant effect is anticipated to be more than that expected for the Purple B route and Green route;
- Marginally greater magnitude of effect anticipated for the Purple A route and Purple B route for properties on Golf view (VP9) than the Red route and Green route and lower capacity to introduce mitigation measures in order to reduce the effects; and
- A similar number of residential receptors, north of Old Coagh Road (VP16), are anticipated to be subject to significant effects compared to the other three route options.

Purple B route

Policy and Legislation

- The Purple B route is expected to have a marginally greater direct impact on Green Belt designated land than the Red route, due to a greater permanent land take in designated land. The Purple B route is expected to have broadly the same impact as the Purple A route and Green route.

Landscape

- The Purple B route is expected to have greater likelihood of locally significant effects within LLCA4 Cookstown Farmlands compared to the Red route as a result of the route being introduced in a marginally more rural context and effects anticipated to be in the higher order of Moderate adverse. Impacts within LLCA4 would be broadly the same as the Purple A route and Green route;
- The Purple B route is expected to have a marginally higher order of moderate adverse residual effect than the Red route during operation on LLCA4 due to being set further into the Cookstown Settled Farmland landscape;
- The Purple B route, together with the Purple A route and Green route, would include a noticeable loss of hedgerow and hedgerow trees as well as substantial cutting slopes to the north of Cloghog Road within LLCA4 (Ch1900-2400 m); and
- The alignment of the Purple B route across the western slopes of the Lissan Valley to the north of Old Coagh Road (Ch3500-4000 m) would be locally more detrimental to the local landscape than the alignment of the other three route options, lying within the drumlins to the west of the valley and over a slightly longer distance.

Visual

- There are approximately 20% fewer residential receptors are anticipated to be subject to visual impacts than the Red route and marginally fewer anticipated to be subject to significant visual effects than the other three route options;
- There are marginally greater magnitude of effects anticipated to properties on Golf view (VP9) than the Red route and Green route and lower capacity to introduce mitigation measures in order to reduce the impacts; and
- A similar number of residential receptors north of Old Coagh Road (VP16) are anticipated to be subject to significant effects to the other three route options.
- Inverton House would not be subject to significant effects with the Purple B route being less visually intrusive than the other three route options.

Green route

Policy and Legislation

- The Green route would have a marginally greater direct impact upon the Green Belt than the Red route, due to a greater permanent land take in designated land with broadly the same impact as the Purple A route and Purple B route.

Landscape

- The Green route is expected to have a greater likelihood of locally significant effects within LLCA4 Cookstown Farmlands during construction compared to all other route options as a result of the vertical alignment and subsequently larger earthworks, notably when passing beneath Castle Road and crossing over the disused railway;
- The Green route is expected to have a marginally higher order of moderate adverse residual effect than the Red route during operation on LLCA4 due to being set further into the Cookstown Settled Farmland landscape;
- The Castle Road underpass (Ch600-1100 m) would involve a larger footprint than the other three route options, comprising a deep cutting as well as Castle Road tie in works extending to the east and west. This will represent a marginally larger scheme footprint and a more noticeable change

in landform and landcover to the north and south of Castle Road and a slightly more noticeable extent of vegetation clearance in comparison to the other three route options. Effects are anticipated to be in the higher order of Moderate adverse (significant);

- The Green route, together with the Purple A route and Purple B route, would include a noticeable loss of hedgerow and hedgerow trees as well as substantial cutting slopes between Cloghog Road and Old Coagh Road within LLCA4 (Ch1900-2400 m); and
- To the north of Ch2200 m the Green route follows a slightly more westerly alignment than the Purple A route, as far north as the roundabout tie in with the A29 Moneymore Road. The impacts of construction activity on the local landscape would be similar to both Purple routes between Ch2200 m and Old Coagh Road (Ch2850 m), to the north of which there would be marginally more mature vegetation loss as a result of the Green route which has a greater construction footprint due to taller embankment slopes crossing the disused railway.

Visual

- There are approximately 20% fewer residential receptors that would be subject to visual impacts in comparison to the Red route although a similar number subject to a significant effect anticipated and marginally more significantly affected than the Purple B route;
- The Green route is expected to have a marginally lower order of effects, and impact a fewer number of receptors on Golf view (VP9) than for the other three route options due to the potential for tree retention in the existing block of woodland on the boundary of the Killymoon golf course, and for the higher capacity to introduce mitigation measures in order to reduce the effects. However, despite these marginal differences, the significance of effect is anticipated to be the comparable to the other route options;
- Two residential properties on Castle Road are likely to be subject to a marginally higher magnitude of effect than for all other route options due to the larger footprint of the Green route in deep cutting passing underneath Castle Road. An additional detached property immediately west of the alignment would be subject to a greater impact and resulting effect than the other route options, due to open views onto the alignment and resulting mature tree loss on the property boundary opening views further;
- In relation to a group of three properties off Coagh Road (VP13) and to the east of the Green Route where it deviates west from the Purple A alignment (Ch2200-2800 m). Effects for two detached properties on Coagh Road and a farmhouse to the south of Coagh Road to the east of the Green route would be of a lower magnitude than for the Purple A route and Purple B route, with the alignment not in as close proximity to the view;
- A group of three properties off Coagh Road and to the west of the Green route (VP13) would have a marginally higher magnitude of effect in comparison to the Purple A route, due to the alignment being in closer proximity;
- The Green route is expected to have marginally lower impacts on residential receptors between Coagh Road and Old Coagh Road (VP13 & VP14) although the likelihood of significant effects would remain; and
- A group of properties off Old Coagh Road (VP14), comprising one low lying detached bungalow would have a substantially lower impact when compared to the Purple A route and Purple B route. A further three other properties would have lower impacts and resulting effects, with the Green route alignment lying slightly further west than the Purple A route and Purple B route.

Table 6-15 below provides a summary schedule of the receptors associated with each route option which would be potentially subject to material change.

Table 6-15 – Summary of sensitive receptors subject to change

Route Option	Visual receptors likely to be subject to change during either Construction or Operation	Visual receptors likely to be subject to a significant residual effect (worst-case) during either Construction or Operation (Moderate or above)	Landscape receptors impacted by the proposed route option	
			During Construction (worst-case) effects	During Operation (worst-case) effects (Opening Year)
Red route	254	73	LLCA1 - Neutral effect likely LLCA2 - Neutral effect likely LLCA3 – Slight adverse effects likely LLCA4 – Likely to be in the lower order of Moderate adverse (significant) LLCA5 – Moderate adverse (significant) effects likely LLCA6 – Major adverse (significant) effects likely LLCA7 - Neutral effect likely Ballinderry River LLPA1 – Local Major adverse (significant) effects likely Killymoon Castle Historic Park, Garden and Demesne – Local Moderate adverse significant effects likely	LLCA1 - Neutral effect likely LLCA2 - Neutral effect likely LLCA3 – Neutral effect likely LLCA4 – Likely to be in the lower order of Moderate adverse (significant) LLCA5 – Slight adverse (non-significant) effects likely LLCA6 – Moderate adverse (significant) effects likely LLCA7 - Neutral effect likely Ballinderry River LLPA1 – Local Moderate adverse (significant) effects likely Killymoon Castle Historic Park, Garden and Demesne – Local Slight adverse significant effects likely
Purple A route	147	73	LLCA2 - Neutral effect likely LLCA4 – Likely to be higher order of Moderate adverse (significant) LLCA5 – Moderate adverse (non-significant) effects likely LLCA6 – Major adverse (significant) effects likely LLCA7 - Neutral effect likely Ballinderry River LLPA1 – Local Major adverse (significant) effects likely Killymoon Castle Historic Park, Garden and Demesne – Local	LLCA2 - Neutral effect likely LLCA4 – Moderate adverse (significant) LLCA5 – Slight adverse (non-significant) effects likely LLCA6 – Moderate adverse (significant) effects likely LLCA7 - Neutral effect likely Ballinderry River LLPA1 – Local Moderate adverse (significant) effects likely Killymoon Castle Historic Park, Garden and Demesne – Local Slight

Route Option	Visual receptors likely to be subject to change during either Construction or Operation	Visual receptors likely to be subject to a significant residual effect (worst-case) during either Construction or Operation (Moderate or above)	Landscape receptors impacted by the proposed route option	
			During Construction (worst-case) effects	During Operation (worst-case) effects (Opening Year)
			Moderate adverse significant effects likely	adverse (significant) effects likely
Purple B route	157	69	LLCA2 - Neutral effect likely LLCA4 – Likely to be higher order of Moderate adverse (significant) LLCA5 – Moderate adverse (non-significant) effects likely LLCA6 – Major adverse (significant) effects likely LLCA7 - Neutral effect likely Ballinderry River LLPA1 – Local Major adverse (significant) effects likely Killymoon Castle Historic Park, Garden and Demesne – Local Moderate adverse significant effects likely	LLCA2 - Neutral effect likely LLCA4 – Moderate adverse (significant) LLCA5 – Slight adverse (non-significant) effects likely LLCA6 – Moderate adverse (significant) effects likely LLCA7 - Neutral effect likely Ballinderry River LLPA1 – Local Moderate adverse (significant) effects likely Killymoon Castle Historic Park, Garden and Demesne – Local Slight adverse (significant) effects likely
Green route	147	71	LLCA2 - Neutral effect likely LLCA4 – Likely to be higher order of Moderate adverse (significant) LLCA5 – Moderate (non-significant) effects likely LLCA6 – Major adverse (significant) effects likely LLCA7 - Neutral effect likely Ballinderry River LLPA1 – Local Major adverse (significant) effects likely Killymoon Castle Historic Park, Garden and Demesne – Local Moderate adverse significant effects likely	LLCA2 - Neutral effect likely LLCA4 – Likely to be higher order of Moderate adverse (significant) LLCA5 – Slight adverse (non-significant) effects likely LLCA6 – Moderate adverse (significant) effects likely LLCA7 - Neutral effect likely Ballinderry River LLPA1 – Local Moderate adverse (significant) effects likely Killymoon Castle Historic Park, Garden and Demesne – Local Slight adverse (significant) effects likely

Route Option	Visual receptors likely to be subject to change during either Construction or Operation	Visual receptors likely to be subject to a significant residual effect (worst-case) during either Construction or Operation (Moderate or above)	Landscape receptors impacted by the proposed route option	
			During Construction (worst-case) effects	During Operation (worst-case) effects (Opening Year)
Sandholes Link Road	32	2	LLCA7 – Slight adverse (non-significant) effects likely	LLCA7 – Likely to be No Change
Differentiator	The Red route has the highest number of visual receptors subject to change	Marginally higher degree of change on visual amenity from the Red and Purple A routes. Greater opportunity for mitigation of the Green route alignment to the east of Golf View (VP9) and likely to be fewer receptors subject to a significant effect.	Marginally higher degree of change on local landscape character from the Green route due to its marginally larger footprint and alignment passing underneath Castle Road in deep cutting.	Marginally higher degree of change on local landscape character from the Green route due to its marginally larger footprint and alignment passing underneath Castle Road in deep cutting.

6.4.4.1. Mitigation

At this stage of the design process mitigation measures have been considered at a broad level to outline an approach to be take forward into the detailed design stage. The broad principles that should be applied to the likely impacts of the proposed scheme during construction and operational phases are outlined in LA 104 and below:

- avoidance and prevention: design and mitigation measures to prevent the effect (e.g. alternative design options or avoidance of environmentally sensitive sites);
- reduction: where avoidance is not possible, then mitigation is used to lessen the magnitude or significance of effects; and
- remediation: where it is not possible to avoid or reduce a significant adverse effect, these are measures to offset the effect.

Environmental assessment shall report on the following categories of mitigation:

- embedded mitigation: project design principles adopted to avoid or prevent adverse environmental effects; and
- essential mitigation: measures required to reduce and if possible offset likely significant adverse environmental effects, in support of the reported significance of effects in the environmental assessment"

This could be achieved through more specific landscape related measures for the proposed scheme outlined below:

- Achieving best fit within the existing landform, to minimise the need for engineered embankments and cuttings;
- Consider opportunities for planting that would integrate the proposed scheme into the existing landscape framework whilst providing ecological opportunities;
- Identify hedgerows and field boundaries that would be affected by the proposals and that would require planting to restore local connectivity;
- Identify opportunities for site specific mitigation to provide screening of significant views e.g. the use of walls, environmental barriers, earth mounding;
- Identify requirements for additional land take to provide essential landscape integration planting or visual screening;
- Develop an approach to hard structures, surface finishes and treatments to better integrate the proposed scheme into the existing infrastructure framework. Careful consideration should be given to the proposed hard structures of proposed overbridges and roundabout junctions, particularly within the Ballinderry River valley;
- Mitigation within deep cutting slopes would generally not be required; however selective planting at the mouth of the cutting could reduce the awareness and scale of the landform;
- Integrating the proposed scheme into the existing landscape framework would involve extensive hedgerow planting within the proposed scheme extents in order to restore local connectivity and ecological corridors;
- Opportunities would also exist to incorporate remnant field corners, severed by the proposed scheme, or former boundaries into woodland blocks and/or new blocks of woodland to reduce the impact of the loss of associated woodland, provide specific screening to visual receptors, and reduce the effect of the scheme on the perception of landscape character;
- Where space allows, visual screen bunds would help to integrate the proposed scheme where in close proximity to residential properties and help to screen views of traffic and lower level road clutter. Visual screen fences should also be considered at all phases where space does not allow for planting or where an immediate screening function is required;
- In order to integrate the proposed scheme into the rolling drumlin landscape to the east of Cookstown, the possibility of softening engineered earthworks should be considered;
- A sensitive design approach should be considered for the earthworks through the Ballinderry River valley for all route options; and
- Identify potential locations to enhance and offset the loss of biodiversity.

Consideration of the appropriateness of mitigation measures should also be given for those views from sensitive receptors that are likely to change specifically as a result of mitigation (e.g. mitigation planting may screen an open rural view).

Broad mitigation treatments specific to each route option have been summarised as follows:

Red route

Although this is the shortest route it also has the highest number of visual receptors that would be subject to changes in their outlook and would potentially require more extensive mitigation planting to provide both visual screening and a landscape integration function.

For residents of Golf View (VP9), which is anticipated to be subject to a significant effect, the alignment offers the opportunity for marginally more effective mitigation solutions than the two Purple routes, due to the amount of land available, although mitigation measures may screen the existing open outlook across the golf course. The Green route however is the preferred alignment passing Golf View due to the potential to retain screening woodland vegetation.

The long length of embankment between Cloghog Road and The Dales (Ch2100-2850 m) and the deep cutting adjacent to Inverton House (Ch3050-3250 m) should be considered for a more sensitive design approach, potentially through additional land take in order to integrate the cutting slopes more effectively into the local landform.

Purple A route

The two Purple routes are similar in the way mitigation can be approached as they both pass through the Cookstown settled farmland landscape (LLCA4) to the north and east of the study area.

Extensive mitigation planting between Old Coagh Road and the A29 Moneymore Road would not sit well within the surrounding generally flat landscape and absence of existing woodland. Integrating the route into the existing landscape framework should involve appropriate slope profiling, and extensive hedgerow planting within the highway boundary in order to restore local connectivity and ecological corridors, resulting in reduced impacts on the existing landscape patterns.

Adjacent to Golf View the alignment of the two Purple routes would not allow sufficient space for a screen bund and the elevated road adjacent to properties would result in substantial and intrusive impacts regardless of mitigation measures.

The deep cutting slopes to the north of Cloghog Road would be prominent and modify the local drumlin forms (Ch1900-2400 m) and should be considered for a more sensitive design approach, through additional landtake in order to integrate the engineered earthworks more effectively into the local landform.

Purple B route

The only mitigation principle for the Purple B route where it differs to that of the Purple A route is outlined below:

The engineered earthworks through the local Lissan valley, to the north of Old Coagh Road (Ch3500-4000 m) would be prominently uncharacteristic of local landform. The location should be considered for a more sensitive design approach, through additional landtake in order to integrate the engineered earthworks more effectively into the local landform.

Green route

The only mitigation principle for the Green route where it differs to that of the Purple A route is outlined below:

Consideration should be given to the treatment of the Castle Road underpass and the design of the bridge, which will be visible from within the Ballinderry River valley (LLPA1).

For residents of Golf View (VP9), which is anticipated to be subject to a significant effect, the alignment potentially offers the opportunity for more effective mitigation solutions than the two Purple routes. There is also the potential to retain screening vegetation on the boundary of three properties on Golf View to the north of Killymoon golf course, due to the alignment being slightly further east than the other three route options.

Table 6-16 – Options Comparision

Parameter	Preferred Route Option	Least Preferred Route Option
Construction Landscape	Red (marginal)	Green (marginal)
Construction Visual	Purple B	Red / Purple A
Operational Landscape	Red	Green (marginal)
Operational Visual	Purple B	Red / Purple A
Mitigation Opportunities	Green	Purple B
Overall	**Red (marginal)**	**Green (marginal)**

6.5. BIODIVERSITY

6.5.1. ASSESSMENT SCOPE

This section presents the results of the DMRB Stage 2 appraisal[18] of the alternative route options of the proposed scheme (i.e. the Red route, Purple A route, Purple B route and Green route, as well as the Sandholes Link Road which is common to all four route options). It establishes the baseline conditions and potential impacts of each route option on both terrestrial and aquatic ecological receptors and considers designated sites, terrestrial and freshwater habitats, plants and fauna.

This DMRB Stage 2 Simple Assessment has been informed by desk study and preliminary field survey data. The field surveys for this assessment have focused on identifying priority and ecologically important habitats and the presence of, and potentially suitable habitat for legally protected and notable species of conservation concern. The information collected through the desk study and field surveys has been used to identify likely ecological impacts associated with the four route options, thereby allowing a preferred route to be identified from an ecological perspective which will inform the overall preferred route selection process. It has also been used to identify the requirement for specific surveys during the DMRB Stage 3 Assessment of the final selected route option.

6.5.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the biodiversity assessment are provided in Environmental Appendix B.

6.5.1.2. Study Area

A Preliminary Ecological Appraisal (PEA)[19] was undertaken in 2019 to establish the baseline ecological conditions and inform this Stage 2 Route Option Appraisal. A copy of the PEA Report,

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[18] The Highways Agency et al., (1993). Volume 5, Section 1, Part 2. Scheme Assessment Reporting TD 37/93. [online] Available at: https://www.standardsforhighways.co.uk/dmrb/search/80bdc2d9-be88-403d-a531-b3f7f6e90cff [Accessed 03/08/2020].

[19] Woodrow Sustainable Solution, (2019). Preliminary Ecological Appraisal for Proposed A29 Cookstown Bypass Scheme at Lands in Cookstown, Co. Tyrone. November 2019.

which was conducted in alignment with the methodologies described by the Chartered Institute of Ecology and Environmental Management (CIEEM)[20], is provided in Appendix B-10. Although the Green route was not under consideration at the time of the PEA, its alignment sits amongst the other three route options and therefore the Green route is still situated largely within the survey area covered by the other route options. Only very small areas of intensively managed agricultural land in the northern section of the Green route alignment (where it passes between the Red route and Purple A route options) were not within the areas surveyed. The omission of these small areas is not considered to represent a significant limitation of the assessment of baseline ecological conditions associated with the Green route. The Sandholes Link Road also followed a slightly different alignment at its southern end when the PEA was undertaken. However, the footprint of the new alignment was within the study area for the original alignment.

A separate consultation exercise was also undertaken with statutory and non-statutory consultees. Details of the various search areas for different categories of ecological receptor applied during these studies are detailed below.

Designated Sites

Statutory International/European and National Sites

The extent of searches conducted for European/International designated sites (i.e. SAC, SPA and Wetlands of International Importance (Ramsar Sites)) and national designated sites (i.e. ASSI, Nature Reserves (NR) and National Nature Reserves (NNR)) was dependent on their potential connectivity to the proposed scheme and immediately surrounding area. This included direct connectivity, such as via watercourses, or indirect connectivity, such as through the potential use of habitats within and/or in close proximity to the proposed scheme which may be used by qualifying species of designated sites in the wider surrounding area (termed ‘functionally linked’ habitat).

The DMRB guidance on Habitats Regulations Assessments[21] details that consideration should be given to SACs where bats are the qualifying interest within 30 km of the proposed scheme.

Meanwhile, searches for sites designated for their ornithological interests (i.e. SPAs and Ramsar Sites) extended up to 20 km from the proposed scheme. This was based on the recognised upper range commuting distance of some species of geese[22], which are often qualifying interests of wetland sites.

Searches for all other European/international and national designated sites also extended to 20 km from the proposed scheme.

Non-statutory Sites

Searches for all non-statutory designated sites (e.g. Sites of Local Nature Conservation Importance (SLNCI)) extended to at least 5 km from the proposed scheme.

Habitat and Species Records

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[20] CIEEM, (2017). Guidelines for Preliminary Ecological Appraisal, 2nd edition. Chartered Institute of Ecology and Environmental Management, Winchester.
[21] Highways England et al., (2019). DMRB Volume 11, Section 4, Part 1: LA 115 Habitats Regulations Assessment. [online] Available at: https://www.standardsforhighways.co.uk/dmrb/search/e2fdab58-d293-4af7-b737-b55e08e045ae [Accessed 03/08/2020].
[22] SNH, (2016). Assessing Connectivity with Special Protection Areas (SPAs). [online] Available at: https://www.nature.scot/assessing-connectivity-special-protection-areas [Accessed 03/08/2020].

The PEA included a desk-based study to search for information on habitats and species of conservation interest intersected by the proposed scheme and wider surrounding area. A separate consultation exercise was also undertaken with various statutory and non-statutory consultees to inform this Stage 2 Route Option Appraisal. Searches for most habitat and species information extended to 2 km from the proposed scheme but was increased up to 10 km for bat species records.

Information was also obtained from the original DMRB Stage 2 Assessment Report for the A29 Cookstown Bypass Scheme[23].

Preliminary Field Surveys

Terrestrial and aquatic ecological field surveys were undertaken as part of the PEA, as summarised below. The terrestrial surveys covered the footprint of the proposed scheme plus a surrounding buffer of 100 m, while the aquatic surveys extended to 200 m up- and downstream of the locations where the proposed scheme intersects with the Ballinderry River.

6.5.1.3. Methodology

The assessment was undertaken in accordance with the DMRB guidance LA 108 Biodiversity. For more detail on methodology refer to Environmental Appendix B.

6.5.1.4. Consultation

The separate consultation exercise undertaken to inform this Stage 2 Assessment involved the following statutory and non-statutory consultees:

- Mid Ulster Council;
- DAERA;
  - Northern Ireland Environment Agency (NIEA) Wildlife Team;
  - Environment, Marine and Fisheries Division (EMF); and
  - Council for Nature Conservation and the Countryside (CNCC);
- Department for Infrastructure Rivers Headquarters;
- Fisheries Conservancy Board for Northern Ireland (FCBNI);
- Loughs Agency;
- Agri-food & Biosciences Institute (AFBI);
- Ulster Wildlife;
- Royal Society for the Protection of Birds (RSPB), Northern Ireland;
- British Trust for Ornithology (BTO);
- Northern Ireland Raptor Study Group (NIRSG)
- CEDaR;
- National Biodiversity Data Centre (NBDC);
- Botanical Society of the British Isles (BSBI);
- Northern Ireland Bat Group (NIBG);
- Northern Ireland Environment Link (NIEL); and
- Woodland Trust.

[23] Mouchel, (2010). A29 Cookstown Bypass. Stage 2 Scheme Assessment Report. Preferred Options Report. Prepared by Mouchel for the Northern Ireland Roads Service. March 2010.

6.5.1.5. Assumption and Limitations

Details of assumptions and limitations for biodiversity assessment are provided in Environmental Appendix B.

6.5.2. BASELINE CONDITIONS

6.5.2.1. Designated Sites

Statutory International/European and National Sites

There are no SACs designated for bats in Northern Ireland and hence none within the relevant 30 km study area.

A total of 11 statutory international/European designated sites of nature conservation importance are located within 20 km of the proposed scheme, seven of which are SACs, one is an SPA, and three are Ramsar Sites. The locations of these sites are presented in Figure 6.5.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0162).

Of these sites, three are located in close proximity to, directly connected or potentially functionally linked with the proposed scheme.

- Upper Ballinderry River SAC, designated for its freshwater habitats, otter and freshwater pearl mussel populations. This site is located immediately adjacent to (i.e. within approximately 20 m) the northern end of the Sandholes Link Road at the Derryloran Bridge and is hydrologically connected to the four route options where they cross the Ballinderry River further downstream.
- Lough Neagh and Lough Beg SPA, designated for its breeding and overwintering waterbirds, and overwintering waterbird assemblage. This site is located approximately 11.4 km east of the proposed scheme by direct distance and although it is hydrologically connected via several watercourses including the Ballinderry River, it is over 20 km downstream of the proposed scheme. Land associated with the proposed scheme could also potentially provide supporting ('functionally linked') habitat for qualifying interests including whooper swan (*Cygnus cygnus*) and greylag geese (*Anser anser*).
- Lough Neagh and Lough Beg Ramsar Site is affiliated with (though not entirely consistent with) Lough Neagh and Lough Beg SPA and is designated for its open water and wetland habitats; and associated flora and fauna including invertebrates, breeding and overwintering waterbird populations and fish species.

There are 24 statutory national designated sites within 20 km of the proposed scheme, of which 21 are ASSIs, two are NRs and one is an NNR. The locations of these sites are presented in Figure 6.5.2 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0163).

Of these sites, three are located in close proximity to, or connected/potentially connected with the proposed scheme:

- Upper Ballinderry River ASSI is directly affiliated/commensurate with Upper Ballinderry River SAC (described above) and is designated for the physical features of the river, and its associated riverine flora and fauna. As with the SAC, this site is located immediately adjacent to the northern end of the Sandholes Link Road section at the Derryloran Bridge and is hydrologically connected to the four route options where they cross the Ballinderry River further downstream;
- Lough Neagh ASSI is affiliated with the relevant corresponding part of Lough Neagh and Lough Beg SPA (described above) and is designated for its flora, fauna (including breeding and

wintering birds), and geological and physiographical features. As with the SPA, this site is located approximately 11.4 km east of the proposed scheme and is hydrologically and potentially functionally connected via watercourses and potential foraging habitat for notified interests (albeit over 20 km downstream along the Ballinderry River); and

- Lough Neagh Islands NR, which is recognised for its breeding bird interest, is located approximately 20 km east of the study area and is potentially connected to the proposed scheme via numerous watercourses, including the Ballinderry River, which flow into Lough Neagh.

Full details of the above sites, as well as the other international/European and national designated sites within the 20 km search area, including their qualifying interests, are provided in the PEA (Appendix B-10).

Non-statutory Designated Sites

- Ten non-statutory designated sites of nature conservation importance are located within 5 km of the proposed scheme, the locations of which are presented in Figure 6.5.3 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0164).

Of these, two are located in close proximity to, or connected/potentially connected with the proposed scheme.

- Cabin Wood Woodland Trust Site is located within 25 m of the proposed scheme on the opposite (eastern) side of the Ballinderry River towards the southern end of the proposed scheme (also shown in Figure 6.5.4 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0165); and
- Killymoon Estate Wood SLNCI, is located approximately 375 m of the proposed scheme towards the southern end of the study area and is connected to it via the Ballinderry River and surrounding woodland.

6.5.2.2. Habitats

All four route options of the proposed scheme extend through a predominantly agricultural landscape over level ground. Fields typically comprise improved grassland lined by trees and/or hedgerows, of which the latter includes occasional species-rich sections (both intact and defunct) which are recognised as a Northern Ireland Priority Habitat. The northern half of the route corridor is bisected by a disused railway embankment. In the southern half, the route options pass in proximity to built-up and amenity-use areas associated with Cookstown, including Killymoon Golf Course, residential properties and commercial/industrial areas. The Sandholes Link Road passes through a mixture of residential and industrialised areas in the southern part of Cookstown. Several TPO are located at the northern end of the Sandholes Link Road section of the proposed scheme, albeit these are beyond the development footprint and hence are not expected to be directly affected (see Figure 6.4.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0128)).

The Ballinderry River is the most substantial watercourse within the proposed scheme and flows eastwards through both the Sandholes Link Road and the southern half of the proposed scheme. Rivers are listed as a Northern Ireland Priority Habitat. Water quality kick sampling along the Ballinderry River suggests that it is moderately polluted. A NIEA River Hydromorphology Assessment Technique (RHAT)[24] survey suggested that the surveyed sections of the Ballinderry River associated

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[24] NIEA, (2009). River Hydromorphology Assessment Technique (RHAT) Training guide 2009. [online] Available at: http://www.epa.ie/wfdstatus/rivers/RW_RHAT_training_guide_final_20_04_09.pdf. [Accessed 03/08/2019].

with the proposed scheme ranged from Moderate to Good classification. This broadly corresponds to these sections being in moderate to high ecological condition. A small number of minor watercourses (small burns and drainage ditches) also pass through the proposed scheme.

Habitats of increased conservation importance identified during the Phase 1 habitat survey include semi-natural broadleaved woodland in the southern half of the proposed scheme associated with Ballinderry River. Oakwoods and mixed ashwoods, examples of which occur along the Ballinderry River corridor, are Northern Ireland Priority Habitats and a small strip of the woodland associated with the Ballinderry River is recognised as ancient semi-natural woodland.

Pockets of semi-improved neutral grassland and marshy grassland exist within the southern half of the proposed scheme and are considered to be of increased conservation importance relative to the wider agriculturally and recreationally managed landscape.

The frequency and distribution of habitats along the route corridor is presented in PEA Figures 7.1 to 7.3 in Appendix B-10.

6.5.2.3. Protected and Priority Species

Figures relating to protected species records and HSA gathered during the PEA field surveys are presented in Figures 8 to 15.2 in Appendix B-10.

Otter

The desk study revealed records of otters along the Ballinderry River and evidence of the species' presence was confirmed during surveys to inform the original Cookstown Bypass Stage 2 Assessment[23]. Evidence of otters, including spraints (droppings) and crayfish predation remains, was also recorded along the Ballinderry River during the 2019 PEA surveys. An entrance to a potential holt was also identified along the Ballinderry River. The evidence detected during the surveys indicates that the Ballinderry River is a well-frequented foraging habitat and commuting corridor to the wider environment, and otters may rest-up at features along the bankside.

Badger

The desk study revealed records of badgers (*Meles meles*) within the 2 km search area surrounding the proposed scheme and the species was confirmed to be present during surveys for the original Cookstown Bypass Stage 2 Assessment[23]. Evidence of badgers was subsequently detected during the PEA surveys including several active setts throughout the route corridor. Due to the sensitivity of badger records, all data pertaining to badger is included in a separate confidential annex to the PEA Report (Appendix B-10, Sub Appendix F).

Bats

The desk study indicated that at least eight species of bat have been recorded within 10 km of the proposed scheme: brown long eared bat (*Plecotus auratus*), common pipistrelle (*Pipistrellus pipistrellus*), Daubenton's bat (*Myotis daubentoniid*), Leisler's bat (*Nyctalus leisleri*), Nathusius' pipistrelle (*Pipistrellus nathusii*), Natterer's bat (*Myotis nattereri*), soprano pipistrelle (*Pipistrellus pygmaeus*) and whiskered/Brandt's bat (*Myotis mystacinus / brandtii*).

Woodland, tree lines, hedgerows, watercourses including the Ballinderry River, and the scrub-lined disused railway in the northern half of the route corridor are likely to be used by bats for foraging and commuting across the wider landscape. Potential Roost Features (PRF) were identified in a high number of trees throughout the proposed scheme during surveys undertaken to inform the PEA, with suitability for different roost types ranging from low to high. These findings correspond with those for the original Cookstown Bypass Stage 2 Assessment[23].

Birds

The desk study identified that a number of protected and notable bird species have been recorded within 2 km of the route corridor. Habitats such as the agricultural fields, woodland, tree lines and hedgerows along the proposed scheme provide suitable breeding, nesting and foraging opportunities for birds. The agricultural fields may also support foraging waterfowl such as whooper swans and greylag geese which are known to overwinter at Lough Neagh and Lough Beg SPA located approximately 12 km to the east of the proposed scheme. Other species of note include suitable habitat for yellowhammer (*Emberiza citrinella*) and observations of kingfisher (*Alcedo atthis*) along the Ballinderry River.

The original Cookstown Bypass Stage 2 Assessment identified a number of Northern Ireland Schedule 1 and Biodiversity Action Plan-listed species to occur along the proposed scheme[23].

Irish hare

Given the predominant arable landscape with pockets of semi-natural habitat and connectivity along field margins and hedgerows, the site is likely to support Irish hare (*Lepus timidus hibernicus*), although no sightings were recorded during surveys for the original Cookstown Bypass Stage 2 Assessment[23] of the 2019 PEA surveys.

Hedgehog

Suitable habitats for hedgehog (*Erinaceus europaeus*) exists along the route corridor including semi-improved neutral grassland, improved grassland, amenity grassland including residential gardens, hedgerows, treelines, and woodland.

Herpetofauna (Reptiles and Amphibians)

The desk study did not return any records of amphibians or reptiles within 2 km of the proposed scheme, although this does not necessarily preclude their existence, as this may be a result of under-recording.

The habitats associated with the proposed scheme are generally considered to be suboptimal for common reptiles, such as common lizard (*Zootoca vivipara*).

No waterbodies were identified along or in proximity to the proposed scheme which could provide breeding habitat for smooth newt (*Lissotriton vulgaris*) or common frog (*Rana temporaria*). Three wet ditches were identified. These were generally considered to be suboptimal for supporting breeding amphibians although frogspawn was identified in a ditch during the initial walkover[25].

Atlantic salmon

Salmonid suitability surveys identified suitable spawning habitat along the sections of the Ballinderry River associated with the Sandholes Link Road and the four route options. Nursery and holding habitat for juvenile and adult Atlantic salmon (*Salmo salar*) exists throughout the stretches of river surveyed. These findings correspond with those for the original Cookstown Bypass Stage 2 Assessment[23].

Freshwater pearl mussel

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[25] WSP, (2019). Ecology Technical Note. A29 Ecology Walk Over Survey Summary. Dated: 25 February 2019.

Due to the sensitivity of freshwater pearl mussels, information pertaining to this species is included in a separate confidential annex to the PEA Report (Appendix B-10, Sub Appendix F). The Ballinderry Rivers Trust is undertaking a project to improve habitat conditions for freshwater pearl mussels as well as release juvenile mussel in the Ballinderry River catchment.

White-clawed crayfish

Habitat suitable for white-clawed crayfish was identified along the surveyed reaches of the Ballinderry River and as noted above, crayfish remains were detected along this watercourse during the otter survey (although definitive species confirmation was not possible). The species was confirmed to be present in the Ballinderry River downstream of Cookstown during surveys for the original Cookstown Bypass Stage 2 Assessment[23].

Invasive non-native species

Stands of giant hogweed (*Heracleum mantegazzianum*) and Japanese knotweed (*Reynoutria japonica*) were identified within the study area, particularly along the Ballinderry River. Other, less invasive non-native species were also recorded including snowberry (*Symphoricarpos albus*), rhododendron (*Rhododendron ponticum*), buddleia (*Buddleja davidii*) and cotoneaster (*Cotoneaster spp*).

6.5.2.4. Potential Biodiversity Receptors and Predicted Importance

Table 6-17 lists the sensitive biodiversity receptors which are either known or have the potential to be associated with the proposed scheme and, where possible, identifies their anticipated level of importance based on the baseline information summarised above and the criteria listed in Table 4-1 of Appendix B.

Table 6-17 – Predicted Biodiversity Receptors and Importance

Receptor	Known or Anticipated Level of Importance
Upper Ballinderry River SAC Lough Neagh and Lough Beg SPA and Ramsar Site	International
Upper Ballinderry River ASSI Lough Neagh ASSI Lough Neagh Islands Nature Reserve	National
Killymoon Estate Wood SLNCI Cabin Wood Woodland Trust Site	County
Ancient Semi-natural Woodland Ballinderry River Oak and Mixed Ash Woodland Species-rich Hedgerows (Intact and Defunct)	National
Semi-natural broad-leaved woodland Minor watercourses Tree lines Species-poor Hedgerows (Intact and Defunct) Semi-improved neutral grassland	Local
Otter	International (based on status as qualifying species of Upper Ballinderry River SAC)
Freshwater pearl mussel	International (based on status as qualifying species of Upper Ballinderry River SAC)

Receptor	Known or Anticipated Level of Importance
Badger	Local
Bats White clawed crayfish Atlantic salmon Birds (breeding and wintering) Irish hare Hedgehog	Yet to be determined – surveys/further information to be gathered during Stage 3 assessment.

6.5.2.5. Future Baseline

In the absence of the proposed scheme, it is not anticipated that the baseline habitats will change significantly in time, owing to the current agricultural land-use and associated management regimes which dominate the landscape.

For protected/priority terrestrial species which occupy a territory that ranges over the study area, there may be localised changes to the distribution of supporting features (e.g. resting sites, foraging sites, mammal pathways) over time. However, there are unlikely to be any significant changes at a local (or above) population level in the short term.

With regards to species associated with the Ballinderry River and other aquatic receptors, there is potential for the water quality to change depending on other factors such as pollution, invasive non-native species, bank erosion etc. or indeed water quality improvements. As with terrestrial species there is potential for populations of aquatic species to increase and decrease over time, both in terms of abundance and distribution, in response to these factors.

In the absence of any control measures, there is potential for the distribution of invasive non-native species identified within the study area to spread, which could result in a degradation of the biodiversity value of the habitats into which the non-native species are introduced.

6.5.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

In relation to biodiversity, the appraisal of the route options under consideration for the proposed scheme (i.e. the Red route, Purple A route, Purple B route and Green route, as well as the Sandholes Link Road which is common to all four route options) focuses on the following aspects:

- potential impacts on designed sites of importance for nature conservation;
- potential impacts on habitats of nature conservation importance; and
- potential impacts on protected and notable species of nature conservation importance.

The following sections present the details and outcomes of the assessment of impacts on biodiversity receptors from the route options for both the construction and operational phases of the proposed scheme, in the absence of mitigation.

Recommendations for ecologically sensitive features, such as mammal underpasses and sensitive lighting for bats, for incorporation into the design of the preferred route option at DMRB Stage 3 and mitigation measures aimed at avoiding or minimise the predicted impacts are detailed in Section 6.5.4: Comparison of Route Options and Proposed Mitigation.

6.5.3.1. Construction

Red Route

Designated Sites

The Red route crosses the Ballinderry River approximately 1.25 km downstream of the downstream extent of the Upper Ballinderry River SAC and ASSI at approximate Ch180 m. Although there will be no direct impacts on the SAC/ASSI itself, construction of a crossing over the river has the potential to pose adverse impacts on associated qualifying/notified species (otter and freshwater pearl mussel), such as disturbance, deterioration of supporting habitat and prey resource. In addition, in the case of freshwater pearl mussel, disturbance of salmonid fish may indirectly affect the species since they are required to facilitate freshwater pearl mussels' larval (glochidial) life-stage. Otters may also potentially be at risk of accidental mortality should they come into contact with the works. Given the international importance of the SAC and its associated qualifying interests such adverse impacts could be of large to very large significance.

Although the Red route is located approximately 12 km from Lough Neagh and Lough Beg SPA and Ramsar Site/Lough Neagh ASSI, and approximately 20 km from Lough Neagh Islands Nature Reserve, it is hydrologically connected to these designated sites via the Ballinderry River which discharges into Lough Neagh (albeit by over 20 km downstream). Construction of a crossing over the river has the potential to cause pollution of the watercourse which could be carried downstream and enter the lough affecting the condition of its habitats and with knock on impacts to associated species. However, the hydrologically connected distance is such that any pollution is likely to have significantly dissipated by the time it reaches Lough Neagh, resulting in negligible impacts of no worse than slight significance.

There is also the potential for qualifying bird interests associated with the SPA, Ramsar Site and ASSI to use habitats along the proposed scheme for foraging, particularly more widely ranging wintering waterfowl. Should such species be found using the habitats within and immediately adjacent to the Red route they may experience loss of, and/or displacement from traditional foraging grounds. Nonetheless, there is considered to be an abundance of similar foraging habitat in the wider surrounding area to which birds may be displaced such that any impacts will be negligible. Consequently, the potential impacts of constructing the Red route of these designated sites are predicted to be of no more than slight significance, despite the international importance of the SPA and Ramsar Site. Similarly, any adverse impacts on Lough Neagh Islands NR, which is significantly further away, are predicted to be of no more than slight significance.

Although the Red route passes within 15 m of the Cabin Wood Woodland Trust Site from approximate Ch425 m and 375 m of Killymoon Estate Wood SLNCI from approximate Ch800 m, both are located on the opposite (eastern) side of the Ballinderry River and so are segregated from the Red route. Consequently, there will be no loss of habitat from these woodland sites. The Red route does however, pass in very close proximity to broadleaved woodland on the western side of the river which forms part of the wooded riparian corridor with which these two sites are associated. Consequently, there is potential for impacts of disturbance, and habitat and air quality deterioration upon the non-designated woodland to indirectly affect the habitat condition and species assemblage associated with the Woodland Trust Site and SLNCI. However, such impacts are unlikely to be greater than moderate level and so the significance of impacts on these designated sites of county importance is anticipated to be no more than slight.

Habitats

Although the Red route intersects with mature trees, typically along field boundaries and around the Killymoon Golf Course (approximate Ch1250 m), it does not pass through any blocks of woodland. Consequently, there is not anticipated to be any loss of what might be considered priority oak or mixed ash woodland. Similarly, the Red route does not intersect with any ancient semi-natural woodland, the closest block of which is located approximately 225 m away, along the downstream side of the Ballinderry River corridor. As stated above however, in relation to the woodland associated with the Cabin Wood Woodland Trust Site and Killymoon Estate Wood SLNCI, there is potential for impacts of disturbance, and habitat and air quality deterioration to affect the condition and species assemblage associated with these woodland habitats. However, at worst, the significance of such impacts is predicted to be no more than slight given the larger distance of separation between the ancient semi-natural woodland and the Red route alignment.

As stated above, the Red route crosses the Ballinderry River downstream of the Upper Ballinderry SAC (at approximate Ch180 m). Construction of a crossing over the river has the potential to pose adverse impacts on the condition of the watercourse, its associated habitats and the distribution and abundance of the species it supports. Potential impacts include loss and disturbance of bankside vegetation, pollution, shading of habitats from structures, smothering of vegetation by dust and potentially changes in the river's hydromorphology depending on the design of the bridge and the location of its piers in relation to the river channel. Given the SAC status of the upper reaches of the Ballinderry River, it is reasonable to extend the international importance of the designated site to the wider river. Consequently, adverse impacts on the wider Ballinderry River could be of large to very large significance.

The Red route intersects with numerous hedgerows as it passes along its alignment. Of these, a small number located in the northern half of the proposed scheme are species-rich (e.g. between approximate Ch2200 m and Ch2650 m). As well as the loss of those sections which it cuts through, this will also result in the fragmentation of these linear features which provide contiguous/semi-contiguous commuting corridors and foraging habitat throughout the wider agricultural landscape. Despite the presence of species-rich hedgerows however, the loss of such habitat is predicted to be limited in the context of the wider surrounding area and hence represent only a minor impact. Meanwhile, the more extensive loss of lower value species-poor hedgerow is similarly considered to represent a minor impact, based on its lower (local) importance. Consequently, the loss and segregation of both specie-rich and species-poor hedgerow habitat, and the deterioration in the resources they provide to locally occurring wildlife are anticipated to result in impacts of no more than slight significance.

All other habitats which the Red route passes through, which are predominantly associated with managed agricultural fields, are considered to be of no more than local importance. As such, the significance of any impacts will be no more than slight.

Species

Surveys have confirmed that otters, a qualifying species of the Upper Ballinderry River SAC, occur along the section of Ballinderry River which is intersected by the proposed development. Although located approximately 1.25 km downstream of the SAC, construction of the Red route's crossing of the Ballinderry River (at approximate Ch180 m) is still anticipated to result in the disturbance of SAC-associated otters, potential deterioration of their supporting habitat and prey resource and the risk of accidental mortality. The potential impact of this is unknown at this stage but could range from minor to major which, given their international importance as a qualifying interest of the SAC, could be of large to very large significance.

Surveys have also confirmed that badgers are present throughout the proposed scheme. The alignment of the Red route through predominantly agricultural fields and associated boundary habitats (tree lines and hedgerows) which represent suitable badger foraging and sheltering habitat, is expected to result in the fragmentation of their territories and access to these resources, as well as the potential loss of some of their setts. Badgers may also potentially be at risk of accidental mortality should they come into contact with the works. Further information is required on the distribution of badgers along this route option in order to fully assess the impacts upon the species. However, based on the species local importance, regardless of the level of impact, adverse impacts are predicted to be of no more than slight significance.

The PEA desk study returned records of eight bats species within 10 km of the proposed scheme and the field surveys identified that there is an abundance of suitable commuting and foraging habitat for bats throughout the study area. Further information is required on the presence, distribution and activity levels of different species of bat along this route option in order to fully assess the impacts upon bats. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on bats. As described in Section 6.5.2.2 however, given that all four route options of the proposed scheme extend through the same agriculture-dominated landscape the limited availability of information on bats is considered to be acceptable for this Stage 2 Assessment as any differences between the route options are not expected to be significant.

Given their status as a qualifying species of the Upper Ballinderry River SAC, there is potential for freshwater pearl mussel to exist within and downstream of the spanned section of the Ballinderry River (at approximately Ch180 m). Further information is required on the presence and distribution of this species in relation to this route option in order to fully assess the impacts upon freshwater pearl mussels. However, given their international importance as a qualifying interest of the SAC any adverse impacts, of any magnitude, could be of large to very large significance.

Surveys undertaken as part of the PEA identified that the Ballinderry River represents suitable habitat for white-clawed crayfish and salmonids and the river is also likely to support other species of fish. Further information is required on the presence and distribution of white-clawed crayfish and different fish species in relation to this route option in order to fully assess the impacts upon them. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on white-clawed crayfish or fish. However, given that all four route options of the proposed scheme cross the Ballinderry River at approximately the same location the limited availability of information on white-clawed crayfish and salmonids is considered to be acceptable for this Stage 2 Assessment as there will be no differences between the route options.

The PEA identified that there is an abundance of suitable nesting and foraging habitat for birds throughout the study area. Further information is required on the presence and distribution of different species along this route option, particularly species of conservation concern, in order to fully assess the impacts upon birds. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on birds. However, as with bats, the limited availability of information on birds is considered to be acceptable for this Stage 2 Assessment since all four route options pass through the same agriculture-dominated landscape such that any differences between them are not expected to be significant.

The PEA identified that there is suitable habitat along the proposed scheme for Irish hare and hedgehog. Further information is required on the presence and distribution of these species in relation to this route option in order to fully assess the impacts upon them, although surveys for hedgehog are unlikely to confirm the species' presence and distribution. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on these species. As with bats and birds, the limited availability of information on these species is considered to be acceptable for this Stage 2 Assessment since all four route options pass through the same agriculture-dominated landscape and are expected to pose very similar impacts.

Purple A Route

Designated Sites

The Purple A route crosses the Ballinderry River at the same location as the Red route and passes through much the same agricultural fields. Consequently, the potential impacts of constructing the Purple A route on Upper Ballinderry River SAC and ASSI, Lough Beg SPA and Ramsar Site, Lough Neagh ASSI and Lough Neagh Islands NR and associated species interests are anticipated to be much the same as those predicted for the Red route.

The alignment of the Purple A route is also very similar to the Red route in respect of its proximity to the Cabin Wood Woodland Trust Site and Killymoon Estate Wood SLNCI. Therefore, the potential impacts of constructing the Purple A route on these non-statutory designated sites are anticipated to be much the same as those predicted for the Red route.

Habitats

Despite their different alignments, the Purple A route passes through much the same habitat types as the Red route. It will not result in the loss of any ancient semi-natural or priority woodland, will similarly span the Ballinderry River and will intersect with numerous hedgerows, but will predominantly cut through agricultural habitats of no more than local importance. One slight difference is that the Purple A route intersects with much less species-rich hedgerow than the Red route. Consequently, the potential impacts of constructing the Purple A route on habitats are anticipated to be much the same as those predicted for the Red route, with the exception of impacts on species-rich hedgerows which are predicted to be no more than slight significance.

The only notable difference is that the Purple A route which has a development footprint of approximately 0.382 km^2, takes up an area 8.4% larger than the Red route (0.353 km^2 in area) and so will result in a greater extent of habitat loss and fragmentation, albeit predominantly habitats of no more than local importance.

Species

Since the Purple A route crosses the Ballinderry River at the same point as the Red route and passes through much the same habitats despite their different alignments, the potential impacts of constructing the Purple A route on locally occurring species of conservation concern are anticipated to be much the same as those predicted for the Red route.

The only potential difference, as mentioned above, is that the Purple A route has a larger footprint than the Red route and so affects a greater extent of habitats and supporting species. Consequently, it could potentially result in impacts of slightly greater significance than the Red route.

Purple B Route

Designated Sites

The Purple B route crosses the Ballinderry River at the same location as the Red route and Purple A route and passes through much the same agricultural fields. Consequently, the potential impacts of constructing the Purple B route on Upper Ballinderry River SAC and ASSI, Lough Beg SPA and Ramsar Site, Lough Neagh ASSI and Lough Neagh Islands NR and associated species interests are anticipated to be much the same as those predicted for the Red route and Purple A route.

The alignment of the Purple B route is also very similar to the Red route and Purple A route in respect of its proximity to the Cabin Wood Woodland Trust Site and Killymoon Estate Wood SLNCI. Therefore, the potential impacts of constructing the Purple B route on these non-statutory designated sites are anticipated to be much the same as those predicted for the Red route and Purple A route.

Habitats

Despite their different alignments, the Purple B route passes through much the same habitats as the Red route and Purple A route. It will not result in the loss of any ancient semi-natural or priority woodland, will similarly span the Ballinderry River and will intersect with numerous hedgerows, but will predominantly intersect with agricultural habitats of no more than local importance. As with the Purple A route, the Purple B route also intersects with less species-rich hedgerow than the Red route.

Consequently, the potential impacts of constructing the Purple B route on habitats are anticipated to be much the same as those predicted for the Purple A route. The only notable difference is that the Purple B route, which has a development footprint of approximately 0.388 km^2, takes up an area 9.8% larger than the Red route (0.353 km^2 in area) and 1.34% larger than the Purple A route (0.382 km^2 in area) and so will result in a greater extent of habitat loss and fragmentation, albeit habitats of predominantly local importance.

Species

Since the Purple B route crosses the Ballinderry River at the same point as the Red route and Purple A route, and passes through much the same habitats despite their different alignments, the potential impacts of constructing the Purple B route on locally occurring species of conservation concern are anticipated to be much the same as those predicted for the Red route and Purple A route.

The only potential difference, as mentioned above, is that the Purple B route has a larger footprint than the Red route and Purple A route and so affects a greater extent of habitats and potentially supporting species. Consequently, it could potentially result in impacts of slightly greater significance than the Red route and Purple A route.

Green Route

Designated Sites

The Green route crosses the Ballinderry River at approximately the same location as the Red route, Purple A route and Purple B route and passes through much the same agricultural fields as the other three route options, particularly the Purple A route. Consequently, the potential impacts of constructing the Green route on Upper Ballinderry River SAC and ASSI, Lough Beg SPA and Ramsar Site, Lough Neagh ASSI and Lough Neagh Islands NR and associated species interests are anticipated to be much the same as those predicted for the other route options, particularly the Purple A route.

The alignment of the Green route is also very similar to the Red route, Purple A route and Purple B route in respect of its proximity to the Cabin Wood Woodland Trust Site and Killymoon Estate Wood SLNCI. Therefore, the potential impacts of constructing the Green route on these non-statutory designated sites are anticipated to be much the same as those predicted for the other three route options.

Habitats

Despite their different alignments, the Green route passes through much the same habitats as the Red route, Purple A route and Purple B route. It will not result in the loss of any ancient semi-natural or priority woodland, will similarly span the Ballinderry River and will intersect with numerous hedgerows, but will predominantly intersect with agricultural habitats of no more than local importance. As with the Purple A route and Purple B route, the Green route also intersects with less species-rich hedgerow than the Red route.

Given their similar alignments, the potential impacts of constructing the Green route on habitats are anticipated to be comparable to those predicted for the Purple A route. The only notable difference is that the Green route, which has a development footprint of approximately 0.404 km^2, takes up an area 14.6% larger than the Red route (0.353 km^2 in area), 5.7 % larger than the Purple A route (0.382 km^2 in area) and 4.3% larger than the Purple B route (0.388 km^2 in area) and so will result in the greatest amount of habitat loss and fragmentation of all the route options under consideration, albeit predominantly habitats of no more than local importance.

Species

Since the Green route crosses the Ballinderry River at approximately the same point as the Red route, Purple A route and Purple B route, and passes through much the same habitats despite their different alignments, the potential impacts of constructing the Green route on locally occurring species of conservation concern are anticipated to be comparable to those predicted for the other three route options, particularly the Purple A route.

The main difference between the Green route and the other route options under consideration, as mentioned above, is that it has the largest footprint and so is predicted to affect the greatest amount of habitat and potentially supporting species.

Sandholes Link Road

Designated Sites

The northern end of the Sandholes Link Road extends to within 20 m of the Upper Ballinderry River SAC and ASSI. Although there will be not be any direct impacts on the SAC/ASSI itself (e.g. no works directly within the river) construction of the nearest sections of the upgraded Sandholes Link Road has the potential to pose adverse impacts on designated site and its associated qualifying/notified species such as disturbance, accidental mortality, deterioration of supporting habitat and prey resource and, in the case of freshwater pearl mussel, disturbance of salmonid fish. Given the international importance of the SAC and its associated qualifying interests such adverse impacts could be of large to very large significance.

There is a low risk of construction works associated with the Sandholes Link Road resulting in pollution of Lough Neagh and Lough Beg SPA and Ramsar Site and Lough Neagh ASSI which are hydrologically connected via the Ballinderry River. There is however, no potential for qualifying bird interests associated with the SPA, Ramsar Site and ASSI to use habitats in the vicinity of the

Sandholes Link Road. As with the potential impacts associated with the wider proposed scheme, any potential adverse impacts on these designated sites from the Sandholes Link Road are predicted to be negligible and hence of no more than slight significance, despite the international importance of the SPA/Ramsar Site.

There is negligible/no potential for works on the Sandholes Link Road to result in in pollution of Lough Neagh Islands NR which is over 20 km away. Similarly, although they are located downstream along the Ballinderry River, there is no potential for works on the Sandholes Link Road to result in impacts on the Cabin Wood Woodland Trust Site or Killymoon Estate Wood SLNCI.

Habitats

The habitats along the Sandholes Link Road are predominantly urban/semi-urban habitats of no more than local importance when considered in isolation. The upgrade of the Sandholes Link Road is unlikely to result in the substantial loss or fragmentation of the associated habitats, although it may require the removal of several broad-leaved trees (albeit none which have TPOs) and will also involve working in close proximity to the Ballinderry River, as detailed above. Given its SAC status, any adverse impacts on the Ballinderry River could be of large to very large significance.

Impacts on all other habitats associated with the Sandholes Link Road are expected to be no more than slight significance.

Species

As stated above in relation to the four proposed route options, surveys have confirmed that otters occur along the Ballinderry River, including the designated section which comes into close proximity with, and is just beyond, the northern extent of the Sandholes Link Road. Although the proposed extent of the upgrade works do not overlap with the SAC (i.e. there are no proposals to undertake any bridge works or in-stream works), potential impacts on otters might include disturbance, accidental mortality and possibly pollution of the watercourse with associated effects on habitat condition and prey resource availability. Given their international importance as a qualifying interest of the SAC, such adverse impacts on otters could be of large to very large significance.

The PEA revealed no evidence of badger presence along the highly urbanised route of the Sandholes Link Road. Consequently, there are no predicted impacts on badgers from this part of the proposed scheme.

As with the wider proposed scheme the Sandholes Link Road contains suitable commuting and foraging habitat for bats, particularly the Ballinderry River. However, further information is required on the presence, distribution and activity levels of different species of bat along the Sandholes Link Road in order to fully assess the impacts upon bats. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on bats. However, as the Sandholes Link Road is common to all route options, any impacts on bats, which will be identified through detailed surveys at Stage 3, will be the same, irrespective of which route is preferred.

As with otters, freshwater pearl mussels are likely to exist in proximity to, and downstream of the spanned section of the Ballinderry River, given their status as a qualifying species of the Upper Ballinderry River SAC. Further information is required on the presence and distribution of this species in order to fully assess the impacts upon freshwater pearl mussels, although given their international importance any adverse impacts could be of large to very large significance.

As with the section of the Ballinderry River which is crossed by the four proposed route options, the section associated with the Sandholes Link Road represents suitable habitat for white-clawed crayfish and salmonids as well as other species of fish. Further information is required on the presence and distribution of these species in order to fully assess the impacts upon them. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on white-clawed crayfish or fish.

Unlike the rural habitats of the wider proposed scheme the urban/semi-urban habitats associated with the Sandholes Link Road are most likely to support common birds of low conservation concern. Nonetheless, further information is required on the presence and distribution of different species along this route, particularly species of conservation concern, in order to fully assess the impacts upon birds. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on birds. As with bats however, given that the Sandholes Link Road is common to all route options, any impacts on birds, which will be identified through detailed surveys at Stage 3, will be the same, irrespective of which route is preferred.

While Irish hare are unlikely to occur within the urbanised habitats of the Sandholes Link Road, hedgehog may well be present. As stated above however, in relation to construction impacts, it is unlikely that surveys would establish the species' presence and distribution in this area. Assuming that the species is present in this part of the proposed scheme, its importance is unlikely to be greater than local and so the significance of any impacts are unlikely to be greater than slight.

6.5.3.2. Operation

Red Route

Designated Sites

Impacts on Upper Ballinderry River SAC and ASSI may include accidental mortality of otters, should they venture onto the carriageway, and the indirect effects of air and water pollution and resulting habitat/water quality deterioration on associated qualifying species (given that the proposed crossing point is downstream of the designated site). Given the international importance of the SAC and its associated qualifying interests such adverse impacts could be of large to very large significance.

Due to the large direct and hydrologically connected distances between the proposed scheme and Lough Neagh, the indirect effects of air and water pollution are unlikely to have significant adverse impacts on Lough Neagh and Lough Beg SPA and Ramsar Site, Lough Neagh ASSI and Lough Neagh Islands NR. With regards to qualifying bird interests associated with the SPA, Ramsar Site and ASSI using habitats along the proposed scheme for foraging, particularly wintering waterfowl, while such species may be disturbed and discouraged from the immediate vicinity of the Red route, there is considered to be an abundance of similar foraging habitat in the wider surrounding area to which birds may be displaced. It is also possible that some birds may become habituated to the operational road such that any displacement effects are minimal. Consequently, any such impacts are predicted to be of neutral significance, despite the International importance of the SPA and Ramsar Site.

Given the close proximity of the Red route to Cabin Wood Woodland Trust Site (15 m from approximate Ch425 m) and Killymoon Estate Wood SLNCI (375 m from approximate Ch800 m), there is potential for impacts of disturbance and air quality deterioration upon these woodland sites and associated species. However, such impacts are unlikely to be greater than moderate level and so the significance of impacts on these designated sites of country importance is anticipated to be no more than slight.

Habitats

Impacts on habitats are expected to be limited to the indirect effects of air, water and ground pollution resulting in deterioration in habitat conditions. The most sensitive habitat along the Red route is the Ballinderry River (approximate Ch180 m). Pollution of this watercourse has the potential to pose adverse impacts on the condition of its associated habitats and species, two of which, otter and freshwater pearl mussel, are qualifying interests of the Upper Ballinderry River SAC. Although the SAC is located upstream of the Red route's crossing point, it is reasonable to extend the international importance of the designated site to the wider river. Consequently, adverse impacts on the wider Ballinderry River and associated species effects could be of large to very large significance.

As discussed above in relation to Cabin Wood Woodland Trust Site and Killymoon Estate Wood SLNCI, there is potential for the impacts of pollution, particularly air pollution, to affect the condition of these and other woodland habitats associated with the Ballinderry River corridor. This includes ancient semi-natural woodland. While such impacts are predicted to be localised to the immediate vicinity of the carriageway this may still cause deterioration of woodland habitat within several hundred meters of the Red route. Consequently, there is potential for airborne emissions from vehicles using the Red route to result in pollution and deterioration of the semi-natural broad-leaved woodland associated with the Ballinderry River corridor, including the ancient semi-natural woodland; the nearest block of which to the Red route is approximately 225 m away. Although such impacts are expected to be of no more than minor, for nationally important woodland habitat such as ancient woodland, this could result in an impact of slight to moderate significance.

Elsewhere along the Red route, pollution impacts on habitats are predicted to be localised to the immediate vicinity of the carriageway. Despite habitat features such as species-rich hedgerows potentially being of national importance, any such impacts are predicted to be negligible and therefore of no more than slight significance.

Species

Impacts to species will include disturbance and potential displacement, an increased risk of accidental mortality through collision with vehicles and pollution and deterioration of supporting habitat.

Otters occurring along the Ballinderry River are likely, at least initially, to be disturbed by the traffic associated with the Red route (i.e. in vicinity of the crossing at approximate Ch180 m). This may discourage them from progressing up- and downstream of the crossing thereby limiting the extent of territory and shelter and foraging resource available to them. Over time however, locally occurring individuals are expected to become habituated to the new road, such that up- and downstream connectivity is maintained. As discussed above in relation to habitats, pollution from the road may enter the river affecting water quality and the general condition of otter habitat. Finally, depending on the design of the crossing, otters may be forced or encouraged to leave the riparian corridor and access the carriageway where they will be at increased risk of injury or mortality through vehicle collision. At worst, these impacts result in impacts of large to very large significance given the species' status as a qualifying species of the Upper Ballinderry River SAC.

The Red route is also likely to result in the disturbance, displacement and increased risk of injury or mortality to badgers given that is intersects with suitable foraging, commuting and sheltering habitat. Further information is required on the distribution levels of badgers along this route in order to fully assess the impacts upon this species. However, based on the species local importance, adverse impacts are predicted to be of no more than slight significance.

The Red route is likely to pose similar impacts on bats. In addition, insensitively designed lighting along the Red route could disturb and discourage bats from accessing traditionally used foraging and commuting areas, effectively acting as a barrier to their localise movements. As stated above however in relation to construction impacts, further information is required on the distribution and activity levels of bats along the Red route, as well as the lighting design, in order to fully assess the impacts upon them. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on bats.

As with otters, there is potential for freshwater pearl mussels to be affected by pollution (by air and water) entering the river from the road and affecting water quality and the general condition of their habitat. Further information is required on the presence and distribution of this species in relation to the Red route in order to fully assess the impacts upon freshwater pearl mussels. However, given their international importance as a qualifying interest of the SAC any adverse impacts could be of large to very large significance.

White-clawed crayfish and fish, including salmonids and their riverine habitat may also be affected by air- and waterborne pollution entering the river from the road. As with many of the other species considered above, further information is required on the presence and distribution of these species in relation to the Red route in order to fully assess the impacts upon them. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on white-clawed crayfish or fish.

Finally, traffic from the operational Red route may result in the disturbance, displacement and accidental mortality of locally occurring birds, Irish hare and hedgehog. As stated in relation to impacts associated with construction, further information is required on the presence and distribution of different species along the Red route, particularly species of conservation concern, in order to fully assess the impacts upon birds. Due to a lack of information at this stage it is not possible to predict the potential significance of impacts on these species.

Purple A Route

Designated Sites

As identified in relation to construction impacts, the Purple A route interacts with and potentially affects habitats and qualifying species associated with the Upper Ballinderry River SAC and ASSI, Lough Beg SPA and Ramsar Site, Lough Neagh ASSI and Lough Neagh Islands NR in much the same way as the Red route. Therefore, the impacts associated with the operational Purple A route, should it be selected, on these designated sites and the significance of their associated effects are anticipated to be much the same as those predicted for the Red route.

Similarly, the impacts associated with the operational Purple A route on Cabin Wood Woodland Trust Site and Killymoon Estate Wood SLNCI are anticipated to be much the same as those predicted for the Red route based on their very similar alignments in proximity to these non-statutory designated sites.

Habitats

As identified in relation to construction impacts, the Purple A route interacts with and potentially affects much the same habitats as the Red route (i.e. Ballinderry River, broad-leaved woodland, hedgerows, tree lines and agricultural fields). Therefore, the impacts associated with the operational Purple A route on these habitats and their associated significance are anticipated to be much the same as those predicted for the Red route.

The only notable difference is that the Purple A route, at approximately 3,994 m in length, is 8.6% longer than the Red route (3,650 m in length) and so may result in a greater extent of habitat pollution and deterioration, albeit of predominantly habitats of local importance.

Species

The potential impacts of constructing the Purple A route on locally occurring species of conservation concern are anticipated to be much the same as those predicted for the Red route, since the two route options interact with and potentially affect much the same habitats with which those species are expected to be associated. Therefore, the impacts associated with the operational Purple A route on these species and their associated significance are anticipated to be much the same as those predicted for the Red route.

As stated above, the only notable difference is that the Purple A route is longer than the Red route and so might be expected to result in a greater extent of impacts than the Red route.

Purple B Route

Designated Sites

The Purple B route interacts with and potentially affects habitats and qualifying species associated with the Upper Ballinderry River SAC and ASSI, Lough Beg SPA and Ramsar Site, Lough Neagh ASSI and Lough Neagh Islands NR in much the same way as the Red route and Purple A route. Therefore, the impacts associated with the operational Purple B route, should it be selected, on these designated sites and the significance of their associated effects are anticipated to be much the same as those predicted for the Red route and Purple A route.

Similarly, the impacts associated with the operational Purple B route on Cabin Wood Woodland Trust Site and Killymoon Estate Wood SLNCI are anticipated to be much the same as those predicted for the Red route and Purple A route based on their very similar alignments in proximity to these non-statutory designated sites.

Habitats

The Purple B route interacts with and potentially affects much the same habitats as the Red route and Purple A route (i.e. Ballinderry River, broad-leaved woodland, hedgerows, tree lines and agricultural fields). Therefore, the impacts associated with the operational Purple B route on these habitats and their associated significance are anticipated to be much the same as those predicted for the Red route. The only notable difference is that the Purple B route, at approximately 4,292 m in length, is 14% and 6.9% longer than both the Red route and Purple A route respectively and so may result in a greater extent of habitat pollution and deterioration, albeit habitats which are still predominantly of local importance.

Species

The potential impacts of constructing the Purple B route on locally occurring species of conservation concern are anticipated to be much the same as those predicted for the Red route and Purple A route, since the four route options interact with and potentially affect much the same habitats with which those species are expected to be associated. Therefore, the impacts associated with the operational

Purple B route on these species and their associated significance are anticipated to be much the same as those predicted for the Red route and Purple A route.

As stated above, the only notable difference is that the Purple B route is longer than the Red route and Purple A route and so might be expected to result in a greater extent of impacts. Consequently, it could potentially result in impacts of slightly greater significance than the Red route and Purple A route.

Green Route

Designated Sites

As identified in relation to construction impacts, the Green route interacts with and potentially affects habitats and qualifying species associated with the Upper Ballinderry River SAC and ASSI, Lough Beg SPA and Ramsar Site, Lough Neagh ASSI and Lough Neagh Islands NR in much the same way as the Purple A route. Therefore, the impacts associated with the operational Green route, should it be selected, on these designated sites and the significance of their associated effects are anticipated to be much the same as those predicted for the Purple A route.

Similarly, the impacts associated with the operational Green route on Cabin Wood Woodland Trust Site and Killymoon Estate Wood SLNCI are anticipated to be much the same as those predicted for the Red route, Purple A route and Purple B route based on their very similar alignments in proximity to these non-statutory designated sites.

Habitats

As identified in relation to construction impacts, the Green route interacts with and potentially affects very similar habitats as the Purple A route (i.e. Ballinderry River, broad-leaved woodland, hedgerows, tree lines and agricultural fields). Therefore, the impacts associated with the operational Green route on these habitats and the significance of their associated effects are anticipated to be much the same as those predicted for the Purple A route.

The only notable difference is that the Green route, at approximately 3,806 m in length, is 4.7% and 11.3% shorter than the Purple A route (3,994 m in length) and Purple B route (4,292 m in length) respectively and so will result in marginally less habitat pollution and deterioration compared to these route options, albeit of predominantly habitats of local importance. The Green route is however, approximately 4.1% longer than the Red route and so may result in marginally less habitat pollution and deterioration compared to this route option, albeit of predominantly habitats of local importance.

Species

The potential impacts of constructing the Green route on locally occurring species of conservation concern are anticipated to be much the same as those predicted for the Purple A route, since the two route options interact with and potentially affect much the same habitats with which those species are expected to be associated. Therefore, the impacts associated with the operational Green route on these species and their associated significance are anticipated to be much the same as those predicted for the Purple A route.

As stated above, the only notable difference is that the Green route is relatively shorter than the Purple A and Purple B routes and so might be expected to result in marginally lower impacts than these route options.

Sandholes Link Road

Designated Sites

Operation of the upgraded Sandholes Link Road is not predicted to significantly increase the disturbance, mortality, or waterborne pollution risk above that already experienced under the baseline conditions of the existing road. It is possible however, that the anticipated increase in traffic flow capacity will cause a rise in local air emissions. This in turn may result in increased pollution deposition into the Upper Ballinderry River SAC. This could adversely affect the water quality within the SAC and the general habitat condition for the species it supports. Given the international importance of the SAC and its associated qualifying interests such adverse impacts could be of large to very large significance.

Increased levels of air pollution associated with the Sandholes Link Road are unlikely to significantly effect Lough Neagh and Lough Beg SPA and Ramsar Site, Lough Neagh ASSI, Lough Neagh NR, Red route to Cabin Wood Woodland Trust Site or Killymoon Estate Wood SLNCI. This is based on the localised nature of the pollution and distance of separation between the Sandholes Link Road and these designated sites, regardless of hydrological connectivity.

Habitats

Increased levels of airborne pollution may also be expected to adversely affect the habitats associated with the Sandholes Link Road. With most of the habitats being urban/semi-urban habitats of no more than local importance (in isolation) any impacts are predicted to be of no more than slight significance. As detailed above however, air emissions could affect the Ballinderry River, which given the international importance of the SAC, could give rise to adverse impacts of large to very large significance.

Species

Operation of the upgraded Sandholes Link Road is not predicted to significantly increase the disturbance or the risk of mortality or pollution of supporting habitat for most locally occurring species of conservation concern above that already experienced under the baseline conditions of the existing road. The only species which may experience adverse effects are aquatic species (freshwater pearly mussel, white-clawed crayfish and fish) as a result of habitat deterioration in the Ballinderry River caused by increased deposition of air pollution arising from the anticipated increase in traffic flow capacity. Further information is required on the presence and distribution of these and other species in order to fully assess the impacts of the Sandholes Link Road upon them, but given their international importance of freshwater pearl mussel at least, any adverse impacts on them could be of large to very large significance.

There is also potential for bats (and other nocturnal species adapted to urban settings) to be adversely affected by any upgraded streetlighting which may be designed for this part of the proposed scheme. At this stage however, there are no details of any proposed changes to the streetlighting regime to compare against that which currently exists already. Therefore, it is not possible to predict the potential significance of any such impacts on bats.

6.5.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

In light of the predicted effects of the proposed scheme detailed in the sections above, and the impacts they may have on the relevant biodiversity receptors the following outline mitigation measures are proposed in order to avoid or minimise those impacts during the construction and operation of the proposed scheme, as relevant. This list is indicative only, and not exhaustive; essential and desirable mitigation would be identified during DMRB Stage 3.

Construction

- A CEMP will be prepared in advance of works commencing. This will detail the pollution prevention and environmental and ecological mitigation measures and good practice working methods which will be implemented and adhered to throughout the construction of the proposed scheme. The CEMP will include particularly stringent pollution prevention and good practice working methods for works in or near watercourses to avoid/minimise the risk of their pollution, particularly Ballinderry River;
- Retention of bat roosts, and otter and badger resting sites where possible;
- Implementation of sensitive construction methods for all works near otter, badger and bat resting sites, to be carried out under licence as necessary. If any such features are to be destroyed, alternative shelters must be constructed and have become occupied prior to destruction;
- Maintenance of fish passage for watercourse crossings;
- Sensitive timing of works in relation to the fish migration period, in order to avoid/minimise vibrational disturbance;
- Felling of trees and clearance of vegetation to be undertaken outside of bird breeding season, or otherwise only following pre-clearance checks by a suitably qualified ecologist within 24 hours in advance. Any active nests identified through such checks will be protected by a works exclusion zones to a distance commensurate with the sensitivity of the species in question;
- Screening of works in the unlikely event that waterbirds associated with Lough Neagh and Lough Beg SPA and Ramsar Site are found to use habitats along the proposed scheme to forage;
- Avoidance of woodland with mature or semi-mature trees, retention of habitat connectivity;
- Integrate woodland into the development as boundary features to ensure their long-term management and retention;
- Avoidance of species-rich hedgerow, those containing large trees or which form town boundaries and retention of characterful hedgerows and/or those which provide connectivity through the wider surrounding area where possible;
- Integration of hedgerows into the development as boundary features or part of the open space provision to ensure their long-term management and retention;
- Planting of native trees and hedgerows with species of local provenance as part of the landscaping scheme to create wildlife buffer zones, commuting corridors and foraging habitat away from the road, connecting where possible, to existing habitat features (e.g. hedgerows, woodland and watercourses); and
- Avoidance and/or control/management of invasive non-native plant species along the route to prevent their spread.

Operation

- Incorporation of mammal passes and entrainment fencing for otters (along watercourses) and badgers (on identified commuting pathways) along the proposed scheme; and

- Sensitive lighting design to avoid disturbance to bats and avoid discouraging them from favoured commuting routes and/or foraging areas; lighting (both during construction and operation) should comply with specifications in the latest guidance from BCT[26].

It is anticipated that implementation of the above measures, as and where feasible, would reduce the predicated significance of adverse impacts to the residual impacts presented in Table 6-18.

Table 6-18 – Overall Summary of Effects* for Biodiversity during Construction (C) and Operation (O)

Receptor	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Upper Ballinderry River SAC	C&O - Slight	C&O - Slight	C&O - Slight	C&O - Slight	None
Lough Neagh and Lough Beg SPA and Ramsar Site	C&O - Neutral	C&O - Neutral	C&O - Neutral	C&O - Neutral	None
Upper Ballinderry River ASSI	C&O – Slight	C&O - Slight	C&O - Slight	C&O - Slight	None
Lough Neagh ASSI	C&O - Neutral	C&O - Neutral	C&O - Neutral	C&O - Neutral	None
Lough Neagh Islands Nature Reserve	C&O - Neutral	C&O - Neutral	C&O - Neutral	C&O - Neutral	None
Killymoon Estate Wood SLNCI	C&O - Neutral or Slight	C&O - Neutral or Slight	C&O - Neutral or Slight	C&O - Neutral or Slight	None
Cabin Wood Woodland Trust Site	C&O - Neutral or Slight	C&O - Neutral or Slight	C&O - Neutral or Slight	C&O - Neutral or Slight	None
Ballinderry River	C&O – Slight	C&O - Slight	C&O - Slight	C&O - Slight	None
Minor watercourses	C&O - Neutral or Slight	C&O - Neutral or Slight	C&O - Neutral or Slight	C&O - Neutral or Slight	None
Ancient Semi-natural Woodland	C&O - Slight	C&O - Slight	C&O - Slight	C&O - Slight	None
Oak and Mixed Ash Woodland	C&O - Slight	C&O - Slight	C&O - Slight	C&O - Slight	None
Semi-natural broad-leaved woodland	C&O - Neutral or Slight	C&O - Neutral or Slight	C&O - Neutral or Slight	C&O - Neutral or Slight	None
Tree lines	C - Neutral or Slight O - Neutral	C - Neutral or Slight O - Neutral	C - Neutral or Slight O - Neutral	C - Neutral or Slight O - Neutral	None

[26] BCT (2018). Bats and artificial lighting in the UK, Guidance Note 08/18.

Receptor	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Hedgerows (species-rich and species-poor)	C&O - Slight	C&O - Slight	C&O - Slight	C&O - Slight	Negligible
Semi-improved neutral grassland	C&O - Neutral	C&O - Neutral	C&O - Neutral	C&O - Neutral	None
Otter	C&O - Slight	C&O - Slight	C&O - Slight	C&O - Slight	None
Badger	C&O - Slight	C&O - Slight	C&O - Slight	C&O - Slight	None
Bats	C&O - Yet to be determined for all four options depending on findings of dedicated surveys				None
Freshwater pearl mussel	C&O - Yet to be determined for all four options depending on findings of dedicated surveys				None
Fish	C&O - Yet to be determined for all four options depending on findings of dedicated surveys				None
White-clawed crayfish	C&O - Yet to be determined for all four options depending on findings of dedicated surveys				None
Birds	C&O - Yet to be determined for all four options depending on findings of dedicated surveys				None
Irish hare	C&O - Yet to be determined, but predicted to be no more than slight across all four options				None
Hedgehog	C&O - Yet to be determined, but predicted to be no more than slight across all four options				None

*Summary of Effects includes Sandholes Link Road for each route.

As identified in Table 6-18, the residual impacts on the various biodiversity receptors associated with the proposed scheme are comparable across all four route options (no worse than slight adverse). This is because the Red route, Purple A route, Purple B route and Green route cross the Ballinderry River at the same location and pass through much the same woodland and agricultural habitats and interact with the various ecological designated sites in much the same way as each other, despite their different alignments in the northern half of the proposed scheme.

The most notable difference between the four route options, as noted in the Assessment of Impacts section, is that the footprints of the Purple A route, Purple B route and Green route take up much larger areas than the Red route and so will result in greater extents of habitat loss and fragmentation, albeit habitats of predominantly local importance which are common to all route options. These larger route option footprints may also have proportionately greater impacts on locally occurring species. Since the Green route has the largest footprint of all four route options, their preferred order from an ecological perspective is as follows:

- 1st preference: Red route (based on having the smallest footprint of the four route options, despite comparable ecological effects);
- 2nd preference: Purple A route (based on having a 8.4% larger footprint than the Red route, but a 1.3% and 5.4% smaller footprint than the Purple B route and Green route respectively, despite comparable ecological effects);

- 3rd preference: Purple B route (based on having a 9.8% and 1.3% larger footprint than the Red route and Purple A route respectively, but a 4.2% smaller footprint than the Green route, despite comparable ecological effects); and
- 4th preference: Green route (based on having the largest footprint (14.6%, 5.7% and 4.3% greater than the Red route, Purple A route and Purple B respectively), despite comparable ecological effects).

6.6. GEOLOGY AND SOILS

6.6.1. ASSESSMENT SCOPE

This section reports the outcome of the assessment of likely effects arising from the proposed scheme route options on geology and soils.

The assessment of this topic area follows DMRB LA 109 Geology and Soils[27] and considers potential impacts relating to the following receptors:

- Effects on geology and soils including geological designations;
- Effects on soil resources;
- Effects from contamination on human health (site users and adjacent site users including construction workers); and
- Effects on surface waters and groundwater.

Only effects on controlled waters in the context of geology and soils is discussed and considered. Reference should also be made to Section 6.11 Road Drainage and the Water Environment which covers wider hydrology and hydrogeological issues. Effects on ecological receptors are reported in Section 6.5 Biodiversity. Material assets and waste are considered within Section 6.7.

This geology and soils section describes the assessment methodology, the baseline conditions across the study area and provides some assumed mitigation measures. It includes a summary of the likely effects taking into account national legislation, and describes the further mitigation measures required to prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

6.6.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the geology and soils assessment are provided in Environmental Appendix B.

6.6.1.2. Study Area

The study area comprises the proposed scheme footprint and a surrounding 250 m buffer area, although a 1,500 m search area from the proposed scheme footprint for sites of geological interest is used. The study area complies with the requirements of DMRB LA 109. In addition, the 250 m buffer is suitable for the requirements of CIRIA C552[28] to assess for sites such as gasworks, landfills, dye

[27] Highways England, (2019). DMRB LA 109 Geology and Soils. [online] Available at: https://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/LA%20109%20Geology%20and%20soils-web.pdf [Accessed 27/02/2020].
[28] Rudland, D. J., Lancefield, R. M. and Mayell, P. N., (2001). Contaminated land Risk Assessment, A Guide to Good Practice (C552). CIRIA.

works and bleach works, which can be particularly contaminated and from which contamination could have migrated into the proposed scheme footprint.

6.6.1.3. Methodology

The assessment was undertaken in accordance with the DMRB guidance LA 109 Geology and Soils. For more detail on methodology refer to Environmental Appendix B.

6.6.1.4. Consultation

The following consultees were consulted during the assessment process and their responses are summarised:

Mid Ulster Council Environmental Health Department.

- Assessment of any potential for contamination risk to proposed sensitive receptors to be undertaken in line with the guidance set out in the Model Procedures for the Management of Land Contamination (CLR11);
- The Environmental Health Service confirmed they have no specific information relating to contaminated land along the route options; and
- The Environmental Health Service confirmed NIEA are the primary regulators in relation to illegal waste disposal and have powers to require the proper disposal of such waste, or deal with waste where there is imminent danger, and may have records to this effect.

DAERA

- DAERA noted that the development may encounter areas of contaminated land and advised that the applicant should consult the NIEA Historical Land Use Layer and other available sources of information, to identify current and previous industrial land uses of the application site and in the surrounding area (within 250 m) that may have caused the land at the site to become contaminated. The Land Use Layer includes information on landfills and waste management operations across NI and is available to view and search through the Spatial NI Geoportal at: https://www.spatialni.gov.uk/geoportal/catalog/main/home.page; and
- DAERA confirmed that should potential contaminating activity be identified then a Preliminary Risk Assessment (PRA) should be provided, as a minimum, to further identify land contamination issues for the application site.

6.6.1.5. Assumption and Limitations

Details of assumptions and limitations for geology and soils assessment are provided in Environmental Appendix B.

6.6.2. BASELINE CONDITIONS

6.6.2.1. Geology

Published Bedrock Geology

Sheet 27[29] and 35[30] (1:50,000 scale geological maps) indicate four main stratigraphic units across the study area:

- Rossmore Mudstone Formation - Dark grey mudstone, thin siltstone beds and fine grained mudstone located in the south of the study area;

[29] GSNI, (2010). Sheet 27. 1:50,000 scale geological maps. Geological Survey of Northern Ireland.
[30] GSNI, (1995). Sheet 35. 1:50,000 scale geological maps. Geological Survey of Northern Ireland.

- Derryloran Formation - Fine grained conglomerates and sandstone located in the northern part of the Sandholes Link Road study area with small areas in the central part of the study area to the south of Clare Lane;
- Rockdale Formations - Shelly limestone and thin beds of mudstone and sandstone located across much of the central portion of the study area; and
- Sherwood Sandstone Group - Breccia and sandstone located in the north and east of the study area.

Published Superficial Geology

Sheet 27 and 35 (1:50,000 scale) geological maps indicate the following superficial deposits across the study area:

- Glacial Till is the primary superficial deposit in the study area. However, river terrace deposits, alluvium and glaciofluvial deposits are also present.

Encountered Natural Geology

The WSP Ltd PSSR[31] presents a summary of the ground conditions recorded during previous phases of intrusive GI targeting the Red, Purple A and Purple B routes.

Peat and organic rich deposits were identified in isolated areas across the study area. They were generally associated with areas of low-lying ground and waterways.

Alluvial and River Terrace deposits were also encountered in areas of low-lying ground and waterways. Alluvial deposits were significant around the Fairy Burn, Ballinderry River, and near the Lissan Water. River Terrace deposits were generally concentrated around the Ballinderry River and Lissan Water, although historical logs describe a significant area of River Terrace deposits between Cloghog Road and B73 Coagh Road on the Red route. The Alluvium and terrace deposits encountered were variable in strength and density.

Glaciofluvial deposits were generally focused south of the Fairy Burn, and in the northern section of the study area near the Moneymore A29 Road tie in. These deposits were recorded as highly variable and often difficult to distinguish from weathered (softened) Till.

Glacial Till deposits are the predominant drift geology across the study area. Due to their nature of deposition, they are over consolidated and therefore, generally firm to stiff in consistency. The drumlin topography surrounding Cookstown was formed of Glacial Till.

Bedrock was encountered in several locations within the study area. The underlying bedrock was generally Sandstone, although Mudstone and Limestone were also encountered at the Ballinderry River. The Mudstone was generally very weak to weak in strength, whilst the Sandstone was weak to moderately strong. Table 6-19 below summarises the ground conditions encountered during the previous phases of intrusive works. It should be noted that the previous phases of intrusive work were not targeted at the Green route or the new alignment of the Sandholes link road as this was not a developed route option during these works.

[31] WSP, (2020). Preliminary Site Sources Report 2020.

Table 6-19 – Summary of Natural Ground Encountered

Geological Unit	General Description	Depth Encountered (m bgl)	Typical Thickness (m)	General Location
Topsoil	Soft to firm, dark brown, slightly sandy, slightly gravelly clay with rootlets	0.0	0.2 – 0.5	Across Red route, Purple A route and Purple B route
Peat	Soft, black, fibrous peat	0.3 – 0.6	0.2 – 0.9	Isolated areas, including near Loughry roundabout and Kidds Bridge
Alluvium	Very loose to loose, light brown to reddish brown, slightly silty, slightly clayey, slightly gravelly, fine to coarse sand and firm, reddish brown, slightly sandy, slightly gravelly clay	0.3 – 0.4	3.0 – 7.5	Generally localised around watercourses
River Terrace Deposits	Stiff to very stiff, reddish brown, slightly sandy, slightly gravelly clay with low to medium cobble content	3.0	13.5	Ballinderry River and Lissan Water
Glaciofluvial Deposits	Soft to very stiff, reddish brown, slightly sandy, slightly gravelly clay with low to medium cobble content Loose to very dense, greyish brown, clayey, sandy, gravel with medium cobble content	0.1	In excess of 9.4m	Near Moneymore Road and the southern end of Sandholes Road
Glacial Till	Firm to stiff, red brown, silty, slightly gravelly, sandy clay with low to medium cobble content Firm to very stiff, light brown to orange brown, sandy, gravelly silt with frequent cobbles and boulders. Medium dense, reddish brown, gravelly, fine to coarse sand with low cobble content	0.4 – 3.0	In excess of 20m	Main superficial lithological unit underlying most of the study area
Sandstone	Moderately strong to weak, weathered, orange brown sandstone Unweathered, grey brown to red brown sandstone	0.4 – 7.1	Not proven	Main bedrock lithological unit underlying most of the study area
Limestone	Completely weathered, brown, Marl and sandy limestone	3.5 – 5.2	Not proven	Ballinderry River crossing
Mudstone	Slightly to moderately weathered, weak or very weak, reddish brown mudstone	11.0 – 16.5	Not proven	Ballinderry River crossing

6.6.2.2. Made Ground

Made Ground was encountered in isolated areas across the study area. Where associated with existing roads, it is likely to have been placed with controlled compaction. Elsewhere it is likely to be un-engineered, may contain various material of differing strengths, and has potential for contaminants.

2008 Ground Investigation

The preliminary GI in 2008 only targeted the Red route, Purple A route and Purple B route and identified made ground at the locations identified within Table 6-20.

Table 6-20 – Summary of Made Ground Recorded During the 2008 Ground investigation

Exploratory Hole Location	Route	Chainage (m)	Depth of Made Ground
TP04	Purple B route, south east of Cloghog Road roundabout	1600	0.0 m to 2.8 m
TP15	Purple B route	3550	0.0 m to 0.4 m
BH09	Red route, adjacent to Cloghog Road roundabout	1650	0.0 m to at least 3.10 m
BH09A	Red route, adjacent to Cloghog Road roundabout	1650	0.0 m to 3.0 m
TP05	Red route, adjacent to Cloghog Road roundabout	1700	0.0 m to 2.1 m
TP08	Red route, north of Cloghog Road roundabout	1950	0.0 m to 0.5 m
TP16	To the west of the Red route	N/A	0.0 m to at least 4.0 m

The made ground generally comprised reworked natural soils with concrete and brick although plastic was also recorded in TP04 and TP08. However, TP16 where the thickest made ground was recorded (although this is away from any of the route options) also recorded glass, brick, plastic, tile, ceramic and slate. None of the Engineers logs recorded gross contamination.

Limited chemical testing was undertaken on samples from TP04, TP05 and TP16 for a standard suite of determinants comprising:

- Metals and non-metals;
- Total Petroleum Hydrocarbons;
- Phenols;
- Volatile Organic Compounds; and
- Semi-Volatile Organic Compounds.

The chemical testing does not appear to indicate gross contamination, although screening against generic human health assessment or controlled water criteria has not been undertaken.

2011 Ground Investigation

A further phase of GI in 2011 targeted the Purple A route and identified made ground at 23 locations. This is presented in Table 6-21. It should be noted that the chainages referenced below are from the 2011 highway design and may not align with the current design.

Table 6-21 – Summary of Made Ground Identified During the 2011 Ground Investigation

Exploratory Hole Location	Approximate Chainage (m)	Depth of Made Ground
BH1-11	50	0.0 m to at least 2.4 m
BH1A-11	50	0.0 m to 4.0 m
BH2-11	150	0.0 m to 0.9 m
BH2-11R	125	0.0 to 3.0 m
BH18-11	1400	0.0 m to 2.2m
BH19-11	1600	0.0 m to at least 1.8 m
BH34-11	Sandholes Road 400	0.0 m to 3.0 m
TP1-11	50	0.0 m to at least 3.0 m
HDP1-11	3150	0.0 m to at least 1.2 m
HDP2-11	3150	0.0 m to at least 1.2 m
WS1-11	Sandholes Road 600	0.0 m to 2.0 m
WS2-11	Sandholes Road 590	0.0 m to 1.75 m
WS3-11	Sandholes Road 580	0.0 m to 1.65 m
WS4-11	Sandholes Road 520	0.0 m to 1.32 m
WS6-11	Sandholes Road 380	0.0 m to at least 1.2 m
WS6A-11	Sandholes Road 380	0.0 m to 1.6 m
WS7-11	Sandholes Road 320	0.0 m to at least 1.45 m
WS8-11	Sandholes Road 260	0.0 m to 0.1 m
WS10-11	Sandholes Road 80	0.0 m to 0.8 m
WS12-11	Sandholes Road 50	0.0 m to 0.3 m
WS13-11	Sandholes Road 10	0.0 m to 0.2 m
WS15-11	Sandholes Road -40	0.0 m to 0.5 m
WS16-11	Sandholes Road -40	0.0 m to at least 1.5 m
WS16A-11	Sandholes Road -40	0.0 m to at least 1.8 m

The made ground recorded along the Purple A route generally comprised reworked natural soils with wood, glass, slate, plastic and ceramics; although the Engineers logs for a number of locations did not specify the made ground constituents. The Engineers logs do not record gross contamination.

Limited chemical testing was undertaken on samples from WS1-11 and WS16A for a standard suite of determinants comprising:

- Metals and non-metals;
- Polyaromatic Hydrocarbons; and
- Phenols.

The limited chemical testing does not appear to indicate gross contamination, although screening against generic human health assessment or controlled water criteria has not been undertaken.

6.6.2.3. Soil Classification

The soil map for Northern Ireland developed using the WRB indicates the soil classifications in the study area.

The majority of the study area is covered with Cambisols. These are soils at the beginning of soil formation and horizon differentiation is therefore weak. Cambisols are developed in medium and fine-textured materials derived from a wide range of rocks, mostly in alluvial, colluvial and aeolian deposits. Cambisols make good agricultural land and are intensively used.

There is a small area in the south west corner of the study area that is covered with Stagnosols. These are soils with strong mottling of the soil profile due to redox processes caused by stagnating surface water. Stagnosols are periodically wet and mottled in the topsoil and subsoil and are developed in a wide variety of unconsolidated materials like glacial till, and loamy aeolian, alluvial and colluvial deposits and physically weathered siltstone. The agricultural suitability of Stagnosols is limited because of their oxygen deficiency resulting from stagnating water above a dense subsoil. Therefore, they have to be drained. Drained Stagnosols can be fertile soils owing to their moderate degree of leaching.

The Cookstown urban area is classified as urban soils.

6.6.2.4. Agricultural Land Classification

The Sandholes Link Road is wholly within the area of urban soils associated with Cookstown. Within the study area there are areas of Grade 2, Grade 3B and Grade 4 agricultural soils beyond the extent of the urban area.

Agricultural Land Classification outside of the Cookstown urban area is mainly classified as Grade 2 (very good quality agricultural land); land with minor limitations which affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown but on some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than Grade 1. Based on the available soil mapping, the following total area of loss of Grade 2 agricultural soil have been calculated within the proposed fenceline of the route options:

- Red route – 25.84 ha;
- Purple A route – 31.84 ha;
- Purple B route – 29.23 ha; and
- Green route – 34.50 ha.

However, it should be noted that the above calculation does not take into account land that is not currently in agricultural use having been previously developed but is still classified on the Geological Survey of Northern Ireland, Digimap NI107 mapping as agricultural i.e. Killymoon Golf Club, existing highways, watercourses, commercial properties, residential properties and former railway lines. Taking approximate areas for these non-agricultural land uses into account reduces the areas of Grade 2 agricultural loss to the following approximations:

- Red route – approximately 19.36 ha;
- Purple A route – approximately 24.78 ha;
- Purple B route – approximately 24.55 ha; and
- Green route – approximately 26.20 ha.

Discrete areas across the study area are classified as Grade 3B (moderate quality agricultural land). Land capable of producing moderate yields of a narrow range of crops, principally cereals and grass or lower yields of a wider range of crops or high yields of grass which can be grazed or harvested over most of the year. Loss of Grade 3B agricultural soils varies as follows:

- Red route - 5.16 ha;
- Purple A route - 5.12 ha;
- Purple B route - 7.56 ha; and
- Green - 4.83 ha.

Towards the centre of the study area close to Clare Lane, there is a small area classified as Grade 4A mineral soil (Poor Quality Agricultural Land); land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land. Loss of Grade 4A agricultural soils varies as follows:

- Red route - 0.99 ha;
- Purple A route - 1.08 ha;
- Purple B route - 1.09 ha; and
- Green route - 0.82 ha.

6.6.2.5. Mining and Quarrying

A review of the OSNI Geo Index shows no record of mining activities within the study area, however, historical mapping indicates the presence of former mineral workings, quarries and gravel pits:

- Historical mineral workings, recorded as limestone quarries and limekilns are located on the alignment of the Red route, Purple A route, Purple B route and Green route between the Waste Water Treatment Works and the Ballinderry River, approximately at Ch550 m. This is identified by OSNI as a quarry in use between circa 1904 and circa 1930;
- Historical ceramics, cement and asphalt manufacturing works, recorded as limestone quarries and limekilns are located on the Red route, at the junction of Clare Lane and Molesworth Road at approximate Ch1800 m. No information on the date of use is available on the OSNI website; and
- Historical mineral workings, recorded as limestone quarries and limekilns are present adjacent to the northern side of Coagh Road at approximate chainage Ch2300 m and are recorded by OSNI as being active between circa 1834 and circa 1856. Whilst not directly on the Red route, this site is within the embankment works for the Red route / Coagh Road crossing.

6.6.2.6. Topography

The topography within the study area is generally undulating with drumlins rising to approximately 20 m above the surrounding ground level. Between drumlins, the ground level is generally flat and low lying. The existing road network is predominantly at grade following the contours.

The route options are in part constrained by the Ballinderry River and the drumlin topography.

6.6.2.7. Hydrology

The main surface watercourse in the study area is Ballinderry River which meanders from west to east through the southern part of the study area. In the south east corner of the study area, the Killymoon River flows north and meets the Ballinderry River.

Further detail can be found in Section 6.11 - Road Drainage and the Water Environment.

6.6.2.8. Hydrogeology

The NIEA designates the hydrogeology as follows:

- Sherwood Sandstone Formation - a high productivity fracture/intergranular flow aquifer. These aquifers can provide high to moderate yields but are dependent on fracture flow and include an element of regional flow;
- Rockdale Limestone and Derryloran Formations - moderate potential productivity fracture flow aquifers which can provide high to moderate yields. These aquifers may provide regional flow and provide significant local flow; and
- Rossmore Mudstone Formation - limited productivity fracture flow aquifer that can provide moderate yields, although low yields are more common. Regional flow is limited and shallow.

The Groundwater Vulnerability Map of Northern Ireland indicates the following:

- In the eastern part of the study area, high potential productivity with fracture/intergranular flow;
- In the western part of the study area, moderate potential productivity with fracture flow; and
- In the south west part of the study area, limited potential productivity with fracture flow.

Further detail can be found in Section 6.11- Road Drainage and the Water Environment.

6.6.2.9. Designated Sites

There are no geologically designated sites within the study area. However, there are other designated sites nearby. Those that could be affected by impacts on geology and soils are noted below:

- Bally Sudden ASSI, is located approximately 1.3 km south west of the Sandholes / A29 junction roundabout. This ASSI is composed of Carboniferous limestone palaeokarst features;
- Upper Ballinderry River ASSI is located within 1 km to the north west of the Sandholes Link Road and is classified as a result of Otters and Freshwater Pearl Mussels;
- Upper Ballinderry River SAC is located within 1 km to the north west of the Sandholes Link Road and is classified as a result of its water courses of plain to montane levels and flora; and
- The study area is hydraulically linked to the Lough Neagh SPA / ASSI and the Upper Ballinderry River via a number of watercourses.

Further detail can be found in Section 6.11- Road Drainage and the Water Environment and Section 6.5 - Biodiversity.

6.6.2.10. POTENTIALLY CONTAMINATED LAND

With the exception of the Sandholes Link Road, the route options are predominantly within an agricultural environment. Residential development is sporadic outside of the town boundaries and generally occurs as isolated single dwellings and farms. Industrial development is generally confined within the current town boundaries. The Sandholes Link Road will be constrained by the existing industrial development.

The walkover undertaken on 12 February 2019 by the WSP geotechnical team did not identify any areas where widespread contamination appeared to be present. However, isolated sites were identified that could contain contamination including;

- car sales/repair;
- depots;

- spoil heaps;
- fuel storage/sales (active and disused);
- water treatment works;
- disused railway line;
- historic landfill; and
- disused and infilled quarries and sand and gravel pits.

The disused railway line crosses the study area generally in cutting. Some infilling of the cutting may have occurred and could contain contaminated materials. Contamination, in particular, hydrocarbons from oils and grease could also be present in the subsoils as a result of the previous use.

The historic landfill noted above is located between Coagh Road and Limekiln Lane and was operated by Cookstown District Council. This could contain contaminated soils and could also be generating landfill gas but is located approximately 400 m west of the Red route and is therefore not considered likely to pose a significant risk to geology and soils within the study area.

Several former quarries and sand and gravel pits are noted on historical maps of the area and also within historical land use data. Those that are on or close to the route options and could therefore pose a risk to geology and soils are discussed in Section 6.6.2.5. It is possible that they were infilled in an uncontrolled manner and could contain contaminated material. The possibility of encountering contamination cannot therefore be ruled out during GI or construction.

The following response was received on 4 October 2019 from Mid Ulster Council Environmental Health Department in relation to contaminated land – '*Part three of the Waste and Contaminated land order has not been enacted in Northern Ireland and so land contamination is dealt with through land use planning. In the event that there is a request for planning approval, this department would request the applicant to assess any potential for contamination risk to proposed sensitive receptors in line with the guidance set out in the Model Procedures for the Management of Land Contamination (CLR11)*.

The Environmental Health Service has no specific information relating to contaminated land along either of the proposed routes.

The NIEA are the primary regulators in relation to illegal waste disposal and have powers to require the proper disposal of such waste, or deal with waste where there is imminent danger, and may have records to this effect'.

The DAERA consultation response dated 21 October 2019 provides the following in relation to contaminated land – '*DAERA (NIEA) Regulation Unit have considered the proposal and would make the following comments: …… Regulation Unit (RU) note that the development may encounter areas of contaminated land. It is advised that the applicant should consult the NIEA Historical Land Use Layer and other available sources of information, to identify current and previous industrial land uses of the application site and in the surrounding area (within 250 meters) that may have caused the land at the site to become contaminated. The Land Use Layer includes information on landfills and waste management operations across NI and is available to view and search through the Spatial NI Geoportal at: https://www.spatialni.gov.uk/geoportal/catalog/main/home.page*.

Should potential contaminating activity be identified then a Preliminary Risk Assessment (PRA) should be provided, as a minimum, to further identify land contamination issues for the application site.'

The NIEA Historical Land Use Layer available on the OSNI Spatial NI Geoportal was consulted and identified the following potentially contaminative historical site uses in addition to those identified during the walkover and listed above

- unspecified works;
- tape and webbing factory;
- textile works;
- timber products manufacturing (saw mill); and
- flax mill.

6.6.2.11. POTENTIAL CONTAMINATED LAND CONSTRAINTS

The table below summarises the potential contaminated land constraints including those discussed above and those identified from the Constraints Map presented in the WSP PSSR report[32] in Drawing 718314-WSP-B-D-0600-0001.

Table 6-22 – Summary of Potential Contaminated Land Constraints

Constraint	Approximate Chainage (m)	Affected Route
Area of filled ground at the abandoned development site at the Loughry roundabout	0	Red route, Purple A route, Purple B route and Green route
Possible contaminated soil - McKernan Construction Ltd site at 20 Dungannon Road – Paragraph 19 exemption from waste licensing for soil and stones.	250	Red route, Purple A route, Purple B route and Green route although it is difficult to pinpoint the exact location of the site from the OSNI website.
Possible made ground within the Waste Water Treatment Works	550	Red route, Purple A route, Purple B route and Green route
Former mineral workings	550	Red route, Purple A route, Purple B route and Green route
Unspecified: chemical works, engineering works, building works, factories, fuel oil suppliers	800	Red route, Purple A route, Purple B route and Green route
Textile works and dye works - tape and webbing factory	800	Red route, Purple A route, Purple B route and Green route although the site is located off the main route options footprint and may only be within the amendments to Castle Road
Former railway line	1650	Purple A route, Purple B route and Green route
Ceramics, cement and asphalt manufacturing works	1800	Red route
Former railway line	1800	Red route
Former mineral workings	2300	Red route. Whilst not directly on the Red route, this site is within the embankment works for the Red route / Coagh Road crossing
Former railway line	2650	Red route

[32] WSP, (2019). Preliminary Site Sources Report 2020. WSP

Constraint	Approximate Chainage (m)	Affected Route
Former railway line	3150	Purple A route, Purple B route and Green route
Road vehicle fuelling, service and repair: garages and filling station on Moneymore Road	4300	Purple B route
General made ground and urban ground conditions	0 to 650	Sandholes Link Road
General made ground associated with construction of existing highways	0 to 4300	Red route, Purple A route, Purple B route, Green route and Sandholes Link Road

6.6.2.12. Sensitive Receptors

The following potential sensitive receptors and their sensitivity are detailed in the table below.

Table 6-23 – Receptor Sensitivity

Receptor	Sensitive Receptor	Sensitivity
Geology	Bedrock geology	Low
Soils (Agricultural)	Surface soils including agricultural land outside the Cookstown urban area classified as Agricultural Land Classification Grade 2	Very High
Soils (Agricultural)	Surface soils including agricultural land outside the Cookstown urban area classified as Agricultural Land Classification Grade 3B	Medium
Soils (Agricultural)	Surface soils including agricultural land outside the Cookstown urban area classified as Agricultural Land Classification Grade 4A	Low
Soils (Urban)	Surface soils within the Cookstown urban environment	Negligible
Human Health	Site users and adjacent site users including children for a low sensitivity land use (highway)	Low
Controlled Waters	Surface water courses comprising Ballinderry River and various drains	High (Ballinderry River and Fairy Burn) and medium (various drains)
Controlled Waters	Underlying aquifers including public water abstractions	High

6.6.2.13. Potential Pathways

Potential pathways which may exist or become apparent during construction and/or once the proposed scheme is constructed and operational are as follows:

- Human health – ingestion of or dermal contact with contaminated soils or inhalation of contaminated dust, organic vapours or ground / landfill gas; and
- Controlled waters – vertical and lateral migration of mobile contaminants into groundwater and/or surface water, surface run off and direct spills. This includes the potential for construction works in the vicinity of potentially contaminated sites to create new migration pathways through permeable or semi-permeable strata.

6.6.2.14. FUTURE BASELINE

Future geology and soils baseline is not envisaged to change over the lifespan of the proposed scheme.

6.6.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

This section assesses the potential effects of the route options on the receptors identified above in Table 6-23. Potential effects during both construction and operation are assessed although effects on geology and soils are considered likely to be most significant during the construction phase which will include major earthworks.

6.6.3.1. Construction

Detriment to Human Health - Site Users, Adjacent Site Users and Construction Workers

Red route

If human health receptors (site users (including children)), adjacent site users, construction workers and maintenance workers) are exposed to contaminants there is potential for both temporary and permanent health problems to arise. These are dependent on a number of factors including type of potential contaminant (e.g. physical contaminants such as asbestos, or chemical contaminants such as arsenic or hydrocarbons), characteristics of the receptor and duration of the exposure. The length of exposure will also depend on a number of factors such as the amount of time workers spend in the construction area or for site users and adjacent site users, the actual duration of the construction works.

Excavation of potentially contaminated soils could pose a health risk to the public in the immediate vicinity of the study area during the construction period, through inhalation of contaminated dusts and particulate matter generated by excavation activities.

Construction workers are susceptible to exposure to hazardous gases (primarily methane, hydrogen sulphide, carbon monoxide and carbon dioxide) and/or depleted oxygen levels associated within excavations or confined spaces associated with the earthworks and installation of any below GI (e.g. drainage chambers).

The use of machinery and plant associated with the proposed scheme preparation, earthworks and construction activities could give rise to contamination risk to soils, through accidental fuel/oil spills and leaks, and storage of chemicals or fuels. Soils impacted by fuel/oil spills and leaks may represent a future source of contamination to human health.

The sensitivity of the receptor is considered to be low and the magnitude of the effect is considered to be moderate, based on currently available information. There is therefore likely to be a slight adverse effect on human health.

Purple A route

The above potential effects identified for the Red route are applicable to the Purple A route during construction. There is not considered to be any discernible difference between the Purple A route and the other route options for Detriment to Human Health.

Purple B route

The above potential effects identified for the Red route are applicable to the Purple B route during construction. There is not considered to be any discernible difference between the Purple B route and the other route options for Detriment to Human Health.

Green route

The above potential effects identified for the Red route are applicable to the Green route during construction. There is not considered to be any discernible difference between the Green route and the other route options for Detriment to Human Health.

Sandholes Link Road

If human health receptors (site users (including children)), adjacent site users, construction workers and maintenance workers) are exposed to contaminants there is potential for both temporary and permanent health problems to arise. These are dependent on a number of factors including type of potential contaminant (e.g. physical contaminants such as asbestos, or chemical contaminants such as arsenic or hydrocarbons), characteristics of the receptor and duration of the exposure. The length of exposure will also depend on a number of factors such as the amount of time workers spend in the construction area or for site users and adjacent site users, the actual duration of the construction works.

Excavation of potentially contaminated soils could pose a health risk to the public in the immediate vicinity of the study area during the construction period, through inhalation of contaminated dusts and particulate matter generated by excavation activities.

Construction workers are susceptible to exposure to hazardous gases (primarily methane, hydrogen sulphide, carbon monoxide and carbon dioxide) and/or depleted oxygen levels associated within excavations or confined spaces associated with the earthworks and installation of any below GI (e.g. drainage chambers).

The use of machinery and plant associated with the proposed scheme preparation, earthworks and construction activities could give rise to contamination risk to soils, through accidental fuel/oil spills and leaks, and storage of chemicals or fuels. Soils impacted by fuel/oil spills and leaks may represent a future source of contamination to human health.

The sensitivity of the receptor is considered to be low and the magnitude of the effect is considered to be moderate, based on currently available information. There is therefore likely to be a slight adverse effect on human health.

Pollution of Controlled Waters

Red route

The disturbance of contaminated ground and the storage of fuel/oils on the study area during the construction phase have the potential to result in mobilisation and release of contaminants, increasing the potential to negatively impact controlled water.

Potential historical sources of contamination have been identified. Earthworks associated with the construction of the proposed scheme could potentially disturb and release mobile historical contamination impacting controlled waters.

The use of machinery and plant associated with construction activities could give rise to a pollution risk to soils, groundwater and surface water features through accidental fuel/oil and chemical spills and leaks. Soils impacted by spills and leaks may also represent a source of contamination to controlled waters via leaching.

Water pumped from excavations may contain contaminants, which if not managed appropriately could result in discharge and contamination of surrounding surface watercourses.

During construction of buried structures/foundations, new pathways for mobile contaminants to migrate downwards and impact the deeper aquifers could be created.

Contaminated runoff could be generated during the earthworks phase of the proposed scheme, including hydrocarbon contamination and high suspended solid loads, associated with the operation of vehicles. This has the potential to migrate and pollute surrounding surface water courses.

The sensitivity of the Ballinderry River and Fairy Burn receptors is considered to be high and the magnitude of the effect is considered to be negligible based on currently available information. There is therefore likely to be a slight adverse effect on surface waters.

The sensitivity of the various drain surface watercourse receptors is considered to be medium and the magnitude of the effect is considered to be negligible based on currently available information. There is therefore likely to be a neutral effect on surface waters.

The sensitivity of the aquifer water receptor is considered to be high and the magnitude of the effect is considered to be negligible based on currently available information. There is therefore likely to be a slight adverse effect on aquifer waters.

Section 6.11 Road Drainage and the Water Environment further discusses other water related effects and should be read in conjunction with this Geology and Soils Section.

Purple A route

The above potential effects identified for the Red route are applicable to the Purple A route during construction. There is not considered to be any discernible difference between the Purple A route and the other route options for Pollution of Controlled Waters.

Purple B route

The above potential effects identified for the Red route are applicable to the Purple B route during construction. There is not considered to be any discernible difference between the Purple B route and other route options for Pollution of Controlled Waters.

Green route

The above potential effects identified for the Red route are applicable to the Green route during construction. There is not considered to be any discernible difference between the Green route and the other route options for Pollution of Controlled Waters.

Sandholes Link Road

The disturbance of contaminated ground and the storage of fuel/oils on the study area during the construction phase have the potential to result in mobilisation and release of contaminants, increasing the potential to negatively impact controlled water.

Potential historical sources of contamination have been identified. Earthworks associated with the construction of the proposed scheme could potentially disturb and release mobile historical contamination impacting controlled waters.

The use of machinery and plant associated with construction activities could give rise to a pollution risk to soils, groundwater and surface water features through accidental fuel/oil and chemical spills and leaks. Soils impacted by spills and leaks may also represent a source of contamination to controlled waters via leaching.

Water pumped from excavations may contain contaminants, which if not managed appropriately could result in discharge and contamination of surrounding surface watercourses.

During construction of buried structures/foundations, new pathways for mobile contaminants to migrate downwards and impact the deeper aquifers could be created.

Contaminated runoff could be generated during the earthworks phase of the proposed scheme, including hydrocarbon contamination and high suspended solid loads, associated with the operation of vehicles. This has the potential to migrate and pollute surrounding surface water courses.

The sensitivity of the Ballinderry River and Fairy Burn receptors is considered to be high and the magnitude of the effect is considered to be negligible based on currently available information. There is therefore likely to be a slight adverse effect on surface waters.

The sensitivity of the various drain surface watercourse receptors is considered to be medium and the magnitude of the effect is considered to be negligible based on currently available information. There is therefore likely to be a neutral effect on surface waters.

The sensitivity of the aquifer water receptor is considered to be high and the magnitude of the effect is considered to be negligible based on currently available information. There is therefore likely to be a slight adverse effect on aquifer waters.

Section 6.11 Road Drainage and the Water Environment further discusses other water related effects and should be read in conjunction with this Geology and Soils Section.

Geology and Soils – Contaminated Land

Red route

Contamination may be present as discontinuous pockets associated with historic uses including former quarries, landfills, railways, urban areas and industrial sites. During construction, contaminants could be mobilised resulting in cross contamination of uncontaminated ground or controlled waters.

The sensitivity of the geology receptor is considered to be low and the magnitude of the effect is considered to be minor. There is therefore likely to be a slight adverse effect on geology.

Purple A route

The above potential effects identified for the Red route are applicable to the Purple A route during construction. There is not considered to be any discernible difference between the Purple A route and the other route options for Geology and Soils – contaminated land.

Purple B route

The above potential effects identified for the Red route are applicable to the Purple B route during construction. There is not considered to be any discernible difference between the Purple B route and other route options for Geology and Soils – contaminated land.

Green route

The above potential effects identified for the Red route are applicable to the Green route during construction. There is not considered to be any discernible difference between the Green route and the other Red route options for Geology and Soils – contaminated land.

Sandholes Link Road

Contamination may be present as discontinuous pockets associated with historic uses including urban areas and industrial sites. During construction, contaminants could be mobilised resulting in cross contamination of uncontaminated ground or controlled waters.

The sensitivity of the geology receptor is considered to be low and the magnitude of the effect is considered to be minor. There is therefore likely to be a slight adverse effect on geology.

Geology and Soils – Agricultural land

Each of the four route options results in the loss of different areas of Grade 2, Grade 3B and Grade 4A agricultural land.

Table 6-24 below summarises the agricultural land losses in hectares (ha) and includes a percentage agricultural land loss compared to the overall land take of each route.

Table 6-24 – Agricultural Land Loss

Route	Approx. total land take (ha)	Approximate Loss of Grade 2 Agricultural Land		Loss of Grade 3B Agricultural Land (ha)		Loss of Grade 4A Agricultural Land (ha)	
		ha	Percentage of total land take	ha	Percentage of total land take	ha	Percentage of total land take
Red	35.29	19.36	54.86%	5.16	14.62%	0.99	2.81%
Purple A	38.24	24.78	64.80%	5.12	13.39%	1.08	2.82%
Purple B	38.75	24.55	63.35%	7.56	19.51%	1.09	2.81%
Green	40.43	26.2	64.80%	4.83	11.95%	0.82	2.03%
Sandholes Link Road	2.66	N/A – urban soils		N/A – urban soils		N/A – urban soils	

Red route

The Red route results in the loss of approximately 19.3 ha of Grade 2 agricultural soils as a result of construction which results in a moderate rating for the magnitude of effect. The sensitivity of the soil receptor is considered to be very high and the magnitude of the effect is considered to be moderate. There is therefore likely to be a large adverse effect on soils as a result of the loss of Grade 2 agricultural land associated with the Red route.

The Red Route crosses a number of small areas of Grade 3B agricultural soil resulting in the loss of 5.16 ha. This results in a moderate rating for the magnitude of effect. The sensitivity of the Grade 3B soil receptor is medium. There is therefore likely to be a moderate adverse effect on soils as a result of the loss of Grade 3B agricultural land associated with the Red route.

The Red Route crosses a number of small areas of Grade 4A agricultural soil resulting in the loss of 0.99 ha. For the Grade 4A soils this results in the magnitude of effect being not discernible. The sensitivity of the Grade 4A soil receptor is low. There is therefore likely to be a slight adverse effect on soils as a result of the loss of Grade 4A agricultural land associated with the Red route.

There is not considered to be any other discernible difference between the Red route and the other route options from a geology and soils (agricultural land) perspective.

Purple A route

The Purple A route results in the loss of approximately 24.78 ha of Grade 2 agricultural land which is more than the Red route and therefore results in a major rating for the magnitude of effect.

The sensitivity of the soil receptor is considered to be very high and the magnitude of the effect is considered to be major. There is therefore likely to be a very large adverse effect on soils as a result of the loss of Grade 2 agricultural land associated with the Purple A route.

The Purple A Route crosses a number of small areas of Grade 3B agricultural soil resulting in the loss of 5.12 ha. This results in a moderate rating for the magnitude of effect. The sensitivity of the Grade 3B soil receptor is medium. There is therefore likely to be a moderate adverse effect on soils as a result of the loss of Grade 3B agricultural land associated with the Purple A route.

The Purple A Route crosses a number of small areas of Grade 4A agricultural soil resulting in the loss of 1.08 ha. For the Grade 4A soils this results in a moderate rating for the magnitude of effect. The sensitivity of the Grade 4A soil receptor is low. There is therefore likely to be a slight adverse effect on soils as a result of the loss of Grade 4A agricultural land associated with the Purple A route.

There is not considered to be any other discernible difference between the Purple A route and the other route options from a geology and soils (agricultural land) perspective.

Purple B route

The Purple B route results in the loss of approximately 24.5 ha of Grade 2 agricultural land which is similar to the Purple A route and slightly more than the Red route.

The sensitivity of the soil receptor is considered to be very high and the magnitude of the effect is considered to be major. There is therefore likely to be a very large adverse effect on soils as a result of the loss of Grade 2 agricultural land associated with the Purple B route.

The Purple B Route crosses a number of small areas of Grade 3B agricultural soil resulting in the loss of 7.56 ha. This results in a moderate rating for the magnitude of effect. The sensitivity of the Grade 3B soil receptor is medium. There is therefore likely to be a moderate adverse effect on soils as a result of the loss of Grade 3B agricultural land associated with the Purple B route.

The Purple B Route crosses a number of small areas of Grade 4A agricultural soil resulting in the loss of 1.09 ha. For the Grade 4A soils this results in a moderate rating for the magnitude of effect. The sensitivity of the Grade 4A soil receptor is low. There is therefore likely to be a slight adverse effect on soils as a result of the loss of Grade 4A agricultural land associated with the Purple B route.

There is not considered to be any other discernible difference between the Purple B route and the other route options from a geology and soils (agricultural land) perspective.

Green route

The Green route results in the loss of approximately 26.20 ha of Grade 2 agricultural land which is slightly more than each of the other routes.

This loss results in a major rating for the magnitude of effect for the Green route.

The sensitivity of the soil receptor is considered to be very high and the magnitude of the effect is considered to be major. There is therefore likely to be a very large adverse effect on soils as a result of the loss of Grade 2 agricultural land associated with the Green route.

The Green route crosses a number of small areas of Grade 3B agricultural soil resulting in the loss of 4.83 ha. This results in a moderate rating for the magnitude of effect. The sensitivity of the Grade 3B soil receptor is medium. There is therefore likely to be a moderate adverse effect on soils as a result of the loss of Grade 3B agricultural land associated with the Green route.

The Green route crosses a number of small areas of Grade 4A agricultural soil resulting in the loss of 0.82 ha. For the Grade 4A soils this results in the magnitude of effect being not discernible. The sensitivity of the Grade 4A soil receptor is low. There is therefore likely to be a slight adverse effect on soils as a result of the loss of Grade 4A agricultural land associated with the Green route.

There is not considered to be any other discernible difference between the Green Route and the other route options from a geology and soils (agricultural land) perspective.

Sandholes Link Road

The Sandholes Link Road is wholly within an urban area does not result in the loss of agricultural soils therefore no environmental effect in relation to agricultural soils is recorded.

6.6.3.2. Operation

Detriment to Human Health - Site Users, Adjacent Site Users and Construction Workers

Red route

Site users, adjacent site users and maintenance workers are potentially at risk from contaminated soils at or near the surface in landscaping areas through dermal contact, ingestion, and/or inhalation of fugitive dust.

The sensitivity of the receptor is considered to be low and the magnitude of the effect is considered to be moderate, although this could change once the findings of the additional GI are known. Therefore, there could be a slight adverse effect on human health.

Purple A route

The above potential effects identified for the Red route are applicable to the Purple A route during operation. There is not considered to be any discernible difference between the Purple A route and the other route options for Detriment to Human Health.

Purple B route

The above potential effects identified for the Red route are applicable to the Purple B route during operation. There is not considered to be any discernible difference between the Purple B route and the other route options for Detriment to Human Health.

Green route

The above potential effects identified for the Red route are applicable to the Green route during operation. There is not considered to be any discernible difference between the Green route and the other route options for Detriment to Human Health.

Sandholes Link Road

Site users, adjacent site users and maintenance workers are potentially at risk from contaminated soils at or near the surface in landscaping areas through dermal contact, ingestion, and/or inhalation of fugitive dust.

The sensitivity of the receptor is considered to be low and the magnitude of the effect is considered to be moderate. Therefore, there could be a slight adverse effect on human health.

Pollution of Controlled Waters

Red route

Construction works could disturb contaminated ground which could cause mobile contaminants to leach from contaminated soils and migrate vertically or horizontally to impact controlled waters. The migration of mobile contaminants could continue to occur into the operational phase.

The sensitivity of the Ballinderry River and Fairy Burn receptors is considered to be high and the magnitude of the effect is considered to be no change, although this could change once the findings of the additional GI are known. There is therefore likely to be a neutral effect on surface waters.

The sensitivity of the various drain surface watercourse receptors is considered to be medium and the magnitude of the effect is considered to be no change, although this could change once the findings of the additional GI are known. There is therefore likely to be a neutral effect on surface waters.

The sensitivity of the aquifer water receptor is considered to be high and the magnitude of the effect is considered to be no change, although this could change once the findings of the additional GI are known. There is therefore likely to be a neutral effect on aquifer waters.

Section 6.11: Road Drainage and the Water Environment further discusses other water related effects and should be read in conjunction with this Geology and Soils Section.

Purple A route

The above potential effects identified for the Red route are applicable to the Purple A route during operation. There is not considered to be any discernible difference between the Purple A route and the other route options for Pollution of Controlled Waters.

Purple B route

The above potential effects identified for the Red route are applicable to the Purple B route during operation. There is not considered to be any discernible difference between the Purple B route and the other route options for Pollution of Controlled Waters.

Green route

The above potential effects identified for the Red route are applicable to the Green route during operation. There is not considered to be any discernible difference between the Green route and the other route options for Pollution of Controlled Waters.

Sandholes Link Road

Construction works could disturb contaminated ground which could cause mobile contaminants to leach from contaminated soils and migrate vertically or horizontally to impact controlled waters. The migration of mobile contaminants could continue to occur into the operational phase.

The sensitivity of the Ballinderry River and Fairy Burn receptors is considered to be high and the magnitude of the effect is considered to be no change. There is therefore likely to be a neutral effect on surface waters.

The sensitivity of the various drain surface watercourse receptors is considered to be medium and the magnitude of the effect is considered to be no change. There is therefore likely to be a neutral effect on surface waters.

The sensitivity of the aquifer water receptor is considered to be high and the magnitude of the effect is considered to be no change. There is therefore likely to be a neutral effect on aquifer waters.

Section 6.11 Road Drainage and the Water Environment further discusses other water related effects and should be read in conjunction with this Geology and Soils Section.

Geology and Soils

All route options including Sandholes Link Road

No further operational effects are considered likely. All effects on geology and soils will have been realised at the construction stage.

6.6.3.3. Enhancement

The formation of new cuttings in some areas, has the potential to create geological exposures that may enhance the geodiversity of the area. Should such exposures be uncovered then the appropriate stakeholders should be consulted further, to ensure that such incidental benefits to the geodiversity of the proposed scheme are captured. It should be noted however that it is not currently proposed to engineer geodiversity directly

6.6.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

6.6.4.1. Proposed Mitigation

In light of the predicted effects of the proposed scheme detailed in the sections above, the following outline mitigation measures are proposed. This list is indicative only, and not exhaustive; essential and desirable mitigation would be identified during Stage 3. No mitigation measures have been agreed with the Regulators and the potential mitigation measures proposed below may change following assessment of the findings of the further GI works.

- Proposed Mitigation - Construction
  - Detriment to Human Health
    - Development of a CEMP;
    - Earthworks would be completed in accordance with a Materials Management Plan (MMP) or similar protocol to ensure re-used material does not present a risk to human health or the environment. This would ensure any contaminated materials are re-used suitably as part of the cut and fill earthworks associated with the proposed scheme.
    - Earthworks to be undertaken in accordance with a suitable Remediation Strategy (if required), which may need to include the provision for a ‘clean’ validated topsoil/subsoil to be placed in landscaping areas; and
    - The construction Contractor will have a watching brief during the works (excavation in particular) to identify any unforeseen potential contamination. Depending on the site operations occurring where the contamination is encountered, works may need to temporarily cease in that area and samples taken for chemical testing to inform a

remediation strategy to deal with the issue. The remediation strategy shall be prepared by an appropriately qualified Environmental Consultant and agreed with the Regulator prior to implementation.

- Pollution of Controlled Waters
  - Earthworks to be undertaken in accordance with a suitable Remediation Strategy (if required) including remediation of potential contamination risks to controlled waters;
  - A temporary surface water drainage strategy for the construction stage;
  - All drains within the proposed scheme boundary to be would be identified and labelled and measures implemented to prevent polluting substances such as silt from entering them;
  - All temporary stockpiles will be sealed and/or covered if comprising contaminated soils so as not to give rise to a significant increase in sediment load to the drainage network or dust generation risk to human health; and
  - If piling works are required a piling works risk assessment may be required depending upon the location of the piles and the ground conditions.
- Geology and Soils
  - Good working practices and housekeeping during construction such as sealing or covering stockpiles of contaminated soils, treating water removed from excavations prior to discharge and careful handling of excavated topsoil and subsoil within agricultural areas to preserve the soil structure for re-use are considered likely to reduce the impact; and
  - It is unlikely that further mitigation will be possible to mitigate the loss of agricultural land.

- Proposed Mitigation - Operational
  - Detriment to Human Health
    - Potential risks to human health from contamination during the operational phase can be mitigated through placement of an inert soil capping and geotextile membrane in landscaping areas, where necessary during the construction phase.
  - Pollution of Controlled Waters
    - Measures to mitigate spillage and leak impacts to controlled waters from the operational phase of the proposed scheme are discussed in detail in Section 6.11 Road Drainage and the Water Environment; and
    - Mitigation of potential risks to controlled waters from mobile contaminants will have been dealt with during construction as part of the remediation strategy and therefore no further mitigation measures are required at the operational phase.
  - Geology and Soils
    - Mitigation of potential risks to geology and soils will have been dealt with during construction as part of the remediation strategy and therefore no further mitigation measures are possible or required at the operational phase.

6.6.4.2. Potential Residual Effects

Assuming the above outline mitigation measures are implemented, the following residual effects are considered likely:

Detriment to Human Health

The magnitude of change following mitigation is likely to be no change, resulting in a neutral residual effect on human health.

Pollution of Controlled Waters

The magnitude of change following mitigation is likely to be no change, resulting in a neutral residual effect on surface waters and the underlying aquifer.

Geology and Soils

The magnitude of change on geology following mitigation is likely to be negligible, resulting in a neutral residual effect on geology.

No mitigation for the loss of agricultural soils is considered possible, therefore the magnitude of change on soils is likely to be moderate, resulting in a large adverse residual effect on soils for the Red route. However, a very large adverse residual effect will be realised for the Purple A, Purple B and Green route.

Table 6-25 below summarises the residual effects for Geology and Soils.

Table 6-25 – Overall Summary of Residual Effects* for Geology and Soils

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Human Health	Neutral	Neutral	Neutral	Neutral	None
Aquifer Water	Neutral	Neutral	Neutral	Neutral	None
Surface Water	Neutral	Neutral	Neutral	Neutral	None
Geology	Neutral	Neutral	Neutral	Neutral	None
Grade 2 Agricultural Soils	Large Adverse	Very Large Adverse	Very Large Adverse	Very Large Adverse	The Green route results in the greatest loss of Grade 2 agricultural land followed by the Purple A route, the Purple B route and then the Red route. However, the difference between the Purple A, Purple B and Green routes is not large enough to differentiate between the routes other than on the basis of area of loss as the magnitude of the effect is the same for each.
Grade 3B Agricultural Soils	Moderate Adverse	Moderate Adverse	Moderate Adverse	Moderate Adverse	None
Grade 4A Agricultural Soils	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	None

*Summary of Effects includes Sandholes Link Road for each route.

6.7. MATERIAL ASSETS AND WASTE

6.7.1. ASSESSMENT SCOPE

The scope of this section follows the approach set out in Highways England DMRB LA 110 Material Assets and Waste standard[33] (herein, "LA 110").

As defined in LA 110, the scope of this section is to assess the "environmental effects associated with the consumption / use of material assets, and the disposal and recovery of waste" associated with the proposed scheme. This scope, and the underlying approach, will be applied to each route option, as well as Sandholes Link Road.

The assessment scope will cover the construction phase of the proposed scheme, including any required demolition, site preparation and remediation, and construction activity. As detailed in LA 110, the operational phase will comprise the first year of operation (opening year) only. The opening year for the proposed scheme is 2025. This approach is considered proportionate to the assessment as the likely quantity of material resources required, and waste generated / disposed of during the operational phase (for example routine maintenance and repairs) is – using professional judgement - considered negligible and is not expected to result in significant adverse effects. The elements scoped in for assessment are summarised in Table 6-26.

Table 6-26 – Elements scoped in for further assessment for each route option and Sandholes Link Road

Element Scoped in	Proposed scheme phase
Environmental effects associated with the consumption/use of material assets	Construction phase (comprising demolition, site preparation and remediation, and construction)
	First year of operation
Environmental effects associated with the disposal and recovery of waste	Construction phase (comprising demolition, site preparation and remediation, and construction)
	First year of operation

The elements listed in Table 6-27 have been scoped out of the assessment; because they are considered to be either disproportionate to the scale and nature of the proposed scheme (and will therefore not be assessed), or will be assessed in other topic section, or are those that are not considered to give rise to likely significant effects and have therefore not been considered further within the Stage 2 SAR.

Table 6-27 – Elements scoped out of the assessment

Element scoped out	Justification
Lifecycle assessment (including embodied carbon and water) of materials and site arisings, and waste.	The effort and resources required to undertake a full lifecycle assessment of these elements are deemed disproportionate to the benefit they would offer the assessment of significance.

[33] Standards for Highways, (2019). DMRB Sustainability & Environment Appraisal LA 110 Material Assets and Waste. [online] Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3.htm [Accessed 21/01/2020].

Element scoped out	Justification
Impacts arising beyond the first year of operation.	Impacts beyond the first year of operation are expected to be minimal, and hence have – in accordance with LA 110 – been scoped out of further assessment.
Impacts and effects resulting from the transportation of material resources and waste to and from the site.	The impacts associated with transportation have been considered in the air quality (Section 6.2), climate (Section 6.10) and noise and vibration (Section 6.8) assessments – as appropriate to these specialist topics.

6.7.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the material assets and waste assessment are provided in Environmental Appendix B.

6.7.1.2. Study Area

The first and second study areas for Materials Assets and Waste are described in LA 110.

- The first study area will comprise the extent of the works within the boundary of the proposed scheme;
- In accordance with LA 110, the second study area comprises the extent to which waste infrastructure is suitable and available for the management of arisings and waste generated by the proposed scheme. Accordingly, the second study area for waste is determined to be Northern Ireland. The second study is set using professional judgement of the balance between the Proximity Principle and value for money (with regard to materials and waste logistics), and considering the extent of available data to compile a baseline assessment; and
- In accordance with good practice, a study area for the availability of typical materials required for the proposed scheme has been included. The study area for materials has the same geographical extent as that for waste management infrastructure i.e. national.

6.7.1.3. Methodology

The primary standard used to inform the assessment process is LA 110. For more detail on methodology refer to Environmental Appendix B.

6.7.1.4. Consultation

Consultation requests to the following consultees were issued during September 2019 to request information on material resource availably and landfill capacity to support the baseline date:

- DAERA;
- Northern Ireland Planning Minerals Planning Authority; and
- Mid Ulster Council.

A response from DAERA and Mid Ulster Council was received and has been used to inform the baseline (remaining landfill capacity) and Regional and Local Policy. A response from Northern Ireland Planning Minerals Planning Authority was not received.

In addition, the Department for Infrastructure was contacted in September 2019 to request confirmation of methodology to LA 110. A response was not received.

In the absence of a response, standard methodology has been used and a follow up consultation at Stage 3 will be undertaken.

6.7.1.5. Assumption and Limitations

Details of assumptions and limitations for material assets and waste assessment are provided in Environmental Appendix B.

6.7.2. BASELINE CONDITIONS

The baseline conditions relevant to the proposed scheme are summarised below.

6.7.2.1. Materials Currently Required

The current land use is predominantly agricultural land which requires the minimal consumption of construction materials. Where the current land use is road infrastructure, materials currently required for operation and maintenance are anticipated to comprise small quantities of asphalt for minor repair works. Therefore, the current consumption of resources with the first study area is deemed minimal.

6.7.2.2. Availability of Construction Materials

Published information on the availability of the main construction materials in Northern Ireland and the rest of the UK, as required to deliver typical highways schemes[34][35][36] has been reviewed. The information indicates that stocks / production / sales of such materials are buoyant in Northern Ireland and across the UK.

Furthermore, the 2019 Mid Ulster District Councils Local Develop Plan: Minerals Development[34] (provided through consultation with Mid Ulster Council) indicates that Mid Ulster has more than sufficient resource to cover the estimated 18.4 million tonne (Mt) requirement of sand and gravel (as required until 2030 in line with the Local Development Plan – Draft Plan Strategy[37]) with remaining reserves of 43 Mt. Remaining reserves of hard rock within Mid Ulster are, conversely, at risk with an estimated reserve of 4.75 Mt remaining, for a forecast 8.3 Mt requirement. The report does, however, state that responses were not received from all organisations consulted for this data, so there may be 'yet unaccounted for' reserves of hard rock available within Mid Ulster.

6.7.2.3. Site Arisings Currently Generated

The current land use is expected to generate minimal volumes of site arisings, limited to potential earthworks on agricultural land. Where the current land use is road infrastructure, arisings are anticipated to comprise small quantities of vegetation clearance and surplus materials generated

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[34] Mid Ulster District Council, (2019). Local Development Plan Mineral Development, Identification of Areas of Constraints on Mineral Development & Impact of Surface Development on Aggregate Resources in Mid Ulster. [online] Available at https://www.midulstercouncil.org/MidUlsterCouncil/media/Mid-Ulster-Council/Publications/Planning/Local%20Development%20Plan/Background-Evidence-Paper-Identification-of-AOC-on-Min-Dev-Impact-of-Surface-Development.pdf [Accessed 22/01/2020].
[35] Mineral products Association, (2018). Profile of the UK Mineral Products Industry. [online] Available at https://mineralproducts.org/documents/Facts-at-a-Glance-2018.pdf [Accessed 19/09/2019].
[36] Department for the Economy, (2018). Annual Minerals Statements. [online] Available at https://www.economy-ni.gov.uk/publications/annual-minerals-statements [Accessed 19/09/2019].
[37] Mid Ulster District Council, (2019). Local Development Plan 2030 – Draft Plan Strategy. [online] Available at: https://www.midulstercouncil.org/getmedia/dd8d49d7-79a6-4419-948f-2569cb0d0fa5/Local-Development-Plan-2030-Strategy-for-reconsultation.pdf.aspx [Accessed 04/05/2020].

during minor repair works which can be diverted from landfill. Therefore, the current generation of site arisings is deemed minimal.

6.7.2.4. Existing Transfer, Recovery and Recycling Waste Management Infrastructure

A review of waste recovery facilities to identify the availability of infrastructure and capacity for the transfer and recovery of CDE wastes in Northern Ireland suggests that there is the potential to divert site arisings generated by the proposed scheme from landfill. The importance (positive value) of this infrastructure indicates there is considerable potential to re-use / recycle site arisings. This has the potential to materially influence the assessment of materials and waste.

Latest available data (for the financial year 2009/2010) identified that the target set by the Waste Framework Directive to recycle 70% of all non-hazardous construction and demolition waste by 2020 was met within Northern Ireland[38].

The Local Development Plan 2030 – Draft Plan Strategy for Mid Ulster District Council[37], indicates that there are 12 recycling centres in Mid Ulster, although it is not specified if these sites are for public or commercial use. The Local Development Plan 2030 – Draft Plan Strategy notes the importance of such facilities given the proposal to close landfill sites in Mid Ulster by 2020 and therefore the potential need to increase recycling and waste transfer stations in the District.

6.7.2.5. Waste Currently Generated and Disposed Of

The agricultural land within the first study area is not, at present, anticipated to generate significant quantities of waste. Where the current land use is road infrastructure, waste is anticipated to comprise small quantities of arisings that cannot be recovered (hence, sent to landfill), as the result of minor repair works. Therefore, the current waste generation is deemed minimal.

6.7.2.6. Remaining Landfill Capacity

Through consultation with DAERA during October and November 2019, the remaining capacity of permitted landfill sites and capacity trend data was provided and reviewed. In summary:

- Inert landfill capacity has increased from 12.4 million cubic meters (Mm^3) in 2016 to 15.3 Mm^3 in 2018. This equates to a landfill capacity in the region of 19.0 Mt in 2018 based on a conversion factor of 1.24 tonnes per cubic meter[39];
- Non-hazardous landfill capacity has shown a significant reduction: 20.0 Mm^3 in 2013 to 8.1 Mm^3 in 2018. This equates to a remaining landfill capacity of 6.7 Mt in 2018 based on a conversion factor of 0.83 tonnes per cubic meter[40]; and
- No commercially available hazardous landfill sites are available in Northern Ireland. Hazardous wastes are understood to typically be transported to sites within Scotland or England.

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[38] Department of Agriculture, Environment and Rural Affairs, (2019). Waste Management Plan for Northern Ireland 2019. [online] Available at https://www.daera-ni.gov.uk/consultations/Waste-Management-Plan-for-Northern-Ireland [Accessed 21/01/2020].
[39] WRAP, (undated). Waste recording and reporting. [online] Available at http://www.wrap.org.uk/sites/files/wrap/Reporting%20Guidance.pdf [Accessed 02/03/2020].
[40] Environment Agency, (undated). About the 2012 waste management data. [online] Available at https://webarchive.nationalarchives.gov.uk/20140328141656/http://www.environment-agency.gov.uk/research/library/data/150328.aspx [Accessed 04/11/2019].

By the nature of landfill activities for all types of wastes, landfill capacity is likely to become an increasingly sensitive receptor over the life of the proposed scheme to the first full year of operation.

6.7.2.7. Future Baseline

In the future baseline and in the absence of the proposed scheme, it is considered that the land use would remain predominantly agricultural, with the exception of the areas of existing road infrastructure. Therefore, the future consumption of construction and other materials is considered minimal. Similarly, the potential for future generation and disposal of waste is also considered minimal.

6.7.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

6.7.3.1. Introduction

The proposed scheme has the potential to consume material resources (including those recovered from site arisings) and produce and dispose of waste during the construction phase and during the first year of operation. Whilst the impacts of materials consumption on, and waste disposal from the proposed scheme are considered to be adverse, permanent and direct, the re-use of arisings would reduce the adverse impact of waste disposal to landfill. Table 6-28 summarises the impacts associated with material consumption, and waste generation and disposal. The impacts and effects for each route option for the construction phase and operation phase are presented after Table 6-28.

Table 6-28 – Environmental impacts associated with Material Assets and Waste

Element	Direct Impacts	Indirect Impacts
Materials	Consumption of natural and non-renewable resources	Release of greenhouse gas emissions Water consumption and scarcity Nuisance to communities (visual, noise, vibration) Health
Waste	Generation and disposal of waste and reduction of landfill capacity	Release of greenhouse gas emissions Nuisance to communities (visual, noise, vibration) Health
Note: only the direct impacts are assessed within this section. Indirect impacts relevant to the proposed scheme and scope of other specialist sections within the Stage 2 SAR are addressed within Section 0 Air Quality; Section 0 Landscape and Visual Effects, Section 6.8 Noise and Vibration, Section 6.9 Population and Health; and Section 6.10 Climate.		

6.7.3.2. Construction

Red Route

Red Route Material Assets

Table 6-29 describes the type and quantities of materials required to construct the Red route. Where available, information on the planned recycled content and sustainability credentials of materials and products has been provided.

Table 6-29 – Red Route – Material types and quantities

Material Type	Quantity (tonnes)	Comments
Aggregate (Class 6N)	22,849	Required for the construction of structures and culverts. The use of aggregate with a recycled content of 10% (based on Northern Ireland's Delivering Resource Efficiency requirements) has been committed to by the proposed scheme.

Material Type	Quantity (tonnes)	Comments
Aggregate (cement bound granular mixture (CBGM) LA50)	24,936	Required for the construction of road pavement sub-base.
Asphalt	21,374	Required for the construction of road pavements, comprising an upper base layer, pavement binder and pavement surface.
Concrete	5,560	Required for the construction of structures and culverts.
Earthworks (on-site recovery)	284,873	Required for the construction of embankments. It has been assumed that 60% of the cut material can be re-used on the proposed scheme for the engineering of embankments.
Earthworks (imported)	213,038	Required for the construction of embankments. On the basis that 60% of site won material can be re-used, the proposed scheme will require additional earthworks material (as stated adjacent) to be imported to site.
Steel	1,128	Required for the construction of structures and culverts, safety barrier and parapets.
Total	573,758	This total includes 284,873 tonnes of site won earthworks Of all route options, the Red route has lowest quantity of materials

The calculated cut and fill balance for the Red route indicates a deficit of material, with a cut of 379,831 m^3 (approximately 474,789 tonnes) and a fill requirement of 398,329 m^3 (approximately 497,911 tonnes). However, it is anticipated that 60% of the earthworks cut will be suitable for re-use on the proposed scheme. This, therefore, leaves approximately 170,430 m^3 (213,038 tonnes) of fill material that needs to be imported. Overall, the quantity of earthworks material recovered on site meets 57% of the total fill requirement.

Provision for stockpiling materials (particularly earthworks for re-use) will be incorporated into the proposed scheme design. Further details will be available at the next (detailed) design stage.

Red Route Waste

Table 6-30 describes the type and quantities of waste and arisings which will be diverted from landfill from the construction of the Red route .

Table 6-30 – Red Route – Waste and arising types and quantities diverted from landfill

Waste / Arising Type	Quantity (tonnes)	Comments
Earthworks (on-site reuse)	284,873	It is anticipated that 60% of the cut material will be acceptable for re-use and will be used to construct embankments. In the event that this material cannot be re-used on site, it will be taken for off-site recovery.
Earthworks (off-site recycling)	189,916	It is anticipated that 40% of the cut material will be unsuitable for re-use or recovery and will be taken to a waste facility for recovery (and hence diverted from landfill).
General construction wastes e.g. plastics /	Currently not quantifiable	Wastes are likely to be processed at a recycling / recovery facility, rather than disposed of to landfill, in line with the Waste Hierarchy.

Waste / Arising Type	Quantity (tonnes)	Comments
packing, surplus materials and off cuts		
Total	474,789	Of all route options, the Red route is forecast to generate the lowest volume of re-used and recycled waste arisings.

Table 6-31 provides a summary of the type and quantities of waste from the Red route construction which is anticipated to be disposed of to landfill.

Table 6-31 – Red Route – Waste Types and quantities to be sent landfill

Waste Type	Quantity (tonnes)	Comments
Hazardous waste	Currently not quantifiable	Quantities of hazardous waste are anticipated to be negligible, but cannot be quantified at this time.

Provision for stockpiling arisings and storing waste will be incorporated into the proposed scheme design. Further details will be available at detailed design stage.

Red Route Significance of Effect

- Material Assets - in line with the significance criteria set out in LA 110, the effects from material resource use on the Red route are considered slight and therefore not significant. This is based on all earthworks (100%) for the proposed scheme being recovered through on-site re-use and off-site recovery to a waste recycling facility. It is anticipated the earthworks acceptable for on-site re-use will account for 57% of the fill deficit. The proposed scheme has committed to use aggregates in line with the relevant national percentage target (10% recycled content); and
- Waste - for waste diverted from landfill, potential recipient facilities for the recycling of earthworks have been identified (although use of specific facilities will be led by the Contractor during the construction phase). Initial indications suggest that there is sufficient recovery capacity within the region to accommodate surplus arisings from the proposed scheme. Anticipated volumes for waste disposal to landfill have not been quantified at this stage but are considered to comprise negligible quantities, including potential hazardous wastes. Waste to be disposed of is forecast to represent a less than 1% reduction in remaining regional landfill capacity (as of 2018). Remaining landfill capacity at 2018 is estimated to comprise 19 Mt inert waste and 6.7 Mt non-hazardous waste, with 1% of these totals representing 190,000 tonnes and 67,000 tonnes respectively. Based on the available data, no waste disposal is expected to occur outside of Northern Ireland. It is important to note that this position may alter depending on whether any hazardous waste is encountered, however this is not expected to exceed 1% of the total proposed scheme waste arisings. Taking this evidence into account, the significance of waste is considered slight and therefore not significant.

Purple A Route

Purple A Route Material Assets

Table 6-32 describes the type and quantities of materials required to construct the Purple A route. Where available, information on the planned recycled content and sustainability credentials of material and products has been provided.

Table 6-32 – Purple A Route – Material types and quantities

Material Type	Quantity (tonnes)	Comments
Aggregate (Class 6N)	43,436	Required for the construction of structures and culverts. The use of aggregate with a recycled content of 10% (based on Northern Ireland's Delivering Resource Efficiency requirements) has been committed to by the proposed scheme.
Aggregate (CBGM) LA50)	27,165	Required for the construction of road pavement sub base.
Asphalt	23,285	Required for the construction of road pavements, comprising an upper base layer, pavement binder and pavement surface.
Concrete	8,932	Required for the construction of structures and culverts.
Earthworks (on-site recovery)	329,061	Required for the construction of embankments. It has been assumed that 60% of the cut material can be re-used on the proposed scheme for the engineering of embankments.
Earthworks (imported)	168,590	Required for the construction of embankments. On the basis that 60% of site won material can be re-used, the proposed scheme will require additional earthworks material (as stated adjacent) to be imported to site.
Steel	1,848	Required for the construction of structures and culverts, safety barrier and parapets.
Total	602,317	This total includes 329,061 tonnes of site won earthworks In contrast to Red route, Purple A route requires 5% more materials

The calculated cut and fill balance for the Purple A route indicates a surplus of material, with a cut of 438,748 m^3 (approximately 548,435 tonnes) and a fill requirement of 398,121 m^3 (approximately 497,651 tonnes). However, it is anticipated that only 60% of the earthworks cut will be suitable for re-use on the proposed scheme. Consequently, approximately 134,872 m^3 (168,590 tonnes) of fill material will need to be imported. Overall, the quantity of earthworks material recovered on site meets 66% of the total fill requirement.

Provision for stockpiling materials (particularly earthworks for re-use) will be incorporated into the proposed scheme design. Further details will be available at the next (detailed) design stage.

Purple A Route Waste

Table 6-33 describes the type and quantities of waste and arisings which will be diverted from landfill from the construction of the Purple A route.

Table 6-33 – Purple A Route – Waste and arising types and quantities diverted from landfill

Waste / Arising Type	Quantity (tonnes)	Comments
Earthworks (on-site reuse)	329,061	It is anticipated that 60% of the cut material will be acceptable for re-use and will be used to construct embankments. In the event that this material cannot be re-used on site, it will be taken for off-site recovery.
Earthworks (off-site recycling)	219,374	It is anticipated that 40% of the cut material will be unsuitable for re-use or recovery and will be taken to a waste facility for recovery (and hence diverted from landfill).

Waste / Arising Type	Quantity (tonnes)	Comments
General construction wastes e.g. plastics / packing, surplus materials and off cuts	Currently not quantifiable	Wastes are likely to be processed at a recycling / recovery facility, rather than disposed of to landfill, in line with the Waste Hierarchy.
Total	548,435	In contrast to the Red route, the forecast arisings for Purple A route is 15% greater.

Table 6-34 provides a summary of the type and quantities of waste from the Purple A route construction which is anticipated to be disposed of to landfill.

Table 6-34 – Purple A Route – Waste types and quantities to be sent to landfill

Waste Type	Quantity (tonnes)	Comments
Hazardous waste	Currently not quantifiable	Quantities of hazardous waste are anticipated to be negligible, but cannot be quantified at this time.

Provision for stockpiling arising and waste will be incorporated into the proposed scheme design. Further details will be available at detailed design stage.

Purple A Route Significance of Effect

- Material Assets - in line with the significance criteria set out in LA 110, the effects from material resource use on the Purple A route is considered slight and therefore not significant. This is based on all earthworks (100%) for the proposed scheme being recovered through on-site re-use and off-site recovery to a waste recycling facility. It is anticipated the earthworks acceptable for on-site re-use will account for 66% of the fill deficit. The proposed scheme has committed to use aggregates in line with the relevant national percentage target (10% recycled content); and
- Waste - for waste diverted from landfill, potential recipient facilities for the recycling of earthworks have been identified (although use of specific facilities will be led by the Contractor during the construction phase). Initial indications suggest there is sufficient recovery capacity within the region to accommodate surplus arisings from the proposed scheme. Anticipated volumes for waste disposal to landfill have not been quantified at this stage but are considered to comprise negligible quantities including potential hazardous wastes. Waste to be disposed of is forecast to represent a less than 1% reduction in remaining regional landfill capacity (as of 2018). Remaining landfill capacity at 2018 is estimated to comprise 19 Mt inert waste and 6.7 Mt non-hazardous waste, with 1% of these totals representing 190,000 tonnes and 67,000 tonnes respectively. Based on the available data, no waste disposal is expected to occur outside of Northern Ireland. It is important to note that this position may alter depending on whether any hazardous waste is encountered, however this is not expected to exceed 1% of the total proposed scheme waste arisings. Taking this evidence into account, the significance of waste is considered slight and therefore not significant.

Purple B Route

Purple B Route Material Assets

Table 6-35 describes the type and quantities of materials required to construct the Purple B route. Where available, information on the planned recycled content and sustainability credentials of materials and products has been provided.

Table 6-35 – Purple B Route – Material types and quantities

Material Type	Quantity (tonnes)	Comments
Aggregate (Class 6N)	43,436	Required for the construction of structures and culverts. The use of aggregate with a recycled content of 10% (based on Northern Ireland's Delivering Resource Efficiency requirements) has been committed to by the proposed scheme.
Aggregate (CBGM) LA50)	27,203	Required for the construction of road pavement sub base.
Asphalt	23,317	Required for the construction of road pavements, comprising an upper base layer, pavement binder and pavement surface.
Concrete	8,995	Required for the construction of structures and culverts.
Earthworks (on-site recovery)	353,237	Required for the construction of embankments. It has been assumed that 60% of the cut material can be re-used on the proposed scheme for the engineering of embankments.
Earthworks (imported)	159,193	Required for the construction of embankments. On the basis that 60% of site won material can be re-used, the proposed scheme will require additional earthworks material (as stated adjacent) to be imported to site.
Steel	1,862	Required for the construction of structures and culverts, safety barrier and parapets.
Total	617,243	This total includes 353,237 tonnes of site won earthworks In contrast to the Red route, Purple B option uses 8% more materials.

The calculated cut and fill balance for the Purple B route indicates a surplus of material, with a cut of 470,983 m^3 (approximately 588,729 tonnes) and a fill requirement of 409,944 m^3 (approximately 512,430 tonnes). However, it is anticipated that only 60% of the earthworks cut will be suitable for re-use on the proposed scheme. Consequently, approximately 127,354 m^3 (159,193 tonnes) of fill material will need to be imported. Overall the quantity of earthworks material recovered on site meets 69% of the total fill requirement.

Provision for stockpiling materials (particularly earthworks for re-use) will be incorporated into the proposed scheme design. Further details will be available at the next (detailed) design stage.

Purple B Route Waste

Table 6-36 describes the type and quantities of waste and arisings which will be diverted from landfill from the construction of the Purple B route.

Table 6-36 – Purple B Route – Waste and arising types and quantities diverted from landfill

Waste / Arising Type	Quantity (tonnes)	Comments
Earthworks (on-site reuse)	353,237	It is anticipated that 60% of the cut material will be acceptable for re-use and will be used to construct embankments. In the event that this material cannot be re-used on site, it will be taken for off-site recovery.
Earthworks (off-site recycling)	235,492	It is anticipated that 40% of the cut material will be unsuitable for re-use or recovery and will be taken to a waste facility for recovery (and hence diverted from landfill).

Waste / Arising Type	Quantity (tonnes)	Comments
General construction wastes e.g. plastics / packing, surplus materials and off cuts	Currently not quantifiable	Wastes are likely to be processed at a recycling / recovery facility, rather than disposed of to landfill, in line with the Waste Hierarchy.
Total	588,729	In contrast to Red route, the forecast total arisings for Purple B route is 24% greater.

Table 6-37 provides a summary of the type and quantities of waste from the Purple B route construction which is anticipated to be disposed of to landfill.

Table 6-37 – Purple B Route – Waste types and quantities to be sent to landfill

Waste Type	Quantity (tonnes)	Comments
Hazardous waste	Currently not quantifiable	Quantities of hazardous waste are anticipated to be negligible, but cannot be quantified at this time.

Provision for stockpiling arising and waste will be incorporated into the proposed scheme design. Further details will be available at detailed design stage.

Purple B Route Significance of Effect

- Material Assets - in line with the significance criteria set out in LA 110, the effects from material resource use on the Purple B route are considered slight and therefore not significant. This is based on all earthworks (100%) for the proposed scheme being recovered through on-site re-use and off-site recovery to a waste recycling facility. It is anticipated the earthworks acceptable for on-site re-use will account for 69% of the fill deficit. The proposed scheme has committed to use aggregates in line with the relevant national percentage target (10% recycled content); and
- Waste - for waste diverted from landfill, potential recipient facilities for the recycling of earthworks have been identified (although use of specific facilities will be led by the Contractor during the construction phase). Initial indications suggest that there is sufficient recovery capacity within the region to accommodate surplus arisings from the proposed scheme. Anticipated volumes for waste disposal to landfill have not been quantified at this stage but are considered to comprise negligible quantities, including potential hazardous wastes. Waste to be disposed of is forecast to represent a less than 1% reduction in remaining regional landfill capacity (as of 2018). Remaining landfill capacity at 2018 is estimated to comprise 19 Mt inert waste and 6.7 Mt non-hazardous waste, with 1% of these totals representing 190,000 tonnes and 67,000 tonnes respectively. Based on the available data, no waste disposal is expected to occur outside of Northern Ireland. It is important to note that this position may alter depending on whether any hazardous waste is encountered, however this is not expected to exceed 1% of the total proposed scheme waste arisings. Taking this evidence into account, the significance of waste is considered slight and therefore not significant.

Green Route

Green Route Material Assets

Table 6-38 describes the type and quantities of materials required to construct the Green route. Where available, information on the planned recycled content and sustainability credentials of materials and products has been provided.

Table 6-38 – Green Route – Material types and quantities

Material Type	Quantity (tonnes)	Comments
Aggregate (Class 6N)	44,805	Required for the construction of structures and culverts. The use of aggregate with a recycled content of 10% (based on Northern Ireland's Delivering Resource Efficiency requirements) has been committed to by the proposed scheme.
Aggregate (CBGM) LA50)	27,778	Required for the construction of road pavement sub-base.
Asphalt	23,810	Required for the construction of road pavements, comprising an upper base layer, pavement binder and pavement surface.
Concrete	11,175	Required for the construction of structures and culverts.
Earthworks (on-site recovery)	611,262	Required for the construction of embankments. It has been assumed that 60% of the cut material can be re-used on the proposed scheme for the engineering of embankments.
Earthworks (imported)	159,838	Required for the construction of embankments. On the basis that 60% of site won material can be re-used, the proposed scheme will require additional earthworks material (as stated adjacent) to be imported to site.
Steel	2,339	Required for the construction of structures and culverts, safety barrier and parapets.
Total	881,007	This total includes 611,262 tonnes of site won earthworks. In contrast to the Red route, the Green route uses 54% more materials.

The calculated cut and fill balance for the Green route indicates a surplus of material, with a cut of 815,016 m^3 (approximately 1,018,770 tonnes) and a fill requirement of 616,880 m^3 (approximately 771,100 tonnes). However, it is anticipated that only 60% of the earthworks cut will be suitable for re-use on the proposed scheme. Consequently, approximately 127,870 m^3 (159,838 tonnes) of fill material will need to be imported. Overall the quantity of earthworks material recovered on site meets 79% of the total fill requirement.

Provision for stockpiling materials (particularly earthworks for re-use) will be incorporated into the proposed scheme design. Further details will be available at the next (detailed) design stage.

Green Route Waste

Table 6-39 describes the type and quantities of waste and arisings which will be diverted from landfill from the construction of the Green route.

Table 6-39 – Green Route – Waste and arising types and quantities diverted from landfill

Waste / Arising Type	Quantity (tonnes)	Comments
Earthworks (on-site reuse)	611,262	It is anticipated that 60% of the cut material will be acceptable for re-use and will be used to construct embankments. In the event that this material cannot be re-used on site, it will be taken for off-site recovery.
Earthworks (off-site recycling)	407,508	It is anticipated that 40% of the cut material will be unsuitable for re-use or recovery and will be taken to a waste facility for recovery (and hence diverted from landfill).
General construction wastes e.g. plastics / packing, surplus materials and off cuts	Currently not quantifiable	Wastes are likely to be processed at a recycling / recovery facility, rather than disposed of to landfill, in line with the Waste Hierarchy.
Total	1,018,770	In contrast to Red route, the forecast total arisings for Green route is 115% greater.

Table 6-40 provides a summary of the type and quantities of waste from the Green route construction which is anticipated to be disposed of to landfill.

Table 6-40 – Green Route – Waste types and quantities to be sent to landfill

Waste Type	Quantity (tonnes)	Comments
Hazardous waste	Currently not quantifiable	Quantities of hazardous waste are anticipated to be negligible, but cannot be quantified at this time.

Provision for stockpiling arisings and storing waste will be incorporated into the proposed scheme design. Further details will be available at detailed design stage.

Green Route Significance of Effect

- Material Assets - in line with the significance criteria set out in LA 110, the effects from material resource use on the Green route are considered slight and therefore not significant. This is based on all earthworks (100%) for the proposed scheme being recovered through on-site re-use and off-site recovery to a waste recycling facility. It is anticipated the earthworks acceptable for on-site re-use will account for 79% of the fill deficit. The proposed scheme has committed to use aggregates in line with the relevant national percentage target (10% recycled content); and
- Waste - for waste diverted from landfill, potential recipient facilities for the recycling of earthworks have been identified (although use of specific facilities will be led by the Contractor during the construction phase). Initial indications suggest that there is sufficient recovery capacity within the region to accommodate surplus arisings from the proposed scheme. Anticipated volumes for waste disposal to landfill have not been quantified at this stage but are considered to comprise negligible quantities, including potential hazardous wastes. Waste to be disposed of is forecast to represent a less than 1% reduction in remaining regional landfill capacity (as of 2018). Remaining landfill capacity at 2018 is estimated to comprise 19 Mt inert waste and 6.7 Mt non-hazardous waste, with 1% of these totals representing 190,000 tonnes and 67,000 tonnes respectively. Based on available data, no waste disposal is expected to occur outside of Northern Ireland. It is important to note that this position may alter depending on whether any hazardous waste is encountered; if it is, it would not be expected to exceed 1% of the total proposed scheme waste

arisings. Taking this evidence into account, the significance of waste is therefore considered slight and not significant.

Sandholes Link Road

Sandholes Link Road Material Assets

Table 6-41 describes the type and quantities of materials required to construct the Sandholes Link Road. Where available, information on the planned recycled content and sustainability credentials of materials and products has been provided.

Table 6-41 – Sandholes Link Road – Material types and quantities

Material Type	Quantity (tonnes)	Comments
Aggregate (Class 6N)	243	Required for the construction of structures and culverts. The aggregate is expected to have a recycled content of 10% based on Northern Ireland's Delivering Resource Efficiency requirements
Aggregate (CBGM) LA50)	5,491	Required for the construction of road pavement sub base.
Asphalt	4,707	Required for the construction of road pavements, comprising an upper base layer, pavement binder and pavement surface.
Concrete	119	Required for the construction of structures and culverts.
Earthworks (on-site recovery)	2,152	Required for the engineering of embankments. It has been assumed that 70% of the cut material can be re-used on the proposed scheme for the construction of embankments.
Earthworks (imported)	10,342	Required for the construction of embankments. On the basis that 70% of site won material can be re-used, the proposed scheme will require additional earthworks material to be imported to site.
Steel	22	Required for the construction of structures and culverts.
Total	23,076	This total includes 2,152 tonnes of site won earthworks.

The calculated cut and fill balance for the Sandholes Link Road indicates a deficit of material, with a cut of 2,459 m^3 (approximately 3,074 tonnes) and a fill requirement of 9,749 m^3 (approximately 12,186 tonnes). It is anticipated that 70% of the earthworks cut will be suitable for re-use on the Sandholes Link Road. Consequently, approximately 8,028 m^3 (10,035 tonnes) of fill material will need to be imported. Overall the quantity of earthworks material recovered on site meets 18% of the total fill requirement.

Provision for stockpiling materials, particularly earthworks for re-use, will be incorporated into the proposed scheme design. Further details will be available at the next (detailed) design stage.

Sandholes Link Road Waste

Table 6-42 describes the type and quantities of waste and arisings which will be diverted from landfill during the construction of the Sandholes Link Road.

Table 6-42 – Sandholes Link Road – Waste and arising types and quantities diverted from landfill

Waste / Arising Type	Quantity (tonnes)	Comments
Earthworks (on-site reuse)	2,152	It is anticipated that 70% of the cut material will be acceptable for re-use and will be used to construct embankments. In the event that this material cannot be re-used on site, it will be taken for off-site recovery.
Earthworks (off-site recycling)	922	It is anticipated that 30% of the cut material will be unsuitable for re-use or recovery and will be taken to a waste facility for recovery (and hence diverted from landfill).
General construction wastes e.g. plastics / packing, surplus materials and off cuts	Currently not quantifiable	Wastes are likely to be processed at a recycling / recovery facility, rather than disposed of to landfill, in line with the Waste Hierarchy.
Total	3,074	

Table 6-43 provides a summary of the type and quantities of waste from the Sandholes Link Road construction which is anticipated to be disposed of to landfill.

Table 6-43 – Sandholes Link Road – Waste types and quantities to be sent to landfill

Waste Type	Quantity (tonnes)	Comments
Hazardous waste	Currently not quantifiable	Quantities of hazardous waste are anticipated to be negligible, but cannot be quantified at this time.

Provision for stockpiling arisings and storing waste will be incorporated into the proposed scheme design. Further details will be available at detailed design stage.

Sandholes Link Road Significance of Effect

- Material Assets - in line with the significance criteria set out in LA 110, the effects of material resource use on the Sandholes Link Road are considered slight and therefore not significant. This is based on all earthworks (100%) for the proposed scheme being recovered through on-site re-use and off-site recovery to a waste recycling facility. It is anticipated the earthworks acceptable for on-site re-use will account for 18% of the fill deficit. The proposed scheme has committed to use aggregates in line with the relevant national percentage target (10% recycled content); and
- Waste - for waste diverted from landfill, potential facilities for the recycling of earthworks have been identified (although use of specific facilities will be led by the Contractor during the construction phase). Initial indications suggest that there is sufficient recovery capacity within the region to accommodate waste from the proposed scheme. The anticipated waste disposal to landfill has not been quantified at this stage but is considered to comprise negligible quantities, including potential hazardous wastes. Data acquired forecast a less than 1% reduction in remaining regional landfill capacity (as of 2018). Remaining landfill capacity at 2018 is estimated to comprise 19 Mt inert waste and 6.7 Mt non-hazardous waste, with 1% representing 190,000 tonnes and 67,000 tonnes, respectively. Based on the current data, no waste disposal is expected to occur outside of Northern Ireland. This may alter depending on whether any hazardous waste is encountered, although this is not expected to exceed 1% of the total proposed scheme waste arisings. Taking into available data, the significance of waste is considered slight and therefore not significant.

6.7.3.3. Operation

No quantitative data for materials, arisings or waste has been provided for the first year of operation. However, the forecast material resources required, and quantity of waste generated for disposal to landfill, are considered to be negligible as operational works are anticipated to comprise minor defect or repair works. Operational effects are considered to be similar for each route option (Red route, Purple A route, Purple B route and Green route) and Sandholds Link Road.

Operational effects during the first year of operation are considered to be, under a worst case scenario, slight for material assets and slight for waste, and therefore not significant in either case.

6.7.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

Mitigation

Materials

- Use off-site construction and pre-fabrication of structures and components, thereby encouraging a process of assembly rather than construction;
- Design for deconstruction, disassembly, material reuse and recycling, including material and product reassignment at end-of-life;
- Reuse of excavated and other arisings on-site or on other approved developments; and
- Incorporation of sustainable features in materials and products to reduce adverse environmental impacts.

Waste

- Engage contractors throughout the design development process to identify further enhancement and mitigation measures, and opportunities to reduce waste through collaboration and synergies between developments;
- Identify and quantify opportunities to achieve on-site and off-site reuse and recycling of waste; and
- Identify opportunities for advanced on-site waste treatment, e.g. land remediation.

Options Comparison

Table 6-44 presents the summary of effects for construction and operation for Material Assets and Waste for each route option (with Sandholes Link Road common to each route option).

Table 6-44 – Overall Summary of Effects* for Material Assets and Waste

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Consumption/ use of material assets (Construction)	Slight Adverse Not Significant	Slight Adverse Not Significant	Slight Adverse Not Significant	Slight Adverse Not Significant	Red route requires the least volume of material resources. This is not sufficient to result in different assessments of effect.

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Disposal and recovery of waste (Construction)	Slight Adverse Not Significant	Slight Adverse Not Significant	Slight Adverse Not Significant	Slight Adverse Not Significant	Green route has the greatest percentage of re-useable earthworks. This is not sufficient to result in different assessments of effect.
Consumption/ use of material assets (Operation)	Slight Adverse Not Significant	Slight Adverse Not Significant	Slight Adverse Not Significant	Slight Adverse Not Significant	None
Disposal and recovery of waste (Operation)	Slight Adverse Not Significant	Slight Adverse Not Significant	Slight Adverse Not Significant	Slight Adverse Not Significant	None

*Summary of Effects includes Sandholes Link Road for each route.

Using the criteria set out in LA 110, the differences in materials resources use and waste generational and disposal for each route option are not sufficient to result in different assessments of effect.

The environmental effects of the route options, based on the data and proposed scheme commitments currently provided, have been found to be slight and not significant. The Red route option with Sandholes Link Road requires the least volume of material resources and generates the least volume of arisings, as summarised in Table 6-45. However, based on the cut and fill balance and the volume of re-usable site won earthwork arisings, Green route with Sandholes Link Road has the greatest percentage of re-useable earthworks, reducing the quantity of imported earthworks material required for the proposed scheme.

Therefore it is concluded that the preferred route on the basis of Material Assets and Waste is either the Red route as less materials are required and less waste is generated, or Green route as a greater percentage of material recovery is expected.

Table 6-45 – Summary of Material Assets and Waste Data*

	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Materials required (including site won arisings) (tonnes)	596,526	625,085	640,012	903,775	Red route slightly preferred
Waste diverted from landfill (including site	477,863	551,509	591,803	1,021,844	Green route slightly preferred

	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
won arisings) (tonnes)					
Percentage of reusable earthworks for fill deficit	56%	65%	68%	78%	Green route slightly preferred

*Summary includes Sandholes Link Road for each route.

6.8. NOISE AND VIBRATION

6.8.1. ASSESSMENT SCOPE

A comparison of potential construction and operational road traffic noise impacts of the four route options in the proposed year of opening (2025), has been undertaken in alignment with the guidance in the DMRB, LA 111, Noise and Vibration[41].

A proportionate approach has been undertaken, focussing on the key elements that differentiate the route options, and based on the quality of data available and the risk of likely significant effects occurring.

This section presents the predicted road traffic noise impacts arising from the route options on surrounding sensitive receptors. The four route options considered in this assessment are: Red route; Purple A route; Purple B route and Green route. For each of the four route options, the Sandholes Link Road online roads improvements scheme is also considered.

The assessments scoped in for Stage 2 are:

- Operational road traffic noise assessment, short-term, daytime; and
- Simple level construction noise assessment.

Traffic flow data for each route option has been used to predict operational road traffic noise levels in line with the Calculation of Road Traffic Noise[42] (CRTN) method. LA 111 guidance has been followed to identify the 'initial assessment' of significance for each route option, which is based on the short term magnitude of change. A comparison of the impacts of each route option has then been made.

The assessments scoped out in Stage 2 are:

- Determination of the final operational significance;
- Operational road traffic noise assessment: Long-term, daytime;
- Short and long-term night-time operational road traffic noise assessment;
- Operational vibration assessment; and
- Detailed construction noise and vibration assessment.

[41] Highways England, Transport Scotland, Welsh Government and the Department for Infrastructure Northern Ireland, (2020). DMRB, LA 111 revision 2. Noise and Vibration. [online] Available at: https://www.standardsforhighways.co.uk/dmrb/search/cc8cfcf7-c235-4052-8d32-d5398796b364 [Accessed 03/08/2020].
[42] Department of Transport and Welsh Office, (1988). Calculation of Road Traffic Noise. London: H.M.S.O.

Determination of the final operational significance is scoped out of the Stage 2 options appraisal. This is a multi-layered assessment which requires detailed consideration of both objective and subjective elements; it is not considered necessary or appropriate to complete for the options comparison appraisal. Determination of the final operational significance will be included as part of the Stage 3 assessment process for the preferred option.

Long-term daytime operational road traffic noise is scoped out, this element is not material to the 'initial assessment' of significance. In addition, it is not considered to represent a key differentiator between the route options. The long-term daytime operational noise effects for the preferred route option will be included in the Stage 3 noise assessment.

Short and long-term night-time operation is scoped out as detailed hourly traffic data is unavailable, and because these elements are not material to an 'initial assessment' of significance for comparison purposes. LA 111 advises that when night-time noise levels are calculated from daytime traffic data, then "*on congestion relief projects, it has the potential to over predict increases in night-time traffic*" noise. A night-time operational noise assessment will be included with the scope of the Stage 3 works.

Operational vibration is scoped out of this and any future assessment. As stated in LA 111, "*a maintained road surface will be free of irregularities as part of project design and under general maintenance, so operational vibration will not have the potential to lead to significant adverse effects*."

At this stage, neither a construction programme nor details of the likely construction plant and equipment to be used are confirmed. Due to the absence of data, a detailed assessment is scoped out. An indicative assessment based on property counts within 100 m of each route option has been completed.

6.8.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the noise and vibration assessment are provided in Environmental Appendix B.

6.8.1.2. Study Area

Construction Study Area

The construction noise study area considered for each route option plus Sandholes Link Road, includes the area within 100 m of the earthworks extent of each route option.

As the construction assessment is qualitative, it is appropriate to size the considered construction noise study area to include sensitive receptors which have the potential to experience significant effects. The study area extent is selected using professional experience gained from other road scheme projects.

The construction noise assessment study areas for each route option are shown in Figure 6.8.1 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0181).

Operational Study Area

The study area for the operational noise assessment has been determined based on the guidance contained within LA 111.

The study area includes the area within 600 m of new, altered or bypassed road links. In addition, the study area includes the area within 50 m of other road links which experience a short-term Basic Noise Level[43] (BNL) change of 1.0 dB(A) or more due to the proposed scheme.

For this options appraisal, an aggregate study area has been determined by combining all route option study areas into one.

The aggregate operational road traffic study area includes the following areas: 600 m around each option; 600 m around the Sandholes Link Road; 600 m around the bypassed A29 through Cookstown; and 50 m around road links which experience a short-term BNL change of 1.0 dB(A) or more.

The aggregate operational study area is shown in Figure 6.8.2 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0182).

6.8.1.3. Methodology

Detail on methodology are provided in Environmental Appendix B.

6.8.1.4. Consultation

Mid Ulster Council Environmental Health were consulted to discuss and agree methodology for the route options noise assessment. Further communications relating to the noise monitoring survey locations and method were also held with the council prior to the surveys being in 2019.

6.8.1.5. Assumption and Limitations

Details of assumptions and limitations for air quality assessment are provided in Environmental Appendix B.

6.8.2. BASELINE CONDITIONS

The number of properties subject to baseline noise levels are presented in Table 6-46. The noise model results are defined by the highest noise level, $L_{A10,18h}$, predicted at each of the properties in the opening year do-minimum scenario, and sorted into LOAEL and SOAEL bandings.

Table 6-46 – Operational Noise Baseline – Number of Properties

Time Period	< LOAEL	≥ LOAEL & < SOAEL	≥SOAEL
Day (06:00-24:00)	1989	1586	454

Attended noise measurements have also been made to identify existing noise sources and gain an appreciation of the existing noise climate.

A summary of the baseline measurement results for the day time surveys are given in Table 6-47 below. Refer to Appendix B-11 for further detail of the measurement locations, dates and periodised noise levels, including night time surveys.

[43] The Basic Noise Level is described in the CRTN. It does not relate to any specific receptor, but rather is a measure of source noise, at a reference distance of 10 m from the nearside carriageway edge of a specific length of highway. It is determined by obtaining the estimated noise level from the 18-hour traffic flow and then applying corrections for vehicle speed, percentage of heavy vehicles, gradient and road surface as described in CRTN.

Table 6-47 – Summary of Measured Daytime Noise Levels – Free-field, dB(A)

Location	$L_{Aeq, 3hr}$	$L_{A10, 3hr}$	$L_{A90, 3hr}$
MP1 - Old Rectory Park	64.4	67.9	51.1
MP2 - Sandholes Road	67.3	70.8	51.8
MP3 - Loughrey Roundabout	66.4	69.7	55.5
MP4 - Castle Road	56.4	53.7	47.7
MP5 - Golf View	64.4	61.8	40.2
MP6 - Festival Park	46.3	48.3	42.6
MP7 - Old Coagh Road	67.2	60.3	35.2
MP8 - The Dales	41.6	43.8	38.0
MP9 - Moneymore Road	73.3	77.0	60.5
MP10 - A29 / Moneymore Rd	75.9	80.7	59.4

The dominant background noise source at the majority of the locations is moving road traffic on the A29 and other local roads. Secondary noise sources include general domestic activities and birdsong; distant industrial plant noise was also noted at MP8.

At MP5, MP6, MP7 and MP8, road traffic noise is less dominant. These measurements locations are representative of dwellings on Golf View, Festival Park, Old Coagh Road and The Dales.

6.8.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

Construction

The number of sensitive receptors within the construction study area of each of the four route options, and separately for the Sandholes Link Road, are presented in Table 6-48.

Table 6-48 – Count of Sensitive Receptors within Construction Study Areas

Red route	Purple A route	Purple B route	Green route	Sandholes Link Road
98	111	112	87	88

Operational

The number of sensitive receptors subject to operational noise levels for each of the four route options are presented in Table 6-49. As per the baseline conditions, the noise model results are defined by the highest noise level, LA10,18h, in the opening year do-something scenario, and sorted into LOAEL and SOAEL bandings. Each of the four with-scheme scenario receptor banding counts includes for the noise level changes due to the Sandholes Link Road.

Table 6-49 – Short-term Daytime Operational Noise Levels – Number of Receptors

	Number of sensitive receptors		
Option	< LOAEL	≥ LOAEL & < SOAEL	≥SOAEL
Red route and Sandholes Link Road	1996	1923	110
Purple A route and Sandholes Link Road	2001	1944	84
Purple B route and Sandholes Link Road	2020	1921	88
Green route and Sandholes Link Road	2036	1920	73

The number of sensitive receptors subject to operational noise level changes are presented in Table 6-50. The noise model results are reported for the building façade predicted to experience the greatest magnitude of change (do-minimum opening year compared to the do-something opening year).

Table 6-50 – Short-term Daytime Operational Noise Change – Number of Sensitive Receptors

		Number of sensitive receptors			
Short term magnitude		Red Route and Sandholes Link Road	Purple A Route and Sandholes Link Road	Purple B Route and Sandholes Link Road	Green Route and Sandholes Link Road
Adverse	Major	411	311	291	251
	Moderate	248	235	212	232
	Minor	345	349	327	366
	Negligible	244	183	163	180
	No change	2	1	3	1
Benefit	Negligible	418	343	296	362
	Minor	1692	1950	2057	1974
	Moderate	471	580	518	579
	Major	198	77	162	84

The initial assessment of likely significant effect is presented in Table 6-51.

Table 6-51 – Initial Assessment of Significant Effects

	Number of sensitive receptors			
Initial Assessment of Significance	Red route and Sandholes Link Road	Purple A route and Sandholes Link Road	Purple B route and Sandholes Link Road	Green route and Sandholes Link Road
Significant Adverse	659	546	503	483
Not Significant	2701	2826	2846	2883
Significant Benefit	669	657	680	663

For all the route options, the initial assessment of operational noise significance has found that significant adverse effects are predicted at:

- Old Rectory Park;
- Isolated properties around the Loughry Roundabout;
- Dwellings on Castle Road, Castle Villas, Castle Road, Killymoon Road, Knockmoyle, Lomond Heights and Golf View;
- Properties on Coolnafranky Park;
- Dwellings on Festival Park;
- Isolated dwellings between Clare Lane and Old Coagh Road; and
- Properties on The Dales (the greatest number of higher magnitude adverse impacts are predicted here for the Red route).

Initial significant beneficial effects are predicted for all the options at the following locations:

- The length of the bypassed A29 through Cookstown town centre from the Loughry Roundabout through to Moneymore Road and Dunmore Crescent (slightly more high magnitude beneficial impacts are predicted here for the Red route);
- Morgans Hill Road between Orritor Road and the A29; and
- Properties on Tamlaghtmore Road to the north and west of Moneymore Road between the A29 junction with the East Circular Road northwards to the proposed scheme tie-in at the A29 dual carriageway (greatest beneficial impacts are predicted here for the Purple B route).

6.8.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

Mitigation

Construction

Other than proximity to the local receptors, it is not anticipated that there would be significant differences between the construction noise and vibration impacts of any particular route option over another – all four involve the same number of junctions, river crossings and a broadly similar extent of earthworks and are likely to use the same construction compounds and haulage routes.

As such, the potential construction noise and vibration impacts have not been considered a key differentiator during optioneering stage. More detailed construction noise and vibration impacts and any required temporary mitigation measures to minimise those impacts will be assessed at Stage 3 when the preferred route option and detail of the construction activities, plant required, and construction programme are known.

Operation

It is anticipated that permanent mitigation will be required to reduce noise impacts at the receptors most exposed to the selected route option where initial significant adverse effects have been indicated as listed above.

Options Comparison

A combined route option comparison for each of the assessed environmental effects is presented in Table 6-52 below. The most and least preferred route option for each environmental parameter is given including a subjective overall appraisal for all the parameters in combination.

Table 6-52 – Optional Comparison

Parameter	Preferred Route Option	Least Preferred Route Option
Construction	Green route	Purple A route / Purple B route
Operational Noise Level	Green route (slight over Purple A/B route)	Red route
Operational Noise Change	Green route (slight over Purple B route)	Red route
Operational Initial Significance	Green route	Red route
Overall	**Green route**	**Red route**

With precedence given to the quantified operational environmental parameters, overall the Green route is the preferred route option with the least preferred being the Red route.

6.9. POPULATION AND HEALTH

6.9.1. ASSESSMENT SCOPE

This section provides an assessment of the potential impacts associated with Population and Health arising from the proposed scheme. This section has been completed in accordance with the DMRB Volume 11, Section 3, Part 6, LA 112 Population and human health[44].

This assessment will report on the following elements:

- Land use and accessibility including;
  - Private property and housing;
  - Community land and assets;
  - Development land and businesses;
  - Agricultural land holdings; and
  - Walkers, cyclists and horse-riders (WCH).
- Human health including;
  - Health profiles of affected communities;

[44] Highways England, (2019). DMRB LA 112 Population and human health. [online] Available at https://www.standardsforhighways.co.uk/dmrb/search/1e13d6ac-755e-4d60-9735-f976bf64580a [Accessed 24/09/2020].

- o Health determinants; and
- o Likely health outcomes.

The scope of this assessment will include potential impacts from the following;

- Direct impact on and changes to accessibility and severance for private property and housing;
- Direct impact on and changes to accessibility and severance for community land and assets;
- Direct impact on and changes to accessibility and severance for development land and businesses;
- Direct impact on and changes to accessibility and severance for agricultural land holdings; and
- Likely changes to WCH provisions as a result of the proposed scheme.

Health determinants likely to be affected by the proposed scheme, and included in the assessment of human health include;

- Air quality;
- Noise;
- Water quality;
- Landscape amenity;
- Accessibility to community, social and employment facilities; and
- Opportunities for physical activity.

Land use effects will be assessed during construction and for the first year of operation, while human health effects will be assessed during construction and up to year 15 of operation.

This section should be read in conjunction with the other sections of this report as a whole, and in particular the following:

- Section 6.2: Air Quality for further information regarding health effects;
- Section 6.4: Landscape and Visual Effects for further information regarding amenity for WCH;
- Section 6.6: Geology and Soils for information on agricultural land and soils;
- Section 6.8: Noise and Vibration for further information regarding health effects; and
- Section 6.11: Road Drainage and the Water Environment for further information regarding health effects.

6.9.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the population and health assessment are provided in Environmental Appendix B.

6.9.1.2. Study Area

For the land-use and accessibility aspects of this assessment a 500 m Study Area, around the four route options and Sandholes Link Road (common to all four route options) has been applied, as shown in Appendix A Figure 6.9.1: Drawing Reference 718314-WSP-B-D-3000-0138.

For the human health assessment, the study area is comprised of the communities closest to the proposed scheme, whose populations are most likely to experience changes to their health outcomes. These populations fall within the Cookstown District Electoral Area and therefore the baseline has been informed by data from this administrative area.

6.9.1.3. Methodology

The assessment was undertaken in accordance with the DMRB guidance LA 112 Population and human health. For more detail on methodology refer to Environmental Appendix B.

6.9.1.4. Consultation

The consultation undertaken to date for the Population and Health assessment is summarised within Table 6-53. Where no response has been received, follow-up consultations at Stage 3 will be undertaken.

Table 6-53 – Consultation Undertaken for Population and Health

Organisation	Consultation	Response
Mid Ulster District Council	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	Identified it is not within the remit of Environmental Health to identify Health Priorities for the area and defer to Department of Health. Refers to the Mid Ulster Community Plan and NISRA for datasets.
Agri Food and Biosciences Institute	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	No response received
British Horse Society	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	No response received
Department of Health	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	No response received
Fisheries Conservancy Board	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	Response received 19 December 2019. Detail provided of recreational angling facilities supported and located along the Ballinderry River
Harps Cycling Club	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	No response received
Mid Ulster Walking Club	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	No response received

Organisation	Consultation	Response
Positive steps Community Centre	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	No response received
Public Health Agency	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	No response received
Ulster Federation of Rambling Clubs	Request for information and / or comments on three (Red, Purple A and B) route options and Sandholes Link Road - 16 September 2019	No response received

Further consultation undertaken in relation to Air Quality (Section 6.2), Noise and Vibration (Section 6.8), and Drainage and the Water Environment (Section 6.11) relevant to the assessment of human health are set out in the respective sections of this report.

6.9.1.5. Assumption and Limitations

Details of assumptions and limitations for population and health assessment are provided in Environmental Appendix B.

6.9.2. BASELINE CONDITIONS

Sensitive receptors relevant to the Population and Health assessment are shown on Figure 6.9.1 (Appendix A Figure 6.9.1: Drawing Reference 718314-WSP-B-D-3000-0138).

6.9.2.1. Land Use and Accessibility

The principal land uses associated with the study area are residential and agriculture. Leisure and recreation space are present, including Killymoon Golf Course and playparks and playing fields. Industry and commerce are also present, with a concentration around the Sandholes Link Road section of the proposed scheme. Residential property and associated land is present throughout the study area, particularly around the eastern fringes of Cookstown. Agricultural land is the dominant land use to the east of the proposed scheme and consists mainly of Agricultural Land Classification (ALC) Grade 2 (considered to be "very good quality" best and most versatile land (BMV))[45], with Green Belt land also located to the east of Cookstown[46]. Based on the available soil mapping, the following total areas of loss of Grade 2 agricultural soil have been calculated within the proposed fenceline of the proposed scheme (taking into account land that is not currently in agricultural use having been previously developed but is still classified on the mapping as agricultural i.e. Killymoon Golf Club, existing highways, watercourses and former railway lines):

[45] Agricultural land quality is graded from 1 to 5. Best and most versatile land is considered to be from grades 3a to 1.

[46] Department of the Environment, (2004). Cookstown Area Plan, 2010. [online] Available at: https://wayback.archive-it.org/11112/20190702180401/https://www.planningni.gov.uk/index/policy/development_plans/devplans_az/cookstown_2010.htm [Accessed 07/09/2020].

- Red route – approximately 25.84 ha;
- Purple A route – approximately 31.84 ha;
- Purple B route – approximately 29.23 ha; and
- Green route – approximately 34.50 ha.

Leisure and recreation space are also present throughout the study area. Industrial and commercial land uses are located at the northern and southern ends of the study area. There are also areas that have been identified for potential new housing and industrial expansion surrounding much of the town.

As the scheme extents are predominantly located in rural areas, pedestrian facilities are not widespread. There are six roads to the east of Cookstown town centre, plus Sandholes Road, with footway facilities in the vicinity of the proposed bypass option:

- Dungannon Road (Loughry Roundabout);
- Castle Road;
- Killymoon Road;
- Molesworth Road / Fountain Road / Cloghog Road;
- B73 Coagh Road; and
- Moneymore Road.

The footway facilities typically terminate at the outermost housing developments. Light pedestrian use of the footways was recorded within the scheme extents, with a total of 130 recorded journeys along the footways within the scheme extents when surveyed in March 2019 throughout a full day[47].

There is one National Cycle Route (95), which is an on-road cycle route using Clare Lane / Cloghog Road. There is also a shared-use off-road cycle route, located on the western side of Sandholes Road (north / south), extending from the junction with Drum Road in the north to the junction with Sandholes Road in the south. This facility is also provided along the northern side of Sandholes Road (east / west) which extends from the junction with Kilcronagh Road (Business Park) in the west to A29 Loughry Roundabout in the east.

Private properties, community assets and facilities, businesses, agricultural land holdings, and walking, cycling and horse-riding facilities located within the study area are listed in Appendix B-12: Population and Health Receptors. Further information regarding WCH facilities is also detailed in the Walking, Cycling and Horse Riding Assessment.

6.9.2.2. Human Health

In 2018, the age profile of the Cookstown population was similar to both the regional and national averages, with approximately 22.6% of the population aged under 16, 31.84% of the population aged 16-39, 30.62% of the population aged 40-64, and 14.94% of the population 65 and older[48]. Health is generally better in Mid Uls[t]er than the average for Northern Ireland, however in Cookstown, health outcomes are generally worse than the Mid Ulster average. Indicators collected by the Northern Health and Social Care trust (which covers Mid-Ulster and three other local council areas) demonstrate that population health is similar to the Northern Ireland average. Cookstown experiences a degree of deprivation, with 65% of the population living in the two most deprived quintiles.

[47] WSP, (2020). A29 Cookstown Bypass Walking, Cycling and Horse-Riding Assessment.

Specific indicators demonstrating population health are provided in Appendix B-12: Population and Health.

The data indicates that the proposed scheme is located in an area that experiences inequalities in health outcomes, though the population's health is similar to the national average and has areas of deprivation. As such, health receptors in the area are likely to have a moderate capacity to experience a potential impact without incurring substantial change to their health status. Therefore, human health receptors have been judged to have a medium sensitivity to the proposed scheme.

6.9.2.3. Future Baseline

Between 2008-2018 Cookstown's population change was recorded to increase by 8.0%. This is less than the Mid Ulster rate (10.3%) and greater than Northern Ireland (5.8%) but is still following the shared upward trend.

Population growth is projected for each Local Government District (LGD) in Northern Ireland over the next decade. Ageing of the population is set to continue, with the Northern Ireland population aged 65 and over projected to increase by 25.0% and Mid Ulster projected to experience a 32.0% increase. Mid Ulster is set to experience a growth of 48.1% in the category of those aged 85 and over, the highest percentage growth nationally in this age category. At the Northern Ireland level, the proportion of the population aged 65 and over is projected to overtake that of children by 2028, with this being the case across all LGD's by 2035.[48]

6.9.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

The assessment of environmental effects in this section is broken down by each of the route options, with Sandholes Link Road separate (as it is common to all route options). The effects are also divided into construction and operation phases. Where mitigation has been included within the design, this is described, and the purpose and effectiveness stated.

Impacts are identified through professional judgement and in consideration of the guidance and methodologies described above, for the construction and operation phases, and are outlined below for each of the route options.

It is noted that the assessment undertaken below is based on currently known and available information regarding the route options and baseline information. At this stage, the extent of temporary land take required as a proportion of the total land included within the Site Boundary is not available so it is assumed all land within the Site Boundary will be required permanently and that there is no differentiation across the various routes.

6.9.3.1. Red Route

Land Use and Accessibility

Private property and housing

Construction

The Red route will require land take from 18 land parcels, which are classified as 'Garden ground', with a total of approximately 0.95 ha required permanently. Of these, 16 parcels are less than 1 ha in

[48] Northern Ireland Statistics and Research Agency, (2018). 2016-based Population Projections for Areas Within Northern Ireland. [online] Available at: https://www.nisra.gov.uk/news/2016-based-population-projections-areas-within-northern-ireland [Accessed 02/09/2019].

size, and therefore the receptor value has a medium sensitivity. Two of these parcels are between 1-5 ha and are therefore of high sensitivity. A range of magnitudes from negligible to major change will occur, depending on the amount of land required per parcel. One property on Castle Lane (of medium sensitivity) is likely to be required to be permanently acquired (and demolished) as a result of the Red route. These impacts will result in a (worst case) large adverse effect to private property as a result of the Red route.

Operation

There may be some reduced amenity for residents in affected properties and those in close proximity to the Red route. This is considered further in terms of health outcomes below in the assessment on human health, which considers effects reported in the noise, air quality and landscape sections.

No further effects on private land are anticipated during operation.

Community land and assets

Construction

Permanent land take is required from one land parcel (at Ch1000-1250 m) classified as amenity land which is occupied by the Killymoon Golf Club. The Red route option will require 1.46 ha of land from this facility. According to DMRB guidance criteria, this receptor would be deemed of high sensitivity due to the level of use likely being frequent (daily) by members and the limited alternative facilities available at a local level within adjacent communities. For example, Dungannon Golf Club (18 holes) is approximately 13 km south of Killymoon Golf Course and Ronan Valley (10 holes) and Moyola Park (18 holes) are approximately 14 km north east. However, as it is not a facility that is used by a majority of the community it is deemed that a sensitivity of medium is appropriate in this case. The magnitude of change would be minor due to the partial loss of the asset due to land take of the Red route (three greens and holes are affected), assuming that as a worst case in the short term the golf course is able to operate in a reduced capacity. It should be noted that is understood that the Golf Club intends to reconfigure the course prior to the start of construction in order to enable them to operate during the construction period at full capacity. This will be confirmed and reflected in the assessment as progress is made, and until then a worst case scenario has been applied. Users of the golf course are also likely to be impacted by reduced amenity of minor magnitude due to the proximity to construction works. The Red route would result in a temporary moderate adverse effect to community land and assets in the short-term during construction should not all 18 holes (with a total par of 70) be available for users. Assuming the golf course is able to remain operational, there will be a temporary slight adverse effect due to the reduced amenity due to proximity of construction works.

There are a number of community facilities within 500 m of the Red route (Shiloh Gospel Hall, Phoenix Integrated Primary School, Cookstown Youth Resource Centre, Cookstown Hockey Club, Cookstown High School, Cookstown Police Station, Cookstown Elim Pentecostal Church and St Brigits Church), all of which are located to the west of the Red route. There may be some temporary severance for residents located to the east of the Red route during construction if there is disruption to the road network and WCH routes. At this stage, the routes of temporary diversions are not available and therefore the level of severance cannot be determined. However, it is not anticipated that this will be a differentiator between route options.

Operation

Access to, and use of Killymoon Golf Course, would not be affected by the operation of the Red route, and no further effects are anticipated during operation.

Users of the golf course are likely to be permanently impacted by reduced amenity of negligible magnitude due to the proximity of the Red route. It is expected that the golf course will able to remain operational at full capacity during operation following the provision of compensation (and subsequent re-landscaping to be undertaken by the Golf Club prior to and following the completion of construction), and therefore no permanent impact from loss of this facility is anticipated.

Development land and businesses

Construction

The Red route will require a total land take area of approximately 9.07 ha across 15 land parcels classified as industrial or commercial (both existing and that allocated within the Cookstown Area Plan 2010). Eight of these land parcels are under 1 ha and are therefore of medium sensitivity. Three of these land parcels are between 1-5 ha, and are therefore of high sensitivity, and four of these land parcels are over 5 ha in size and therefore are of very high sensitivity. One of these properties is a veterinary practice (Parklands Veterinary Group off Clare Road), which would lose an area of paddock. Cookstown Meats Factory car park will also be lost to the Red route. The magnitude of change would range from negligible to major, depending on the amount of land required, which could compromise viability of businesses. Two parcels of land will be totally lost to the Red route. The Red route would therefore result in a large adverse effect to development land and businesses during construction.

Five parcels of land classified as residential development land are anticipated to be affected by the Red route, with land take totalling an area of approximately 4.04 ha. Four parcels are between 1-5 ha, and therefore the receptors are of high sensitivity. One parcel is over 5 ha in size and is therefore of very high sensitivity. Impacts on residential development land will range from negligible to moderate magnitudes of change depending on the amount of land required per parcel or allocation. This will result in a (worst case) large adverse effect to private property as a result of the Red route, as some land allocated for residential development may not be viable for development and therefore projected housing figures in the area could be affected.

Operation

Access to and permanent severance during operation will be assessed fully at the next (Preliminary Design) stage when consultation with landowners will be undertaken. No further effects are expected during operation.

Agricultural land holdings

Construction

The Red route will require direct land take from 19 land parcels at a total of approximately 15.74 ha of land classified as Agricultural Land required for the construction of the Red route. Approximately 25.84 ha of this is identified as Grade 2 agricultural soils. From aerial photography, these parcels are identified as a mixture of arable and grazing land. The receptor sensitivity cannot be determined at this stage due to the lack of information regarding the frequency of use, total area of agricultural land holding, or level of reliance on land, which are determining factors under the DMRB guidance. Impacts on these parcels are likely to include the following:

- severance from access and/or other land operated under the agricultural land holding;
- temporary and permanent land take, which could reduce the viability of the agricultural land holding;
- impacts on field drainage;
- compaction of temporarily required land; and
- removal of hedgerows and field boundaries.

The extent of temporarily required land for construction purposes is not known at this stage and will therefore be assessed at the next (Preliminary Design) stage.

Operation

Permanent severance and other impacts during operation will be assessed fully in Stage 3 (Preliminary Design) when consultation with landowners will be undertaken.

Walkers, cyclists and horse-riders

Construction

There are no designated public rights of way within 500 m of the Red Route. There is one National Cycle Route (95) (of very high sensitivity) which crosses the Red Route along Clare Lane, and a recreational permitted route (assumed to be of high sensitivity until further details are known on frequency of use), Cabin Wood Public Walk to the east of the Red route. There are also a number of pedestrian routes along pavements adjacent to carriageways within 500 m of the Red route, which will range in sensitivity from low to high sensitivity depending on the level of use and volume of traffic along the route (and will be determined at the next stage).

It is anticipated at this stage that during construction there would be very limited disruption to WCH and the surrounding routes identified in the WCHAR as a result of the Red route. Temporary public rights of way and other route diversions required during construction are not yet defined and therefore will be assessed at the next (Preliminary Design) stage. However, WCH routes could be subject to temporary diversions in the vicinity of construction activities. In particular, where construction ties in directly adjacent to existing residential areas (Castle Road, Golf View, Clare Lane (including the National Cycle Route), Old Coagh Road and Moneymore Road) or the large community asset of Killymoon Golf Course where there would likely be considerable impact on existing pedestrian routes.

Effects from temporary and permanent diversions and increase in journey time, would be fully assessed at Stage 3 (Preliminary Design) when the location of temporary diversions are known.

Operation

Walking and cycling facilities which are crossed by the Red route or altered by the design (National Cycle Route 95, the Cabin Wood Public Walk and pavements adjacent to carriageways), are likely to have a permanent localised reduction in amenity during operation. There may also be some reduced amenity and perceptions of safety for cyclists using the National Cycle Route, where users will be required to navigate the roundabout on Fountain Road.

Human Health

Construction

The Red route has the potential to result in reduced air quality from fugitive dust and increased levels of ambient PM_{10} concentrations from general construction activities including earthworks and track out of dust material from vehicles onto the public highway. This is likely to result in negative health outcomes for residents in nearby residential properties, users of PRoW and recreational, commercial and community facilities, particularly children, the elderly and those with underlying respiratory ailments (see Section 6.2: Air Quality for further details).

Due to the proximity of Cabin Wood public walk to the Red route, it is anticipated that users will experience reduced amenity as a result of construction activities which will be visible in the mid distance. However, this is unlikely to result in any significant effects (see Section 6.4: Landscape and Visual Effects for further details)

Due to their proximity to the Red route, residential properties to the west of the Red route are expected to experience increased noise levels. This is likely to cause disruption to residents and users of local community facilities, particularly for children and the elderly (see Section 6.8: Noise and Vibration for further details) resulting in negative health outcomes for these population groups.

Works within or in close proximity to watercourses may increase the risk of sedimentation and pollutant spillage (fuel, oil and chemicals), reducing water quality. However, these water courses are not used as public water supply sources and therefore unlikely to directly affect the health of the local population, and are therefore expected to have a neutral effect on health outcomes in the local population (see Section 6.11: Road Drainage and the Water Environment for further details).

Operation

The Red route is seeking to move traffic away from the centre of Cookstown, and therefore further away from sensitive receptors located along the current A29. There is the potential to improve air quality due to a reduction in emissions from vehicle exhausts resulting in positive health outcomes. In locations where the Red route will be in close proximity to sensitive receptors, i.e. residential properties of Castle Villas, Knockmoyle, Golf View, and Festival Park, then there may be a deterioration in air quality that could result in negative health outcomes (see Section 6.2: Air Quality for further details).

Due to the proximity of Cabin Wood public walk to the Red route, it is anticipated that users will experience reduced amenity as a result of the Red route which will be visible in the mid distance. However, this is unlikely to result in any significant effects (see Section 6.4: Landscape and Visual Effects for further details)

The Red route will be in close proximity to residential properties, east of the existing A29 alignment, which as a result are anticipated to experience negative health outcomes as a result of increased noise levels (see Section 6.8: Noise and Vibration for further details).

During operation there is a risk of pollution via run-off, accidental spillages and leaks. Appropriate road drainage is embedded in the design to manage/mitigate the risks of polluting watercourses (see Section 6.11: Road Drainage and the Water Environment for further details), however it is anticipated that these will have a neutral effect on health outcomes in the population. Flood risk and impacts on flood plains are considered within Section 5 Engineering Assessment will be considered once the preferred route is selected as part of the Stage 3 assessment within the Engineering Assessment.

6.9.3.2. Purple A Route

Land Use and Accessibility

Private property and housing

Construction

The Purple A route will require land take from 15 land parcels classified as 'Garden ground' with a total of 0.67 ha required permanently. All land parcels are less than 1 ha in size and therefore the receptor value has a medium sensitivity. A range of magnitudes from negligible to moderate change will occur, depending on the amount of land required per parcel. This will result in a (worst case) moderate adverse effect to private property as a result of the Purple A route. Demolition of private properties is not anticipated.

Operation

There may be some reduced amenity for residents in affected properties and those in close proximity to the Purple A route. This is considered further in terms of health outcomes below within the assessment on human health, which considers effects reported in the noise, air quality and landscape sections.

No further effects on private property are anticipated during operation.

Community land and assets

Construction

Permanent land take is required from one land parcel (at Ch1000-1250 m) classified as amenity land, which is occupied by the Killymoon Golf Club. The Purple A route option will require 1.55 ha of land from this facility. According to DMRB guidance criteria, this receptor would be deemed of high sensitivity due to the level of use likely being frequent (daily) and the limited alternative facilities available at a local level within adjacent communities. For example, Dungannon Golf Club (18 holes) is approximately 13 km south of Killymoon Golf Course and Ronan Valley (10 holes) and Moyola Park (18 holes) are approximately14 km north east. However, as it is not a facility that is used by a majority of the community, it is deemed that a sensitivity of medium is appropriate in this case. The magnitude of change would be minor, due to the partial loss of the asset due to land take of the Purple A route (two greens and holes are affected), assuming that as a worst case in the short term the golf course is able to operate in a reduced capacity. It should be noted that is understood that the Golf Club intends to reconfigure the course prior to the start of construction in order to enable them to operate during the construction period at full capacity. This will be confirmed and reflected in the assessment as progress is made, and until then a worst case scenario has been applied. Users of the golf course are also likely to be impacted by reduced amenity of minor magnitude due to the proximity to construction works at its western end. The Purple A route would result in a worst case temporary moderate adverse effect to community land and assets in the short term during construction, should not all 18 holes (with a total par of 70) be available for users. Assuming the golf course is able to remain operational during construction, there will also be a temporary slight adverse effect due to the reduced amenity due to proximity of construction works.

There are a number of community facilities within 500 m of the Purple A route (Shiloh Gospel Hall, Phoenix Integrated Primary School, Cookstown Youth Resource Centre, Cookstown Hockey Club, Cookstown High School, Cookstown Police Station, Cookstown Elim Pentecostal Church, Derryloran Parish Church, Asda superstore and St Brigits Church), all of which are located to the west of the route option. There may be some temporary severance for residents located to the east of the Purple A route during construction if there is disruption to the road network and WCH routes. At this stage, the route of temporary diversions are not available and therefore the level of severance cannot be determined.

Operation

Users of the golf course are likely to be permanently impacted by reduced amenity of negligible magnitude due to the proximity of the Purple A route. It is expected that the golf course will able to remain operational at full capacity during operation following the provision of compensation (and subsequent re-landscaping to be undertaken by the Golf Club prior to and following the completion of construction), and therefore no permanent impact from loss of this facility is anticipated.

Development land and businesses

Construction

The Purple A route requires a total land take area of 0.48 ha across four industrial, and commercial land parcels (both existing and that allocated within the Cookstown Area Plan 2010). All of these land parcels are under 1 ha and are therefore of medium sensitivity. The magnitude of change would range from negligible to major, depending on the amount of land required, which could compromise viability of businesses. One parcel of land will be almost totally lost to the Purple A route, two will lose between 20% and 30% of the total parcel size and the remaining parcel will lose under 5%. The Purple A route would result in a (worst case) large adverse effect to development land and businesses during construction.

There are also four parcels of land classified as residential development land affected by the Purple A route, with land take totalling an area of approximately 3.37 ha. Two parcels are between 1-5 ha, and therefore the receptors are of high sensitivity. Two parcels are over 5 ha in size and are therefore of very high sensitivity. Impacts on residential development land will range from negligible to moderate magnitudes of change depending on the amount of land required per parcel or allocation. This will result in a (worst case) large adverse effect to private property as a result of the scheme, as some land allocated for residential development may not be viable for development and therefore projected housing figures in the area could be affected.

Operation

Access to and permanent severance during operation will be assessed fully at Stage 3 (Preliminary Design) when consultation with landowners will be undertaken. No further effects are expected during operation.

Agricultural land holdings

Construction

The Purple A route will require land take area of 28.82 ha from 30 land parcels classified as Agricultural Land. Approximately 31.84 ha of this is identified as Grade 2 agricultural soils. From aerial photography, these parcels are identified as a mixture of arable and grazing land. The receptor sensitivity cannot be determined at this stage due to the lack of information regarding the frequency of use, total area of agricultural land holding, or level of reliance on land, which are determining factors under the DMRB guidance. Impacts on these parcels are likely to include the following:

- severance from access and/or other land operated under the agricultural land holding;
- temporary and permanent land take, which could reduce the viability of the agricultural land holding;
- impacts on field drainage;
- compaction of temporarily required land; and
- removal of hedgerows and field boundaries.

The extent of temporarily required land for constructions purposes is not known at this stage and will therefore be assessed at Stage 3 (Preliminary Design).

Operation

Permanent severance and other impacts during operation will be assessed fully at Stage 3 (Preliminary Design) when consultation with landowners will be undertaken.

Walkers, cyclists and horse-riders

Construction

There are no designated public rights of way within 500 m of the Purple A route. There is one National Cycle Route (95) (of very high sensitivity) which crosses the Purple A route along Clare Lane, and a recreational route (assumed to be of high sensitivity until further details are known on frequency of use), Cabin Wood Public Walk to the east of the Purple A route. There are also a number of pedestrian routes along pavements adjacent to carriageways within 500 m of the Purple A route, which will range in sensitivity from low to high sensitivity depending on the level of use and volume of traffic along the route (and will be determined at Stage 3 (Preliminary Design)).

It is anticipated at this stage that during construction there would be very limited disruption to WCH and the surrounding routes identified in the WCHAR as a result of the Purple A route. At this stage there are no exact details available to what exact routes would be temporarily closed during construction and therefore will be assessed at Stage 3 (Preliminary Design). However, WCH routes could be subject to temporary diversions in the vicinity of construction activities. In particular, where construction ties in directly adjacent to existing residential areas (Castle Road, Golf View, Clare Lane, Old Coagh Road and Moneymore Road) or Killymoon Golf Course there would likely be considerable impact on all existing pedestrian routes.

Effects from temporary and permanent diversions and increase in journey time, would be fully assessed at Stage 3 (Preliminary Design) when the location of temporary diversions are known.

Operation

Public rights of way which are crossed by the Purple A route, or altered by the design, are likely to have a permanent localised reduction in amenity during operation.

Human Health

Construction

The Purple A route has the potential to result in reduced air quality from fugitive dust and increased levels of ambient PM_{10} concentrations from general construction activities including earthworks and track out of dust material from vehicles onto the public highway. This is likely to result in negative health outcomes for residents in nearby residential properties, users of PRoW and recreational, commercial and community facilities, particularly children, the elderly and those with underlying respiratory ailments (see Section 6.2: Air Quality for further details).

Due to the proximity of Cabin Wood public walk to the Purple A route, it is anticipated that users will experience reduced amenity as a result of construction activities which will be visible in the mid distance. However, this is unlikely to result in any significant effects (see Section 6.4: Landscape and Visual Effects for further details)

Due to their proximity to the Purple A route, residential properties, community facilities and recreational facilities within the study area, including Cabin Wood and Killymoon Golf Club, are expected to experience increased noise levels. This is likely to cause disruption to residents and users of local community facilities, particularly for children and the elderly (see Section 6.8: Noise and Vibration for further details) resulting in negative health outcomes for these population groups.

Works within or in close proximity to watercourses may increase the risk of sedimentation and pollutant spillage (fuel, oil and chemicals), reducing water quality. However, these water courses are not used as public water supply sources and therefore unlikely to directly affect the health of the local population and are therefore expected to have a neutral effect on health outcomes in the local population (see Section 6.11: Road Drainage and the Water Environment for further details).

Operation

The Purple A route it seeking to move traffic away from the centre of Cookstown, and therefore further away from sensitive receptors located along the current A29. There is the potential to improve air quality due to a reduction in emissions from vehicle exhausts resulting in positive health outcomes. In locations where the Purple A route will be in close proximity to sensitive receptors i.e. residential properties of Castle Villas, Knockmoyle, Golf View, and Festival Park, are likely to see a deterioration in air quality which could result in negative health outcomes (see Section 6.2: Air Quality for further details).

Due to the proximity of Cabin Wood public walk to the Purple A route, it is anticipated that users will experience reduced amenity as a result of the new road corridor which will be visible in the mid distance. However, this is unlikely to result in any significant effects (see Section 6.4: Landscape and Visual Effects for further details)

The Purple A route will be in close proximity to residential properties east of the existing A29 alignment, which as a result are anticipated to experience negative health outcomes as a result of increased noise levels (see Section 6.8: Noise and Vibration for further details).

During operation there is a risk of pollution via run-off, accidental spillages and leaks. Appropriate road drainage is embedded in the design to manage/mitigate the risks of polluting watercourses (see Section 6.11: Road Drainage and the Water Environment for further details), however it is anticipated that these will have a neutral effect on health outcomes in the population. Flood risk and impacts on flood plains are considered within Section 5 Engineering Assessment. Engineering Assessment to be considered once the preferred route is selected as part of the Stage 3 assessment.

6.9.3.3. Purple B Route

Land Use and Accessibility

Private property and housing

Construction

The Purple B route will require land take from 10 land parcels classified as ‘Garden ground’ with a total of 0.52 ha required permanently. All land parcels are less than 1 ha in size and therefore the receptor value has a medium sensitivity. A range of magnitudes from negligible to moderate change will occur, depending on the amount of land required per parcel. This will result in a (worst case) moderate adverse effect to private property as a result of the scheme. Demolition of private properties is not anticipated.

Operation

There may be some reduced amenity for residents in affected properties and those in close proximity to the Purple B route. This is considered further in terms of health outcomes below within the assessment on human health, which considers effects reported in the noise, air quality and landscape sections.

No further effects on private property are anticipated during operation.

Community land and assets

Construction

Permanent land take is required from one land parcel (at Ch1000-1250 m) classified as amenity land which is occupied by the Killymoon Golf Club. The Purple B route will require 1.54 ha of land from this facility. This receptor would be deemed high sensitivity due to the level of use likely being frequent (daily) and the limited alternative facilities available at a local level within adjacent communities. For example, Dungannon Golf Club (18 holes) is approximately 13 km south of Killymoon Golf Course and Ronan Valley (10 holes) and Moyola Park (18 holes) are approximately14 km north east. However, as it is not a facility that is used by a majority of the community, it is deemed that a sensitivity of medium is appropriate in this case. The magnitude of change would be minor due to the partial loss of the asset due to land take of the Purple B route (two greens and holes are affected), assuming that as a worst case in the short term the golf course is able to operate in a reduced capacity. It should be noted that is understood that the Golf Club intends to reconfigure the course prior to the start of construction in order to enable them to operate during the construction period at full capacity. This will be confirmed and reflected in the assessment as progress is made, and until then a worst case scenario has been applied. Users of the golf course are also likely to be impacted by reduced amenity of minor magnitude due to the proximity to construction works at its western end. The Purple B route would result in a worst case temporary moderate adverse effect to community land and assets in the short term during construction, should not all 18 holes (with a total par of 70) be available for users. Assuming the golf course is able to remain operational during construction, there will also be a temporary slight adverse effect due to the reduced amenity due to proximity of construction works.

There are a number of community facilities within 500 m of the Purple B route (Shiloh Gospel Hall, Phoenix Integrated Primary School, Cookstown Youth Resource Centre, Cookstown Hockey Club, Cookstown High School, Cookstown Police Station, Cookstown Elim Pentecostal Church, Derryloran Parish Church, Asda superstore and St Brigits Church), all of which are located to the west of the route option. There may be some temporary severance for residents located to the east of the Purple B route, accessing these facilities during construction if there is disruption to the road network and WCH routes. At this stage, the route of temporary diversions are not available and therefore the level of severance cannot be determined.

Operation

Users of the golf course are likely to be permanently impacted by reduced amenity of negligible magnitude due to the proximity of the Purple B route at its western end. It is expected that the golf course will able to remain operational at full capacity during operation following the provision of compensation (and subsequent re-landscaping to be undertaken by the Golf Club prior to and following the completion of construction), and therefore no permanent impact from loss of this facility is anticipated.

Development land and businesses

Construction

The Purple B route requires a total land take area of 0.49 ha across seven land parcels classified as industrial or commercial (both existing and that allocated within the Cookstown Area Plan 2010). Six of these land parcels are under 1 ha in size, and are therefore of medium sensitivity, and one of these land parcels is over 5 ha in size and therefore is of very high sensitivity. The magnitude of change would range from negligible to major, depending on the amount of land required, which could compromise viability of businesses. One parcel of land will be almost totally lost to the proposed scheme, two will lose between 20% and 30% of the total parcel size and the remaining four will lose under 10%. The Purple B route would result in a (worst case) large adverse effect to development land and businesses during construction.

There are also four parcels of land classified as residential development land affected by the Purple B route, with land take totalling an area of approximately 3.2 ha. Two parcels are between 1-5 ha, and therefore the receptors are of high sensitivity. Two parcels are over 5 ha in size and are therefore of very high sensitivity. Impacts on residential development land will range from negligible to moderate magnitudes of change depending on the amount of land required per parcel or allocation. This will result in a (worst case) large adverse effect to private property as a result of the Purple B route, as some land allocated for residential development may not be viable for development and therefore projected housing figures in the area could be affected.

Operation

Access to and permanent severance during operation will be assessed fully at Stage 3 (Preliminary Design) when consultation with landowners will be undertaken. No further effects are expected during operation.

Agricultural land holdings

Construction

The Purple B route will require land take area of 31.75 ha from 30 land parcels classified as Agricultural Land. Approximately 29.23ha of this is identified as Grade 2 agricultural soils. From aerial photography, these parcels are identified to be a mixture of arable and grazing land. The receptor sensitivity cannot be determined at this stage due to the lack of information regarding the frequency of use, total area of agricultural land holding, or level of reliance on land, which are a determining factors under the DMRB guidance. Impacts on these parcels are likely to include the following:

- severance from access and/or other land operated under the agricultural land holding;
- temporary and permanent land take, which could reduce the viability of the agricultural land holding;
- impacts on field drainage;
- compaction of temporarily required land; and
- removal of hedgerows and field boundaries.

The extent of temporarily required land for constructions purposes is not known at this stage and will therefore be assessed at Stage 3 (Preliminary Design).

Operation

Permanent severance and other impacts during operation will be assessed fully at Stage 3 (Preliminary Design) when consultation with landowners will be undertaken.

Walkers, cyclists and horse-riders

Construction

There are no designated public rights of way within 500 m of the Purple B route. There is one National Cycle Route (95) (of very high sensitivity) which crosses the Purple B route along Clare Lane, and a recreational route (assumed to be of high sensitivity until further details are known on frequency of use), Cabin Wood Public Walk to the east of the Purple B route. There are also a number of pedestrian routes along pavements adjacent to carriageways within 500 m of the Purple B route, which will range in sensitivity from low to high sensitivity depending on the level of use and volume of traffic along the route (and will be determined at Stage 3 (Preliminary Design)).

It is anticipated at this stage that during construction there would be very limited disruption to WCH and the surrounding routes identified in the WCHAR as a result of the Purple B route. At this stage there are no exact details available to what exact routes would be temporarily closed during construction and therefore will be assessed at Stage 3 (Preliminary Design). However, WCH routes could be subject to temporary diversions in the vicinity of construction activities. In particular, where construction ties in directly adjacent to existing residential areas (Castle Road, Golf View, Clare Lane, Old Coagh Road and Moneymore Road) or Killymoon Golf Course there would likely be considerable impact on all existing pedestrian routes.

Effects from temporary and permanent diversions and increase in journey time, would be fully assessed at Stage 3 (Preliminary Design) when the location of temporary diversions are known.

Operation

Public rights of way which are crossed by the Purple B route, or altered by the design, are likely to have a permanent localised reduction in amenity during operation.

Human Health

Construction

The Purple B route has the potential to result in reduced air quality from fugitive dust and increased levels of ambient PM_{10} concentrations from general construction activities including earthworks and track out of dust material from vehicles onto the public highway. This is likely to result in negative health outcomes for residents in nearby residential properties, users of PRoW and recreational, commercial and community facilities, particularly children, the elderly and those with underlying respiratory ailments (see Section 6.2: Air Quality for further details).

Due to the proximity of Cabin Wood public walk to the Purple B route, it is anticipated that users will experience reduced amenity as a result of the construction activities which will be visible in the mid distance. However, this is unlikely to result in any significant effects (see Section 6.4: Landscape and Visual Effects for further details)

Due to their proximity to the Purple B route, residential properties, community facilities and recreational facilities within the study area, including Cabin Wood and Killymoon Golf Club, are expected to experience increased noise levels. This is likely to cause disruption to residents and users of local community facilities, particularly for children and the elderly (see Section 6.8: Noise and Vibration for further details) resulting in negative health outcomes for these population groups.

Works within or in close proximity to watercourses may increase the risk of sedimentation and pollutant spillage (fuel, oil and chemicals), reducing water quality. However, these water courses are not used as public water supply sources and therefore unlikely to directly affect the health of the local population, and are therefore expected to have a neutral effect on health outcomes in the local population (see Section 6.11: Road Drainage and the Water Environment for further details).

Operation

The Purple B route it seeking to move traffic away from the centre of Cookstown, and therefore further away from sensitive receptors located along the current A29. There is the potential to improve air quality due to a reduction in emissions from vehicle exhausts resulting in positive health outcomes. In locations where the Purple B route will be in close proximity to sensitive receptors i.e. residential properties of Castle Villas, Knockmoyle, Golf View, and Festival Park, are likely to see a deterioration in air quality which could result in negative health outcomes (see Section 6.2: Air Quality for further details).

Due to the proximity of Cabin Wood public walk to the Purple B route, it is anticipated that users will experience reduced amenity as a result of the new road corridor which will be visible in the mid distance. However, this is unlikely to result in any significant effects (see Section 6.4: Landscape and Visual Effects for further details)

The Purple B route will be in close proximity to residential properties east of the existing A29 alignment, which as a result are anticipated to experience negative health outcomes as a result of increased noise levels (see Section 6.8: Noise and Vibration for further details).

During operation there is a risk of pollution via run-off, accidental spillages and leaks. Appropriate road drainage is embedded in the design to manage/mitigate the risks of polluting watercourses (see Section 6.11: Road Drainage and the Water Environment for further details), however it is anticipated that these will have a neutral effect on health outcomes in the population. Flood risk and impacts on flood plains are considered within Section 5 Engineering Assessment to be considered once the preferred route is selected as part of the Stage 3 assessment.

6.9.3.4. Green Route

Land Use and Accessibility

Private property and housing

Construction

The Green route will require land take from eight land parcels classified as ‘Garden ground’ with a total of 0.29 ha required permanently. All land parcels are less than 1 ha in size and therefore the receptor value has a medium sensitivity. A range of magnitudes from negligible to moderate change will occur, depending on the amount of land required per parcel. This will result in a (worst case) moderate adverse effect to private property as a result of the Green route. Demolition of private properties is not anticipated.

Operation

There may be some reduced amenity for residents in affected properties and those in close proximity to the Green route. This is considered further in terms of health outcomes below within the assessment on human health, which considers effects reported in the noise, air quality and landscape sections.

No further effects on private property are anticipated during operation.

Community land and assets

Construction

Permanent land take is required from one land parcel (at Ch1000-1250 m) classified as amenity land which is occupied by the Killymoon Golf Club. The Green route will require 2.7 ha of land from this facility. This receptor would be deemed of high sensitivity due to the level of use likely being frequent (daily) and the limited alternative facilities available at a local level within adjacent communities. For example, Dungannon Golf Club (18 holes) is approximately 13 km south of Killymoon Golf Course and Ronan Valley (10 holes) and Moyola Park (18 holes) are approximately14 km north east. However, as it is not a facility that is used by a majority of the community, it is deemed that a sensitivity of medium is appropriate in this case. The magnitude of change would be minor due to the partial loss of the asset due to land take of the Green Route (two greens and three holes are affected), assuming that as a worst case in the short term the golf course is able to operate in a reduced capacity. It should be noted that is understood that the Golf Club intends to reconfigure the course prior to the start of construction in order to enable them to operate during the construction period at full capacity. This will be confirmed and reflected in the assessment as progress is made, and until then a worst case scenario has been applied. Users of the golf course are also likely to be impacted by reduced amenity of minor magnitude due to the proximity to construction works at its western end. The Green route would result in a temporary moderate adverse effect to community land and assets in the short term during construction should not all 18 holes (with a total par of 70) be available for users. Assuming the golf course is able to remain operational during construction, there will be a temporary slight adverse effect due to the reduced amenity due to proximity of construction works.

There are a number of community facilities within 500 m of the Green route (Shiloh Gospel Hall, Phoenix Integrated Primary School, Cookstown Youth Resource Centre, Cookstown Hockey Club, Cookstown High School, Cookstown Police Station, Cookstown Elim Pentecostal Church, Derryloran Parish Church, Asda superstore and St Brigits Church), all of which are located to the west of the route option. There may be some temporary severance for residents located to the east of the Green route during construction if there is disruption to the road network and WCH routes. At this stage, the route of temporary diversions are not available and therefore the level of severance cannot be determined.

Operation

Users of the golf course are likely to be permanently impacted by reduced amenity of negligible magnitude due to the proximity of the Green route at its western end. It is expected that the golf course will able to remain operational at full capacity during operation following the provision of compensation (and subsequent re-landscaping to be undertaken by the Golf Club prior to and following the completion of construction), and therefore no permanent impact from loss of this facility is anticipated.

Development land and businesses

Construction

The Green route requires a total land take area of 0.33 ha across three land parcels classified as industrial or commercial (both existing and that allocated within the Cookstown Area Plan 2010). All of these land parcels are under 1 ha in size, and are therefore of medium sensitivity. The magnitude of change would range from negligible to major, depending on the amount of land required, which could compromise viability of businesses. One parcel of land will be totally lost to the Green route, whilst the other two will lose under 20% of the total parcel size. The Green route would result in a (worst case) large adverse effect to development land and businesses during construction.

There are also four parcels of land classified as residential development land affected by the Green route, with land take totalling an area of approximately 2.1 ha. Three parcels are between 1-5 ha, and therefore the receptors are of high sensitivity. One parcel is over 5 ha in size and is therefore of very high sensitivity. Impacts on residential development land will range from negligible to moderate magnitudes of change depending on the amount of land required per parcel or allocation. This will result in a (worst case) large adverse effect to private property as a result of the Green route, as some land allocated for residential development may not be viable for development and therefore projected housing figures in the area could be affected.

Operation

Access to and permanent severance of development land and businesses during operation will be assessed fully at Stage 3 (Preliminary Design) when consultation with landowners will be undertaken. No further effects are expected during operation.

Agricultural land holdings

Construction

The Green route will require land take from 22 land parcels classified as Agricultural Land, requiring approximately 34.5ha, identified as Grade 2 agricultural soils. From aerial photography, these parcels look to be a mixture of arable and grazing land. The receptor sensitivity cannot be determined at this stage due to the lack of information regarding the frequency of use, total area of agricultural land holding, or level of reliance on land, which are a determining factors under the DMRB guidance. Impacts on these parcels are likely to include the following:

- severance from access and/or other land operated under the agricultural land holding;
- temporary and permanent land take, which could reduce the viability of the agricultural land holding;
- impacts on field drainage;
- compaction of temporarily required land; and
- removal of hedgerows and field boundaries.

The extent of temporarily required land for constructions purposes is not known at this stage and will therefore be assessed at Stage 3 (Preliminary Design).

Operation

Permanent severance and other impacts during operation will be assessed fully at Stage 3 (Preliminary Design) when consultation with landowners will be undertaken.

Walkers, cyclists and horse-riders

Construction

There are no designated public rights of way within 500 m of the Green route. There is one National Cycle Route (95) (of very high sensitivity) which crosses the Green route along Clare Lane, and a recreational route (assumed to be of high sensitivity until further details are known on frequency of use), Cabin Wood Public Walk to the east of the Green route. There are also a number of pedestrian routes along pavements adjacent to carriageways within 500 m of the Green route, which will range in sensitivity from low to high sensitivity depending on the level of use and volume of traffic along the route (and will be determined at Stage 3 (Preliminary Design)).

It is anticipated at this stage that during construction there would be very limited disruption to WCH and the surrounding routes identified in the WCHAR as a result of the Green route. At this stage there are no exact details available to what exact routes would be temporarily closed during construction and therefore will be assessed at Stage 3 (Preliminary Design). However, WCH routes could be subject to temporary diversions in the vicinity of construction activities. In particular, where construction ties in directly adjacent to existing residential areas (Castle Road, Golf View, Clare Lane, Old Coagh Road and Moneymore Road) or Killymoon Golf Course there would likely be considerable impact on all existing pedestrian routes.

Effects from temporary and permanent diversions and increase in journey time, would be fully assessed at Stage 3 (Preliminary Design) when the location of temporary diversions are known.

Operation

Public rights of way which are crossed by the Green route, or altered by the design, are likely to have a permanent localised reduction in amenity during operation.

Human Health

Construction

The Green route has the potential to result in reduced air quality from fugitive dust and increased levels of ambient PM_{10} concentrations from general construction activities including earthworks and track out of dust material from vehicles onto the public highway. This is likely to result in negative health outcomes for residents in nearby residential properties, users of PRoW and recreational, commercial and community facilities, particularly children, the elderly and those with underlying respiratory ailments (see Section 6.2: Air Quality for further details).

Due to the proximity of Cabin Wood public walk to the Green route, it is anticipated that users will experience reduced amenity as a result of the construction activities which will be visible in the mid distance. However, this is unlikely to result in any significant effects (see Section 6.4: Landscape and Visual Effects for further details)

Due to their proximity to the Green route, residential properties, community facilities and recreational facilities within the study area, including Cabin Wood and Killymoon Golf Club, are expected to experience increased noise levels. This is likely to cause disruption to residents and users of local community facilities, particularly for children and the elderly (see Section 6.8: Noise and Vibration for further details) resulting in negative health outcomes for these population groups.

Works within or in close proximity to watercourses may increase the risk of sedimentation and pollutant spillage (fuel, oil and chemicals), reducing water quality. However, these water courses are not utilised as public water supply sources and therefore unlikely to directly affect the health of the local population, and are therefore expected to have a neutral effect on health outcomes in the local population (see Section 6.11: Road Drainage and the Water Environment for further details).

Operation

The Green route it seeking to move traffic away from the centre of Cookstown, and therefore further away from sensitive receptors located along the current A29. There is the potential to improve air quality due to a reduction in emissions from vehicle exhausts resulting in positive health outcomes. In locations where the Green route will be in close proximity to sensitive receptors i.e. residential properties of Castle Villas, Knockmoyle, Golf View, and Festival Park, are likely to see a deterioration in air quality which could result in negative health outcomes (see Section 6.2: Air Quality for further details).

Due to the proximity of Cabin Wood public walk to the Green route, it is anticipated that users will experience reduced amenity as a result of the new road corridor which will be visible in the mid distance. However, this is unlikely to result in any significant effects (see Section 6.4: Landscape and Visual Effects for further details)

The Green route will be in close proximity to residential properties east of the existing A29 alignment, which as a result are anticipated to experience negative health outcomes as a result of increased noise levels (see Section 6.8: Noise and Vibration for further details).

During operation there is a risk of pollution via run-off, accidental spillages and leaks. Appropriate road drainage is embedded in the design to manage/mitigate the risks of polluting watercourses (see Section 6.11: Road Drainage and the Water Environment for further details), however it is anticipated that these will have a neutral effect on health outcomes in the population. Flood risk and impacts on flood plains are considered within Section 5 Engineering Assessment to be considered once the preferred route is selected as part of the Stage 3 assessment.

6.9.3.5. Sandholes Link Road

Land Use and Accessibility

Private property and housing

Construction

The Sandholes Link Road will require land take from two land parcels, which are classified as 'Garden ground', with a total of less than 0.01 ha required permanently (4.99% and 2.2% of the land parcel totals). Both of these parcels are less than 1 ha in size, and therefore the receptor value has a medium sensitivity. A (worst case) minor impact is likely, based on the amount of land required per parcel. These impacts will result in a (worst case) moderate adverse effect to private property as a result of the Sandholes Link Road.

Operation

There may be some reduced amenity for residents in affected properties and those in close proximity to the Sandholes Link Road. This is considered further in terms of health outcomes below within the assessment on human health, which considers effects reported in the noise, air quality and landscape sections.

No further effects on private property are anticipated during operation.

Community land and assets

Construction

The Sandholes Link Road requires land take from one land parcel (Ch0-250 m) classified as "Amenity Land/Open Space" which is occupied with a playpark. It is a small, local park and therefore it serves the local area and it is assumed that the frequency of use at this playpark is weekly. There are no similar facilities in the locality and therefore it is deemed to be of high sensitivity. The potential land take total is 0.2 ha which is approximately 99.81% of the total land holding of this play park. The permanent land take total (99.81%) would result in a permanent loss of resource/amenity and would therefore have a major magnitude of change. This will result in a large effect to community land and assets.

There are a number of community facilities within 500 m of the Sandholes Link Road (Forthill Park Cemetery, St Luarans RC Church and Cookstown Free Presbyterian Church). There may be some temporary severance for residents located in the vicinity of the Sandholes Link Road during construction if there is disruption to the road network and WCH routes. At this stage, the route of temporary diversions are not available and therefore the level of severance cannot be determined.

Operation

No further impacts on community land are anticipated during operation.

Development land and businesses

Construction

The Sandholes Link Road requires land take from 10 land parcels classified as industrial or commercial development land, totalling 0.43 ha. Seven of these land parcels are under 1 ha, and are therefore of medium sensitivity. Three of these land parcels are between 1-5 ha, and are therefore of high sensitivity. The magnitude of change would range from negligible to moderate, depending on the amount of land required, which could compromise viability of businesses This will result in a (worst case) moderate adverse effect to development land and businesses.

There is also one parcel of land classified as residential development land affected by the Sandholes Link Road, with land take totalling an area of approximately 0.03 ha, which is 0.55% of the total parcel area. The parcel is between 1-5 ha, and therefore is of high sensitivity. The impact on this parcel identified as residential development land is likely to be of negligible or minor magnitude of change due to the amount of land required. This will result in a (worst case) moderate adverse effect to private property as a result of the Sandholes Link Road, and some land allocated for residential development may not be viable for development and therefore projected housing figures in the area could be affected.

Operation

No further impacts on development land and businesses are anticipated during operation. Agricultural land holdings

The Sandholes Link Road will require land take area of 0.53 ha from 14 land parcels classified as Agricultural Land. From aerial photography, these parcels are identified as a mixture of arable and grazing land. The receptor sensitivity cannot be determined at this stage due to the lack of information regarding the frequency of use, total area of agricultural land holding, or level of reliance on land, which are a determining factors under the DMRB guidance. Impacts on these parcels are likely to include the following:

- severance from access and/or other land operated under the agricultural land holding;
- temporary and permanent land take, which could reduce the viability of the agricultural land holding;
- impacts on field drainage;
- compaction of temporarily required land; and
- removal of hedgerows and field boundaries.

The extent of temporarily required land for constructions purposes is not known at this stage and will therefore be assessed at Stage 3 (Preliminary Design).

Operation

Permanent severance and other impacts during operation will be assessed fully at Stage 3 (Preliminary Design) when consultation with landowners will be undertaken.

Walkers, cyclists and horse-riders

Construction

There is one designated public right of way within 500 m of the Sandholes Link Road, at the edge of the study area to the north east, which runs south of Forthill Park Cemetery. It is a traffic free route and provides connection from Chapel Road through to Westland Road South, but as it is locally designated and provides local connectivity, it is deemed to be of medium sensitivity. It is not anticipated that any impacts upon this public right of way will occur during construction due to its distance from the Sandholes Link Road.

There is pedestrian provision along Sandholes Road and Old Rectory Park, and there is a bus stop on the north bound carriageway of Sandholes Road. As the only other north/south connecting route between the A505, Drum Road and Sandholes Road in this area is the A29, approximately 750 m to the east, pedestrian provision along this route is considered to be of high sensitivity. At this stage there are no exact details available to what routes would be temporarily closed during construction. However, users of WCH provision along Sandholes Road and its feeder routes could be subject to temporary diversions and disruption in the vicinity of construction activities.

There is a shared-use off-road cycle route, approximately 3 m wide, located on the western side of Sandholes Road (north / south), extending from the junction with Drum Road in the north to the junction with Sandholes Road in the south. This facility is also provided along the northern side of Sandholes Road (east / west) which extends from the junction with Kilcronagh Road (Business Park) in the west to A29 Loughry Roundabout in the east.

Operation

No further impacts are anticipated upon PRoW and other routes affected by the proposed scheme option.

Human Health

Construction

The Sandholes Link Road has the potential to result in reduced air quality from fugitive dust and increased levels of ambient PM_{10} concentrations from general construction activities including earthworks and track out of dust material from vehicles onto the public highway. This is likely to result in temporary adverse effects on nearby residential properties, PRoW and recreational, commercial and community facilities, which is of particular concern to children, the elderly and those with underlying respiratory ailments (see Section 6.2: Air Quality for further details).

The Sandholes Link Road is surrounded by residential properties to the east and commercial properties to the west, however the effects of construction activities on landscape character and views would be minimal within the context of an urban environment (see Section 6.4: Landscape and Visual Effects for further details).

Due to their proximity to the Sandholes Link Road, residential properties alongside the proposed scheme are expected to experience increased noise levels. This is likely to cause disruption to residents, commercial facilities and users of community facilities alongside the route, particularly for children and the elderly (see Section 6.8: Noise and Vibration for further details).

Works within or in close proximity to watercourses may increase the risk of sedimentation and pollutant spillage (fuel, oil and chemicals), reducing water quality. However, these water courses are not utilised as public water supply sources and therefore likely to have a neutral effect on health outcomes (see Section 6.11: Road Drainage and the Water Environment for further details).

Operation

There is the potential for improvements to air quality due to a reduction in emissions from vehicle exhausts resulting in a positive health outcome for sensitive receptors along the existing A29. However, locations in close proximity to Sandholes Road i.e. businesses adjacent to Sandholes Road within the Bailyreagh Business Park and Cookstown Enterprise Centre and residential properties east of Sandholes Road, are likely to see a deterioration in air quality due to an increase in vehicles using the route which would result in negative health outcomes (see Section 6.2: Air Quality for further details).

The Sandholes Link Road would not substantially change the landscape character or views from residential or commercial properties as they would still be overlooking a local road, therefore no significant effects are anticipated (see Section 6.4: Landscape and Visual Effects for further details)

Receptors along the existing Sandholes Road i.e. businesses adjacent to Sandholes Road within the Bailyreagh Business Park and Cookstown Enterprise Centre and residential properties east of Sandholes Road, are likely to experience an increase in noise levels due to an increase in the number of vehicles using that route which could lead to negative health outcomes (see Section 6.8: Noise and Vibration for further details).

During operation there is a risk of pollution via run-off, accidental spillages and leaks (see Section 6.11: Road Drainage and the Water Environment for further details) which is likely to have a neutral effect on health outcomes. Flood risk and impacts on flood plains are considered within Section 5 Engineering Assessment. and will be considered once the preferred route is selected as part of the Stage 3 assessment.

The Sandholes Link Road requires the loss of a play park at the northern end of the scheme. The loss of this recreational facility could impact levels of physical activity in children and young people, which would result in negative health outcomes for this population

6.9.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

Mitigation

A Construction Traffic Management Plan (CTMP) and CEMP will be implemented during construction to limit disruption to Population and Health receptors.

Compensation will be provided to those landowners and tenants who are eligible where land take is required.

Temporary and permanent diversions will be provided for PRoW, other routes and access to property where possible. Should closures to existing property access be required, an alternative will be provided.

Options Comparison

The overall summary of effects is included in Table 6-54 below.

Table 6-54 – Overall Summary of Effects for Population and Human Health

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Private Property and Housing	Large adverse (worst case) (moderate adverse for Sandholes)	Moderate adverse (worst case) (moderate adverse for Sandholes)	Moderate adverse (worst case) (moderate adverse for Sandholes)	Moderate adverse (worst case) (moderate adverse for Sandholes)	Red Route affects most amount of land parcels and existing properties, followed by Purple A, Purple B, and then the Green Route. The Red route is the only route which is likely to require the acquisition (and likely demolition) of an existing property.
Community Land	Temporary moderate adverse, permanent negligible adverse (Large adverse for Sandholes)	Temporary moderate adverse, permanent negligible adverse (Large adverse for Sandholes)	Temporary moderate adverse, permanent negligible adverse (Large adverse for Sandholes)	Temporary moderate adverse, permanent negligible adverse (Large adverse for Sandholes)	None
Development Land and Businesses	15 industrial / commercial properties affected Five residential development land parcels affected (4.04 ha) Large adverse (moderate adverse for Sandholes)	4 industrial / commercial properties affected Four residential development land parcels affected (3.37 ha) Large adverse (moderate adverse for Sandholes)	7 industrial / commercial properties affected Four residential development land parcels affected (3.20 ha) Large adverse (moderate adverse for Sandholes)	3 industrial / commercial properties affected Four residential development land parcels affected (2.10 ha) Large adverse (moderate adverse for Sandholes)	Red Route affects most amount of land parcels and largest area of residential development land
Agricultural Land Holdings	Effect on agricultural land holdings will be determined at	Effect on agricultural land holdings will be determined at	Effect on agricultural land holdings will be determined at	Effect on agricultural land holdings will be determined at	Effect on business viability unknown at this stage

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
	Preliminary Design Stage Land take of Grade 2 land is approximately 25.84ha	Preliminary Design Stage Land take of Grade 2 land is approximately 31.84ha	Preliminary Design Stage Land take of Grade 2 land is approximately 29.23ha	Preliminary Design Stage Land take of Grade 2 land is approximately 34.5ha	Green route requires largest Grade 2 land take from agricultural holdings
WCH	Will be determined at Stage 3 (Preliminary Design Stage)	Will be determined at Stage 3 (Preliminary Design Stage)	Will be determined at Stage 3 (Preliminary Design Stage)	Will be determined at Stage 3 (Preliminary Design Stage)	No differentiator at this stage. All routes affect WCH
Air Quality	Temporary negative during construction Improvements for some receptors along the A29, deteriorations for some along the Red route	Temporary negative during construction Improvements for some receptors along the A29, deteriorations for some along the Purple A route	Temporary negative during construction Improvements for some receptors along the A29, deteriorations for some along the Purple B route	Temporary negative during construction Improvements for some receptors along the A29, deteriorations for some along the Green route	None
Noise	Temporary negative during construction Improvements for some receptors along the A29, deteriorations for some along the Red route	Temporary negative during construction Improvements for some receptors along the A29, deteriorations for some along the Purple A route	Temporary negative during construction Improvements for some receptors along the A29, deteriorations for some along the Purple B route	Temporary negative during construction Improvements for some receptors along the A29, deteriorations for some along the Green route	None
Pollution	A neutral effect on human health is expected during both construction and operation	A neutral effect on human health is expected during both construction and operation	A neutral effect on human health is expected during both construction and operation	A neutral effect on human health is expected during both construction and operation	None
Landscape Amenity	Negative permanent effect as the proposed scheme will be visible during both	Negative permanent effect as the proposed scheme will be visible during both	Negative permanent effect as the proposed scheme will be visible during both	Negative permanent effect as the proposed scheme will be visible during both	None

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
	construction and operation	construction and operation	construction and operation	construction and operation	

6.10. CLIMATE

6.10.1. ASSESSMENT SCOPE

The Climate assessment comprises the assessment of the effects of climate on the proposed scheme (vulnerability to climate change) and the effect of the proposed scheme on climate change (in relation to greenhouse gas (GHG) emissions). As such, there are two components to the climate assessment – GHG emissions and Climate Resilience.

This assessment has been undertaken in line with the DMRB guidance and using relevant IEMA guidance:

- DMRB (2019) Volume 11, Section 3, Part 14 Climate; LA 114 Climate[49];
- IEMA (2017) EIA Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance[50]; and
- IEMA (2020) EIA Guide to Climate Resilience and Adaptation[51].

Greenhouse Gas

The GHG Scoping process follows the principles of PAS 2080:2015 Carbon Management in Infrastructure which provides a breakdown of stages A1-C-4[52] of whole life carbon assessments. The elements shown in Table 6-55 are expected to generate GHG emissions of a small magnitude as a result of the proposed scheme and have therefore not been considered within this section.

Table 6-55 – Elements Scoped Out of the Assessment

Lifecycle Stage	Justification
Construction	
Disposal of waste (A5)	Construction waste is expected to be largely inert, and as such is not expected to result in GHG emissions on disposal.
Land use, land use change and forestry (A5)	No significant emissions are anticipated from land use change from agricultural land to the proposed scheme.

[49] Highways England, (2019). DMRB LA 114 Climate. [online] Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/LA%20114%20Climate-web.pdf [Accessed 24/01/2020].
[50] Institute of Environmental Management and Assessment, (2017). EIA Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance. [online] Available at: https://www.iema.net/assets/newbuild/documents/IEMA%20GHG%20in%20EIA%20Guidance%20Document%20V4.pdf [Accessed 30/09/2019].
[51] Institute of Environmental Management and Assessment, (2020). EIA Guide to Climate Resilience and Adaptation. IEMA.
[52] These alphanumeric values are PAS2080 lifecycle references. They ensure clarity when referring to Lifecycle stages.

Lifecycle Stage	Justification
End of Life	
Decommissioning process (C1-4)	Expected timescales for decommissioning are so far into the future that there is insufficient certainty about the likelihood, type or scale of emissions activity to determine their likely magnitude, even if they take place at all. As such these emissions sources will not be considered.

The elements shown in Table 6-56 depict the GHG emission sources that have been scoped in for this assessment.

Table 6-56 – Elements Scoped into the Assessment

Lifecycle Stage	Potential Sources of Emissions
Construction	
Product stage; including raw material supply, transport and manufacture (A1-3)	Embodied emissions associated with extraction and manufacturing of the required raw materials.
Construction process stage; including transport to/from works site and construction/installation processes (A4-5)	Activities of organisations conducting construction work, including fuel/energy consumption by delivery of materials, transportation of waste and construction plant emissions.
Operation	
Use of the infrastructure by the end-user (B9/D)	Change in end-user emissions from the surrounding network (increase or decrease).
Replacement (B4)	Emissions from replacing construction materials throughout the lifespan of the proposed scheme.
Lighting (B1)	Emissions from the operation of road lighting.

Climate Resilience

The scope of the climate resilience assessment includes identification of changes in climate associated with:

- Precipitation;
- Temperature;
- Wind;
- Solar radiation; and
- Relative humidity.

Impacts have been identified in relation to the following proposed scheme assets:

- Construction:

    Materials;
    Plant and equipment;

Workforce; and
Site compound.

- Operation:

Pavement;
Structures;
Embankments;
Vegetation;
Drainage;
End users; and
Ancillary equipment.

6.10.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the climate assessment are provided in Environmental Appendix B.

6.10.1.2. Study Area

Greenhouse Gas

The GHG assessment is not restricted by geographical area but instead includes any increase or decrease in emissions as a result of the proposed scheme, wherever that may be. This includes:

- Construction emissions from the proposed scheme footprint but also related to the transport of materials to and from the site and their manufacture (this may be distant from the proposed scheme location (for example emissions for manufacture of steel); and
- Operational emissions (increase or reduction in emissions) which result from the end-use of the proposed scheme and any shifts in transport modes/patterns which may occur. Such emissions include those for traffic using the proposed scheme as well as the surrounding regional road network.

The impacts of GHGs relate to their contribution to global warming and climate change. These impacts are global and cumulative in nature, with every tonne of GHGs contributing to impacts on natural and human systems. GHG emissions result in the same global effects wherever and whenever they occur. Therefore, the sensitivity of different human and natural receptors is not considered in this assessment.

Climate Resilience

The study area for climate resilience refers to the impact of climate on the proposed scheme (rather than the impact of the proposed scheme on the environment) and as such the study area is the proposed scheme boundary.

6.10.1.3. Methodology

The assessment was undertaken in accordance with the DMRB guidance LA 114 Climate. For more detail on methodology refer to Environmental Appendix B.

6.10.1.4. Consultation

Greenhouse Gas

No consultation has been undertaken for GHGs. At Stage 3 consultation with a Climate representative within DAERA will be sought.

Climate Resilience

Department for Infrastructure Rivers was consulted however this was not in relation to climate resilience. At Stage 3 consultation with a Climate representative within DAERA will be sought.

6.10.1.5. Assumption and Limitations

Details of assumptions and limitations for climate assessment are provided in Environmental Appendix B.

6.10.2. BASELINE CONDITIONS

Greenhouse Gas

6.10.2.1. Current and future GHG baseline

The 'Do Minimum' (baseline) scenario involves no construction activities and therefore the construction baseline is zero emissions. The future baseline scenario involves no construction activities and therefore the construction baseline is also zero emissions.

Total end-user GHG emissions are presented in Table 6-57 for the year 2025 (the first operational year of the proposed scheme) and the future modelled year 2040. In addition, the average annual and total GHG emissions from 2025 to 2084 are presented for comparison with the 60-year operational period of the proposed scheme.

Table 6-57 – Baseline GHG Emissions Data for End-User Traffic covering the A29 and local road networks in the surrounding area of the Proposed Scheme

Scenario	Total GHG emissions for traffic in the strategic and local road network (tCO_2e)			
	2025 (operational year)	2040 (future year)	Average per year (2025-2084)	Total (2025-2084)
Baseline ('Do Minimum')	91,911	82,700	83,928	5,035,678

Climate Resilience

6.10.2.2. Current climate resilience baseline

The proposed scheme is located in the Met Office regional climate profile region of Northern Ireland which is characterised to experience relatively mild winters and cool summers. However, the indented shape of the coastline and the presence of high ground introduce localised differences in temperature, cloud and precipitation.

Precipitation

- Historic precipitation records of monthly rainfall between 1981 and 2010 indicate that the region is slightly wetter in comparison to the UK average;
- Rainfall data from Lough Fea weather station (approximately 9.5 km to the north west of Cookstown) shows that the study area is slightly wetter than the average for the region; and

- The region experiences extreme rainfall events with an average of three days in the winter where rainfall has exceeded 10 mm and just over two days in the summer.

Temperature

- Northern Ireland is slightly cooler than the UK average in summer and slightly warmer in winter;
- Temperature data from Lough Fea weather station (approximately 9.5 km to the north west of Cookstown) shows that the study area is slightly cooler than the average for the region; and
- Snowfall is closely linked with temperature, with falls rarely occurring if the temperature is higher than 4°C. Snow is more frequent over the hills within the region. The average number of days each year when sleet or snow falls varies from around 15 near the east coast of Northern Ireland to over 35 in the mountains.

Wind

- The strongest winds are associated with the passage of deep areas of low pressure close to or across the UK. The frequency and strength of these depressions is greatest in the winter half of the year when mean speeds and gusts are strongest; and
- Data for Lough Fea shows that the study area is less windy compared to the average for Northern Ireland for most of the year, but windier than average in December.

Solar radiation

- The number of hours of bright sunshine is controlled by the length of day and by cloudiness; and
- Daily sunshine hours in the UK are the highest in the south, decreasing in a northerly direction. Northern Ireland therefore sits in the middle in comparison to the rest of the UK for daily sunshine hours.

Relative humidity

- Relative Humidity is the most common measure of humidity, which measures how close the air is to being saturated; and
- Average relative humidity for Northern Ireland is higher than the average for the UK.

6.10.2.3. Future climate resilience baseline

Information on projected climate is taken from the UKCP18[53]. UKCP18 includes probabilistic projections of a range of climate variables for different emissions scenarios (Representative Concentration Pathways (RCPs[54])) and for a range of time slices to the end of the 21st Century. Projections show the change in climate variables, relative to 1990-2010 baseline data.

The proposed scheme reference lifespan has been confirmed by the design team to be 60 years therefore projections are presented for the 2050s and 2080s for the region of Northern Ireland, under

[53] Met Office, (2019). UK Climate Projections 2018. [online] Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index [Accessed 31/10/19].
[54] The RCPs provide a range of possible trajectories of how global land use and emissions of GHGs and air pollutants may change through the 21st century. They are named according to their radiative forcing values in the year 2100 (2.6, 4.5, 6.0 and 8.5 Wm-2). RCP 8.5 is reflective of a high emissions scenario which combines assumptions about high population and relatively slow income growth with modest rates of technological change and energy intensity improvements, leading in the long term to high energy demand and GHG emissions in absence of climate change policies.

a high emissions scenario (RCP8.5)[55]. The 10th, 50th and 90th percentile values are presented. The 50th percentile is the 'central estimate' and is considered the value for which as much evidence points to a lower outcome as a higher one. The 10th and 90th percentiles reflect the lowest 10% and highest 10% of the model results.

Precipitation

- In general, climate change is projected to lead to wetter winters and drier summers although natural variation, including extreme events such as storms and heat waves, will continue to punctuate these trends. The projected changes to average summer and winter rainfall for the 2050s and 2080s are summarised in Table 6-58.

Table 6-58 – Projected change in mean summer and winter precipitation (%) for the 2050s and 2080s for Northern Ireland

Season / time slice		Percentile Change (%)		
		10th	50th	90th
Summer	2050s	-31	-14	1
	2080s	-41	-21	-2
Winter	2050s	-6	5	17
	2080s	-2	15	34

- Climate change is likely to lead to more rainfall falling during 'intense' events, particularly in winter. UKCP18 indicates an increase in precipitation intensity on wet days in winter across the UK though decreases in summer rainfall intensity is confined across central and southern UK.

Temperature

- Climate change is projected to lead to hotter summers and warmer winters. Table 6-59 summarises the UKCP18 projections for changes in mean temperature from the baseline in Northern Ireland in the 2050s and 2080s under RCP 8.5.

Table 6-59 – Projected change in mean summer and winter temperature (°C) for the 2050s and 2080s

Season / time slice		Percentile Change (°C)		
		10th	50th	90th
Summer	2050s	0.6	1.7	3.0
	2080s	1.5	3.7	6.0
Winter	2050s	0.4	1.4	2.6
	2080s	1.0	2.7	4.4

Wind

[55] In line with guidance outlined in the NPSNN to consider a high emissions scenario against 2080 projections at the 50% probability level where the design life of the asset is 60 years or greater.

- UKCP18 depict a wide spread of future changes in mean surface wind speed. Seasonal changes at individual locations across the UK lie within the range of –15% to +10%. With regards to storms, it is generally considered that the UK will experience an increase in storm events.

Solar radiation

- A regional study[56] suggests that Northern Ireland is likely to see an increase in annual solar radiation by the 2050s of 2.7 Wm^{-2} and by the 2080s of 3.1 Wm^{-2}.
- All regions of the UK are likely to have increased cloud cover (although there is large uncertainty around future projections of cloud cover) and therefore slightly less solar radiation during the winter.

Relative humidity

- Climate change is projected to increase humidity within the UK. Summer and winter humidity in Northern Ireland is predicted to increase. Table 6-60 presents the predicted annual changes in specific humidity in Northern Ireland for the 2050s and 2080s.

Table 6-60 – Projected change in summer and winter humidity (%) for the 2050s and 2080s under RCP 8.5 for Northern Ireland

Season / time slice		Percentile Change (%)		
		10^{th}	50^{th}	90^{th}
Summer	2050s	0.7	9.8	19.5
	2080s	5.5	19.7	35.5
Winter	2050s	0.4	9.4	19.5
	2080s	5.6	20.3	36.6

6.10.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

Greenhouse Gas

6.10.3.1. Construction

Table 6-61 to Table 6-66 provide a summary of the material types and associated emissions for the construction stage for each route option and Sandholes Link Road (common to all route options).

Table 6-61 – Red Route Construction Stage Emissions

Material	Embodied Emissions - A1-3 (tCO_2e)	Transport To/Away from Site Emissions - A4-5 (tCO_2e)
Steel	1,748	13
Concrete	1,488	122
Aggregate (including asphalt)	654	988

[56] Burnett, D., Barbour, E. and Harrison, G.P. (2014) The UK solar energy resource and the impact of climate change. Renewable Energy, 71, 333-343.

Material	Embodied Emissions - A1-3 (tCO_2e)	Transport To/Away from Site Emissions - A4-5 (tCO_2e)
Bitumen	286	17
Earthworks (imported)	5,113	2,405
Earthworks (waste)	192	2,144
TOTAL	**9,481**	**5,689**

Table 6-62 – Purple A Route Construction Stage Emissions

Material	Embodied Emissions - A1-3 (tCO_2e)	Transport To/Away from Site Emissions - A4-5 (tCO_2e)
Steel	2,864	21
Concrete	2,390	195
Aggregate (including asphalt)	851	1,286
Bitumen	311	18
Earthworks (imported)	4,046	1,903
Earthworks (waste)	221	2,476
TOTAL	**10,683**	**5,899**

Table 6-63 – Purple B Route Construction Stage Emissions

Material	Embodied Emissions - A1-3 (tCO_2e)	Transport To/Away from Site Emissions - A4-5 (tCO_2e)
Steel	2,886	21
Concrete	2,407	197
Aggregate (including asphalt)	852	1,287
Bitumen	312	18
Earthworks (imported)	3,821	1,797
Earthworks (waste)	238	2,658
TOTAL	**10,516**	**5,978**

Table 6-64 – Green Route Construction Stage Emissions

Material	Embodied Emissions - A1-3 (tCO_2e)	Transport To/Away from Site Emissions - A4-5 (tCO_2e)
Steel	3,626	26
Concrete	2,990	244
Aggregate (including asphalt)	873	1,319
Bitumen	318	19
Earthworks (imported)	3,836	1,804
Earthworks (waste)	411	4,599
TOTAL	**12,054**	**8,011**

Table 6-65 – Sandholes Link Road (common to all route options) Construction Stage Emissions

Material	Embodied Emissions - A1-3 (tCO_2e)	Transport To/Away from Site Emissions - A4-5 (tCO_2e)
Steel	34	<1
Concrete	32	3
Aggregate (including asphalt)	108	164
Bitumen	63	4
Earthworks (imported)	241	113
Earthworks (waste)	1	10
TOTAL	**479**	**294**

Table 6-66 – Plant Emissions

Route	Plant Emissions – (A5) (tCO_2e)
Red route	181.5
Purple A route	908
Purple B route	900
Green route	1,016

Table 6-67 provides a summary of the total construction emissions of each of the four route options (each including Sandholes Link Road) and demonstrates that the Red route will lead to the smallest increase in emissions, with the Green route estimated to generate the largest increase in emissions during the construction phase.

Table 6-67 – Total Construction Stage Emissions

Route	Route Emissions – (A1-A5) (tCO_2e)
Red route	16,939
Purple A route	18,263
Purple B route	18,167
Green route	21,854

6.10.3.2. Operation

The proposed scheme may result in changes to emissions from changes in end-user traffic throughout its operational life relative to the 'Do Minimum' scenario. These changes could be increases or decreases depending on the net effect of factors including changes in traffic flows, speeds and vehicle types. Results of the end-user traffic emissions are presented in Table 6-68 to Table 6-71, which demonstrate an anticipated reduction in emissions over the lifespan of each route option.

Table 6-68 – Red Route End-User Emissions

Scenario	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO_2e)			
	2025 (operational year)	2040 (future year)	Average per year (2025 – 2084)	Total (2025 – 2084)
Baseline Traffic Emissions ('Do Minimum') (tCO2e)	91,911	82,700	83,928	5,035,678
Proposed Scheme ('Do Something') (tCO2e)	90,497	80,896	82,176	4,930,567
Difference (tCO2e)	-1,414	-1,804	-1,752	-105,111

Table 6-69 – Purple A Route End-User Emissions

Scenario	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO_2e)			
	2025 (operational year)	2040 (future year)	Average per year (2025 – 2084)	Total (2025 – 2084)
Baseline Traffic Emissions ('Do Minimum') (tCO_2e)	91,911	82,700	83,928	5,035,678
Proposed Scheme ('Do Something') (tCO_2e)	90,542	81,012	82,283	4,936,959
Difference (tCO_2e)	-1,369	-1,688	-1,645	-98,718

Table 6-70 – Purple B Route End-User Emissions

Scenario	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO_2e)			
	2025 (operational year)	2040 (future year)	Average per year (2025 – 2084)	Total (2025 – 2084)
Baseline ('Do Minimum') (tCO2e)	91,911	82,700	83,928	5,035,678
Proposed Scheme ('Do Something') (tCO2e)	90,167	80,663	81,919	4,915,806
Difference (tCO2e)	-1,744	-2,037	-1,998	-119,872

Table 6-71 – Green Route End-User Emissions

Scenario	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO_2e)			
	2025 (operational year)	2040 (future year)	Average per year (2025 – 2084)	Total (2025 – 2084)
Baseline ('Do Minimum') (tCO2e)	91,911	82,700	83,928	5,035,678
Proposed Scheme ('Do Something') (tCO2e)	90,656	81,131	82,401	4,944,055
Difference (tCO2e)	-1,255	-1,569	-1,527	-91,623

The results of the emissions from replacement of materials for each route option are presented in Table 6-72, and the results of the emissions from lighting for each route option are presented in Table 6-73.

Table 6-72 – Replacement Emissions per Route option

Source	Red Route	Purple A Route	Purple B Route	Green Route
Replacement (tCO_2e)	1,649	1,770	1,772	1,803

Table 6-73 – Lighting Emissions for each route option

Scenario	Lighting (Equivalent for each route option)
Lighting (average tCO_2e /year)	1.7
Lighting (tCO_2e/lifespan)	102

The results of the total operational emissions throughout the lifespan of each route is presented in Table 6-74, demonstrating that the Purple B route is the most favourable route option is terms of reducing emissions over the lifespan of the proposed scheme.

Table 6-74 – Total Operational Emissions

Source	Red Route	Purple A Route	Purple B Route	Green Route
Total Operational Emissions over Lifespan (tCO_2e)	-103,360	-96,846	-117,998	-93,528

Emissions Context

The emissions reported in Table 6-75 puts the emissions of each option into context of the UK carbon budget and total road transport emissions for Mid Ulster.

The emissions reduction that is anticipated to occur during the operational phase due to changes in traffic compared to the 'Do Minimum' (baseline) scenario, is expected to offset the construction phase emissions and then further reduce emissions relative to the baseline, resulting in overall Moderate Significant (beneficial) emissions. This is due to a change in variables between the Do Minimum and Do Something scenarios, including changes in vehicle distance travelled (km), traffic flows, average speeds and proportion of Heavy Duty Vehicles (HDVs). Note, there is no change in the assumed fuel types of vehicles between the Do Minimum and Do Something scenarios.

Table 6-75 – Emissions Context

Stage / Timing	Red Route	Purple A Route	Purple B Route	Green Route
Total GHG Emissions (tCO_2e)				
Construction phase (2023-2025)	16,939	18,263	18,167	21,854
Operational phase (2025-2084)	-103,360	-96,846	-117,998	-93,528
Total for lifecycle (2023-2084)	-86,421	-78,583	-99,831	-71,674
Comparison of the Proposed Scheme GHG Emissions against UK National Carbon Budget				
Total (tCO_2e) during fourth Carbon Budget period (2023-2027) (% of budget)	12,633 (0.00065%)	14,108 (0.00072%)	12,889 (0.00066%)	18,043 (0.00092%)

Stage / Timing	Red Route	Purple A Route	Purple B Route	Green Route
Total (tCO_2e) during fifth Carbon Budget period (2028-2032) (% of budget)	-7,702 (-0.00045%)	-7,358 (-0.00043%)	-9,188 (-0.00053%)	-6,779 (-0.00039%)
Comparison of the Proposed Scheme GHG Emissions against Transport Emissions for Mid Ulster				
Total Annual Operational Emissions (tCO_2e) relative to Mid Ulster Annual Transport Emissions (% of 421.5 $KtCO_2e$)	-861 (-0.20%)	-807 (-0.19%)	-983 (-0.23%)	-748 (-0.18%)

Climate Resilience

Assessment

Table 6-76 below displays the construction assessment for all route options.

Table 6-76 – Construction Assessment - All Route Options

Receptor	Potential Impact	Likelihood	Consequence	Significance
Materials	Deformation and melting of materials	Medium	Moderate adverse	Significant
	Shorter drying times in summer	Low	Minor adverse	Not Significant
	Increased runoff from materials piles	High	Moderate adverse	Significant
	Excessive moisture in materials	High	Moderate adverse	Significant
	Soil erosion	High	Moderate adverse	Significant
	Destabilisation of material, including topsoil and spoil heaps	High	Minor adverse	Not Significant
	Drying out of materials	High	Minor adverse	Not Significant
	Increase in dust	High	Minor adverse	Not Significant
Workforce	Health and safety risks from heatstroke and ultraviolet radiation	High	Moderate adverse	Significant
	Fire	Medium	Moderate adverse	Significant
	Increase in dust	High	Moderate adverse	Significant
	Risk to cranes and working at height	Medium	Moderate adverse	Significant

Receptor	Potential Impact	Likelihood	Consequence	Significance
Plant and equipment	Overheating of machinery	Medium	Moderate adverse	Significant
	Plant and equipment failure or disruption	Medium	Moderate adverse	Significant
	Risk to cranes and working at height	Medium	Moderate adverse	Significant
Site compound	Flooding of site	Medium	Large adverse	Significant
	Overwhelming of drains	Medium	Large adverse	Significant
	Waterlogging of site and excavations	Medium	Large adverse	Significant
	Increased surface runoff leading to surface water flooding and siltation	Medium	Moderate adverse	Significant
	Drying out and cracking of ground	Medium	Moderate adverse	Significant
	Increased vegetation growth	High	Minor adverse	Not Significant

Table 6-77 below displays the operation assessment of all route options.

Table 6-77 – Operation Assessment - All Route Options

Receptor	Potential Impact	Likelihood	Consequence	Significance
Pavement	Deformation and melting of paved surfaces	Medium	Moderate adverse	Significant
	Fewer ice and snow events leading to lower winter maintenance requirements	Medium	Minor beneficial	Not Significant
	Flooding of the carriageway	Medium	Moderate adverse	Significant
	Drying out and subsidence of substrate leading to cracking of pavement	Medium	Moderate adverse	Significant
Structures	Increase in thermal expansion of bridge joints	Medium	Large adverse	Significant
	Increase in earth pressures	Medium	Moderate adverse	Significant
	Drying out, cracking and subsidence of foundations	Medium	Moderate adverse	Significant
	Increase in wind loading on bridges	Medium	Moderate adverse	Significant
Embankments	Loss of vegetation cover leading to destabilisation	Medium	Moderate adverse	Significant
	Waterlogging and erosion leading to destabilisation	Medium	Moderate adverse	Significant

Receptor	Potential Impact	Likelihood	Consequence	Significance
	Drying out and cracking leading to destabilisation	Medium	Moderate adverse	Significant
	Soil erosion leading to destabilisation	Medium	Moderate adverse	Significant
Drainage	Windborne dust and debris clogging drainage channels and requiring clearing	High	Moderate adverse	Significant
	Drainage infrastructure overwhelmed leading to surface water flooding	Medium	Moderate adverse	Significant
Vegetation	Longer growing season, more vigorous vegetation growth in spring and autumn	High	Minor adverse	Significant
	Loss of vegetation due to scorching	Medium	Negligible	Not Significant
	Death of vegetation	Medium	Minor adverse	Not Significant
End users	Risk of disruption from flooding	High	Moderate adverse	Significant
	Difficult driving conditions and risk of aquaplaning	High	Moderate adverse	Significant
Ancillary equipment	Risk of lightning strike	Medium	Moderate adverse	Significant
	Power loss	Medium	Moderate adverse	Significant

6.10.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

6.10.4.1. Proposed Mitigation

Greenhouse Gas

Construction Stage

- It is recommended that the CEMP consider the following measures:
  - Design optimisation to reflect the carbon reduction hierarchy;
  - Reduce the number of construction elements required for the proposed scheme;
  - Reduce the requirement for construction materials;
  - Substitute construction materials for lower-carbon alternatives (e.g. asphalt with a lower bitumen content); and
  - Use efficient construction processes, such as design for manufacture and assembly.
- As far as possible, incorporating material resource efficiency and waste minimisation best practice into design;
- Select and engage with material suppliers and construction contractors taking into account their policies and commitments to reduction of GHG emissions, including embodied emission in materials.;
- Incorporate a SWMP and MMP, within the CEMP;

- Minimise energy consumption including fuel usage by, for example, minimising plant use, idling and specifying efficient plant (or hybrid or electric plant); and
- Maximise the local sourcing of materials and the use of local waste management facilities.

Operational Stage

- Operate, maintain and refurbish the proposed scheme using best-practice efficient approaches and equipment; and
- Install energy efficient lighting.

Climate Resilience

Construction Stage

- To avoid potential significant effects, the CEMP should include the following measures, which will be explored further at Stage 3:
  - Switch machinery off when not in use;
  - During cooler periods, use machinery which has the potential to overheat;
  - The use of cement CEM 1 during construction to increase the rate and heat of hydration and reduce curing time;
  - Ensure welfare facilities are cooled;
  - Rest breaks to be taken during the hottest part of the day (generally, 11am – 3pm);
  - Provide shade for workers in exposed areas;
  - Use personal protective equipment (PPE) to reduce exposure to ultra violet radiation – light coloured, long-sleeved clothing, sun cream, sun hats;
  - Store chemicals, hazardous materials and plant on high ground or protect with bunds or flood barriers;
  - Ensure any access roads used during construction are monitored during periods of heavy rainfall and appropriate traffic management put in place to avoid areas of potential flooding;
  - Ensure site and compound drainage infrastructure has sufficient capacity and that silt traps are in use/regularly emptied;
  - Use localised water pumps to pump water off site and ensure water levels in excavations do not exceed critical levels;
  - Collect and store rainwater to support other facilities e.g. machinery washing.
  - Cover materials and spoil piles with waterproof materials;
  - Maintenance and checking of equipment following periods of extreme rainfall.
  - Concreting during cooler periods of the day;
  - Dust control measures – water spraying from bowsers, cover spoil heaps;
  - Dust control measures – water spraying from bowsers, cover spoil heaps;
  - Reviewing wind speed before commencing work at height; and
  - Ceasing work at height during storms.

Operational Stage

- To avoid potential significant effects, the design of all Proposed Scheme Option should include the following measures, which will be explored further at Stage 3:
  - Selection of materials that will withstand temperatures up to 4°C more than the baseline before skid resistance is affected during design;
  - Structures designed with expansion joints of capacity to withstand high temperatures;
  - Cut slopes no steeper than 1:2.5 and mitigation planting to avoid runoff;

- Materials selection for surface course that will withstand increases in precipitation;
- The drainage design to include elements of SUDS;
- Drainage design and flood modelling to make an allowance for the increased intensity of rainfall;
- The selected Proposed Scheme option subject to a Flood Risk Assessment (FRA) and further flood risk modelling at Stage 3
- Landscape planting on embankments to improve stability;
- Planting on embankments to be chosen with consideration of permeability;
- Native tree and shrub species to be planted and watering operations to be adapted in periods of drought or heavy rainfall;
- Structures designed to withstand increased wind loading and to withstand lightning shock.
- Monitoring of the carriageway during periods of heavy rainfall;
- Monitoring of drainage infrastructure capability and conditions;
- Regular monitoring of embankment condition and planting;
- Monitoring of drainage infrastructure capability and conditions; and
- Maintenance of vegetation growth.

6.10.4.2. Potential Residual Effects

Greenhouse Gas

Construction Stage

Whilst the application of the mitigation measures will reduce GHG emissions it will not alter the significance of effects. The pre-mitigation impact of the proposed scheme is moderate significant (negative), and the residual impact of construction is also moderate significant (negative) for all route options.

Operational Stage

The mitigation outlined above is expected to reduce GHG emissions due to operation of the proposed scheme, however it is not expected to alter significance. Based on the design and transport information that was made available for the Do Minimum and Do Something scenarios (including total vehicle distance travelled (km), percentage of HDV and average vehicle speed (over each link)), the pre-mitigation impact of the proposed scheme is moderate significant (benefit), and the residual impact of operation is also moderate significant (benefit) for all route options.

Climate Resilience

In the absence of commitment to any mitigation measures at this stage the assessment of effects has concluded that the majority of potential effects for all of the route options are likely to be significant. This will be explored further at Stage 3.

6.10.4.3. Summary

A summary of the impact assessment for each route option is provided in

Table 6-78. It should be noted that the impact significance stated in the table represents the residual impact, taking into account the mitigation discussed above.

Table 6-78 – Overall Summary of Residual Effects for Climate

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Construction Phase Impacts					
Climate Resilience – changes in temperature, precipitation, and extreme weather events	Significant	Significant	Significant	Significant	No differentiator
GHG emissions	Moderate (negative)	Moderate (negative)	Moderate (negative)	Moderate (negative)	During construction, the Red route would have lowest GHG emissions and is therefore the most favourable route for the construction phase.
Operational Phase Impacts					
Climate Resilience – changes in temperature, precipitation, and extreme weather events	Significant	Significant	Significant	Significant	No differentiator
GHG Emissions	Moderate (beneficial)	Moderate (beneficial)	Moderate (beneficial)	Moderate (beneficial)	During the operational phase Purple B route would reduce emissions by the largest amount over the lifespan of the scheme compared to the baseline and therefore is the most favourable route for the operational phase (Table 6-104 and 6-105).

6.11. ROAD DRAINAGE AND THE WATER ENVIRONMENT

6.11.1. ASSESSMENT SCOPE

This section presents the results of the DMRB Stage 2 Simple Assessment[57] of the alternative route options of the proposed scheme (i.e. the Red route, Purple A route, and Purple B route and Green route, as well as the Sandholes Link Road which is common to all four route options). It establishes

[57] Highways England, (2020). DMRB LA 113 Road drainage and the water environment (formerly HD 45/09). [online] Available at: https://www.standardsforhighways.co.uk/dmrb/search/d6388f5f-2694-4986-ac46-b17b62c21727 [Accessed 06/08/2020].

the baseline conditions and potential impacts of each route option on Road Drainage and Water Environment (RDWE).

The comparison of the route options relative to RDWE has focused on, in accordance with the guidance contained in the DMRB LA 113[57] and LA 104[58]:

- Pollution to surface water features during construction due to increased generation and release of sediments and suspended solids, and increased risk of accidental spillage of pollutants such as oil, fuel and concrete associated with construction activities and site storage requirements;
- Pollution to surface water features during operation due to routine road run-off to existing watercourses;
- Pollution during operation due to accidental spillages where spilled materials e.g. hazardous chemicals, organic sludges and detergents may drain from the road surface, polluting the receiving surface water bodies;
- Alterations to the hydromorphological (fluvial geomorphological) conditions such as the sediment regime, channel morphology and natural fluvial processes. A reduction in hydromorphological diversity can impact on water quality and biodiversity, and subsequently may impact upon Water Framework Directive (WFD)[59] status and objectives;
- Loss of standing waters where the route options would be constructed through or close to existing ponds;
- Loss or change to surface water supplies due to degradation of water quality, changes in drainage patterns, or disruption to supply infrastructure, due to route options;
- Pollution of groundwater and aquifers, as a result of construction activities such as excavation of deep cuttings and seepage of spillages through ground profiles;
- Groundwater pollution during construction and operation phase due to accidental spillage;
- Direct loss or changes to shallow and deep aquifers and groundwater supported public and private water supply, changes to groundwater flows and groundwater levels associated with the dewatering of deep cuttings and foundation excavations during construction;
- Changes to surface water and groundwater flows as a result of dewatering activities;
- Loss or changes to groundwater dependent terrestrial ecosystems (GWDTEs), including peatland habitats, either below the footprint of the route options, as a result of severance of habitat, or as a result of changes to groundwater flows and levels associated with dewatering activities; and,
- Increase in surface water runoff due to any increase in impermeable area, as a result of the route options.

This DMRB Stage 2 Assessment has been informed by desk study and field survey data. The field surveys (undertaken between 1 to 4 of July 2019) for this assessment have focused on identifying the following:

- Existing watercourse crossings;
- Local water features; and,
- Potential proposed scheme interactions, in order to establish the sensitivity of receptors.

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[58] Highways England (2020). DMRB LA 104 Environmental assessment and monitoring. [online] Available at: https://www.standardsforhighways.co.uk/dmrb/search/0f6e0b6a-d08e-4673-8691-cab564d4a60a [Accessed 06/08/2020].

[59] The Water Environment (Water Framework Directive) Regulations (Northern Ireland), (2017). [online] Available at: http://www.legislation.gov.uk/nisr/2017/81/contents/made [Accessed 18/01/2020].

The information collected through the desk study and field surveys has been used to identify likely impacts associated with the four route options, towards identification of a preferred route from an RDWE perspective which will inform the overall preferred route selection process. It has also been used to identify the requirement for specific surveys during the DMRB Stage 3 Assessment of the final selected route option.

6.11.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the road drainage and the water environment assessment are provided in Environmental Appendix B.

6.11.1.2. Study Area

The study area defined for the RDWE assessment refers to a 5 km buffer surrounding the combined footprint of the Red route, Purple A route, Purple B route and Green route, and the Sandholes Link Road.

6.11.1.3. Methodology

The assessment has been carried out in accordance with the guidance within the DMRB Section 2, Part 10, LA 113 RDWE[57], LA 104 and Volume 5, Section 1, Part 2 TA 37/93 Scheme Assessment Reporting[60]. For more detail on methodology refer to Environmental Appendix B.

6.11.1.4. Consultation

The following consultees were consulted during the assessment process and their responses are summarised:

- DAERA identified the following for consideration:

The Upper Ballinderry River SAC/ASSI, Ballysudden ASSI and Knockadoo Wood ASSI are located within 5 km of the site.
The Environmental Impact Assessment Report should include a description of the water environment and surrounding area, hydrology, water quality and use of any water resources that may be affected by the development; and the consequences of changes to the hydro-geological systems of the area.
The location of private water supplies across Northern Ireland is available via the Drinking Water Inspectorate (2020) - Private Water Supplies mapping[61].

6.11.1.5. Assumption and Limitations

Details of assumptions and limitations for road drainage and the water environment assessment are provided in Environmental Appendix B.

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[60] Highways Agency, (1993). Volume 5, Section 1, Part 2 TA 37/93 Scheme Assessment Reporting. [online] Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol5/section1/td3793.pdf. [Accessed 18/03/2020].
[61] NIEA, (2018). Water Information Request Viewer. [online] Available at: https://gis.daera-ni.gov.uk/arcgis/apps/webappviewer/index.html?id=7e234827aa7a405d990359aa92c7c287 [Accessed 27/01/2020].

6.11.2. BASELINE CONDITIONS

Baseline data have been determined through desk studies and site surveys. Further detail of baseline information collected to date is included in Appendix B-13 – Water Quality Calculations. The desk study includes the review of the following information:

- Statutory and non-statutory designated sites within the study area, protected as a result of their water environment features;
- Surface water and groundwater bodies within the study area, including their WFD classification;
- Hydrogeological setting, detailing bedrock and superficial geology deposits, and groundwater vulnerability (including GWDTEs); and
- Water supplies (surface and groundwater) including private water supplies, water abstractions and discharges (licensed under The Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006 Permitted Controlled Activities).

6.11.2.1. Climate

The proposed scheme is located within the Meteorological Office Northern Ireland regional climate area[62]. As a result of the moderating effects of the Atlantic Ocean, the climate of this regional area is considered equable, with relatively consistent temperatures throughout the year.

Annual average rainfall across Northern Ireland varies from approximately 2,000 mm around Killester Forest (west of Tyrone) to 800 mm south and east of Lough Neagh.

UK Climate Change Projections (UKCP18)[63] indicates how regional climate trends might change as a result of climate change. The report outcomes for Northern Ireland includes a greater chance of warmer drier summers and wetter winters.

The Armagh Meteorological Office station[64], located at NGR 287800 345800 at 62 m amsl (above mean sea level), approximately 30 km south of the proposed scheme, shows an annual average rainfall of 821 mm for the 1853 – 2019 period.

For further details, please refer to Section 6.10.1.2 climate baseline.

6.11.2.2. Designated Sites

The location of statutory and non-statutory designated sites within the study area are described in the baseline conditions (see Section 6.5.2) and shown in Figures 6.5.1, 6.5.2 and 6.5.3 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0162, Appendix A Drawing Reference 718314-WSP-B-D-3000-0168 and Appendix A Drawing Reference 718314-WSP-B-D-3000-0163. Within the noted designated sites, there are two with citations related to the water environment.

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[62] Met. Office, (2016). Northern Ireland: climate. [online] Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/northern-ireland climate---met-office.pdf [Accessed 25/06/2020].
[63] DAERA, (2018). UK Climate Change Projections (UKCP18). [online] Available at: https://www.daera-ni.gov.uk/articles/uk-climate-change-projections [Accessed 25/06/2020].
[64] Met. Office, (2019). Armagh Climate Station Data. [online] Available at: https://www.metoffice.gov.uk/pub/data/weather/uk/climate/stationdata/armaghdata.txt [Accessed 25/06/2020].

The Upper Ballinderry River SAC, which has been designated because it contains habitat types (watercourses of plain to montane levels with communities of water-crowfoot) and species (otters and freshwater pear mussel) which are rare or threatened within a European context.

The Upper Ballinderry River ASSI, designated as a result of the physical features of the river and its associated riverine flora and fauna. The Upper Ballinderry River is notable for the physical diversity and naturalness of the bank and channel, and the richness and naturalness of its plant and animal communities.

The sites are located within the Sandholes Link Road footprint, and approximately 1.1 km upstream of where the Ballinderry River crosses the route options.

Further detail on the statutory and non-statutory designated sites within the study area are provided in Section 6.5.2.

6.11.2.3. Surface Water

The study area is located across three WFD water body catchments of the Neagh Bann River Basin District[65], including from north to south, the Lissan Water (UKGBNI1NB030308231), the Ballinderry River (Cookstown) (UKGBNI1NB030308230) and the Ballinderry River (Derrygonnigan) (UKGBNI1NB030304063). These are shown in Figure 6.11.4 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0170).

There are also a number of non-classified watercourses within the study area. DfI has a designation system for watercourses that have been approved for maintenance at public expense[66]. The DfI designated watercourses within the study area includes from north to south, Molesworth Road Stormwater Drain, Fountain Road Stormwater Drain Branch (A), Fairy Burn and Strifehill Road Drain.

Data collected by NIEA in 2018 indicates that the Ballinderry River (Derrygonnigan) has a Moderate overall status, with a Moderate biological status and chemical status; the Ballinderry River (Cookstown) has a Moderate overall status, with a Moderate biological status and Good chemical status; and the Lissan Water has a Moderate overall status, with a Good biological status and Moderate chemical status.

6.11.2.4. Hydromorphology

A description of all water features affected by the proposed scheme is provided in the supplementary WFD Screening Assessment[67] (see Appendix B-14). This includes the baseline characteristics for each quality element that comprises the Hydromorphology component of the WFD. Baseline descriptions for biological and physiochemical quality elements are also provided. A summary of the fluvial geomorphological character of each potentially impacted water feature is presented in

[65] OSNI, (2019). PRONI Historical Maps. [online] Available at: https://apps.spatialni.gov.uk/PRONIApplication/ [Accessed 21/01/2020].

[66] DfI, (2020). Designations approved by Drainage Council (NI) ArcGIS web application. [online] Available at: https://dfi-ni.maps.arcgis.com/apps/webappviewer/index.html?id=28b901c557054dd488953180d2309903 [Accessed 25/06/2020].

[67] WSP, (2020). WFD Screening Assessment. A29 Cookstown Bypass.

Table 6-79.

Table 6-79 – Baseline fluvial geomorphological characteristics of potentially impacted water features

Water Feature and location description	WFD River	Associated Route Option	General Geomorphological Character	Sensitivity
Fairy Burn (Approximate Ch0 m)	Yes	Red, Purple A, Purple B and Green routes, and Sandholes Link Road	Sediment Regime Sediment delivery to the lower Fairy Burn does not appear to be significantly restricted by the culvert structure that conveys the channel under the A29 Loughry roundabout. The substrate of the Fairy Burn watercourse is comprised primarily of fine to medium gravels with smaller proportions of coarse gravel and small cobble. The coarser material is arranged into intermittent riffles whilst the pools are comprised of a finer substrate. Channel Morphology The morphology of the Fairy Burn watercourse is generally illustrative of a meandering, riffle-pool system. Towards the downstream reaches, leading to the confluence with the main Ballinderry River, the channel is moderately sinuous, which creates additional flow heterogeneity; however, the historical mapping record reveals that the channel has been realigned at some point prior to the mid-19th Century, following which intermittent periods of readjustment have occurred. The upstream reaches are considerably more constrained by local infrastructure. The flow at this location is heavily modified by artificial bank revetments, culverts and canalisation. Natural Fluvial Processes Natural geomorphic functioning is, for the most part, restricted by the modified nature of the channel, particularly in the vicinity of the Sandholes Link route crossing. Towards the downstream reaches of the channel, approaching the confluence with the main Ballinderry River, some natural fluvial process has recovered (or is less heavily impacted).	Medium
Ballinderry River (Approximate Ch180 m)	Yes	Red, Purple A, Purple B and Green routes	Sediment Regime The sediment regime of the Ballinderry River is strongly influenced by the presence of significant in-channel structures that appear frequently along the watercourse. These serve to limit the transfer of sediment from upstream reaches to downstream, thus disrupting the distribution of material throughout the system. The channel appears to be suffering from considerable fine sediment issues at the interaction point of the route crossings; probably in part due to the urban centre of Cookstown providing a source of fines carried amongst urban runoff; but also, there is evidence of active erosion on the left bank at the three proposed	High

Water Feature and location description	WFD River	Associated Route Option	General Geomorphological Character	Sensitivity
			routes' crossing location, that provides a source of clay and other fines. Furthermore, a succession of flow control structures (informal boulder weirs) appear to create ponded sections of channel that further promote flow regulation and, consequently, depositional processes. Channel Morphology The natural character of the channel is generally an actively meandering, pool-riffle system; however, approximately 250 m downstream of the crossing point, the channel becomes defined by bedrock as it flows through a naturally confined section which limits lateral erosion. In addition, there is a large, formal weir structure approximately 400 m downstream of the interaction point that is controlling the water level for some distance upstream, which disrupts the natural pool-riffle sequencing in the river. Natural Fluvial Processes Natural fluvial processes are suppressed by the succession of weir structures situated upstream and downstream of the point at which the three proposed routes would interact with the watercourse. The regulating influence of these structures is likely to disrupt the transfer and distribution of sediment through the system which, in addition to modification of water levels, influences the natural geomorphic functioning of the river. Lateral fluvial processes are similarly disrupted by local infrastructure. The river is artificially constrained through the urban centre of Cookstown, with artificial banks restricting lateral migration. In addition, little evidence of gravel features (side bars, middle channel bars etc.) was noted during the walkover survey. Is this thought to be a symptom of the modified flow and sediment regimen as opposed an indicator of natural processes.	
Unnamed Watercourse (Killymoon Golf Club) (Approximate Ch1500 m)	Yes	Red, Purple A, Purple B and Green routes	Sediment Regime The channel substrate is comprised of small to medium gravels with riffle features encompassing the coarser size fraction of gravels found through the reach; despite the presence of an existing culvert at the upstream end of the watercourse, sediment delivery to the reach is relatively unimpeded. However, towards the interaction point of the channel and route options, the watercourse is heavily laden with silts suggesting that natural sediment transport processes are diminished. Channel Morphology	Low

Water Feature and location description	WFD River	Associated Route Option	General Geomorphological Character	Sensitivity
			Flow patterns within the unnamed watercourse were noted to vary significantly between the segments upstream and downstream reaches observed during the survey. The segment of watercourse between the interaction point exhibits a riffle-pool morphology within a grossly over-deep, straightened channel. the watercourse was not safely accessible upstream of Clare Lane; however, it is believed to comprise of a modified channel with homogenous flow. Downstream of the interaction point, the channel character is extremely homogenous, with a stagnant, ponded flow character and no perceptible variability in terms of flow dynamics. Natural Fluvial Processes The natural geomorphic functioning of the watercourse is heavily disrupted by the modified nature of its channel. The watercourse lies within a grossly over-deep, straightened channel which eliminates lateral connectivity and restricts development of sinuosity and associated bedform.	
Unnamed Watercourse (Old Coagh Road) (Approximate Ch2900 m)	Yes	Red, Purple A, Purple B and Green routes	Sediment Regime The substrate of the bed is comprised predominantly of small to medium gravels. Towards the downstream segments of the survey reach. The substrate was noted to be clean, free from excessive fine material, including within the gravel matrix, and unconsolidated, suggesting that bed transport processes are active. The structure of the stream bed is consistent with a riffle-pool morphology in that coarser gravels are arranged in riffles, while pools have a fine material substrate. Channel Morphology The general morphology of the unnamed watercourse is characteristic of a riffle-pool system. However, towards the upper reaches this is less evident where the channel is strongly influenced by significant riparian and in-channel plant growth. Further downstream, however, flow patterns become more varied with pool-riffle sequences observed throughout the reach. Natural Fluvial Processes Longitudinal connectivity within the unnamed watercourse is encumbered by a number of culvert structures that were noted during the survey. These likely limit the transfer of sediment to lower reaches of the watercourse. Lateral connectivity is relatively poor in the upper reaches of the watercourse which has an over-deep, ditch-like channel character. However, this	Low

Water Feature and location description	WFD River	Associated Route Option	General Geomorphological Character	Sensitivity
			improves towards crossing location 11 where features such as low sediment berms promote hydraulic connectivity and riparian functionality.	
Unnamed Watercourse (A29 Moneymore Road) (Approximate Ch3900 m)	Yes	Red, Purple A, Purple B and Green routes	Sediment Regime Sediment transport processes within unnamed watercourse are probably significantly restricted by a long pipe culvert that conveys flow under the A29 Moneymore Road. The substrate of the bed is comprised predominantly of small to medium gravels. Towards the downstream segments of the survey reach, the substrate was noted to be clean, free from excessive fine material, including within the gravel matrix, and unconsolidated, suggesting that bed transport processes are active despite the presence of the upstream culvert. The structure of the stream bed is consistent with a riffle-pool morphology in that coarser gravels are arranged in riffles, while pools have a fine material substrate. Channel Morphology The unnamed watercourse in its upper reaches is representative of a straightened, modified channel. Flow was very slow on the day of survey and little variability of flow patterns was observed. Further downstream, however, towards the interaction point with Purple B route, development of a pool-riffle morphology and a generally more complex flow structure was noted. The channel is wider than the upstream reaches due to a small tributary joining the unnamed watercourse immediately before it flows under the A29 Moneymore Road. There is an occasional sediment berm feature within the channel, downstream of the existing culvert outfall, which promote a degree of lateral connectivity. Natural Fluvial Processes Longitudinal connectivity within the unnamed watercourse is encumbered by the pipe culvert under the A29 Moneymore Road that was noted during the survey. This likely limits the transfer of sediment to lower reaches of the watercourse. Lateral connectivity is poor in the upper reaches of the watercourse which has an over-deep, ditch-like channel character; however, despite the watercourse obviously having been realigned in the past, the adjacent land demonstrates some characteristics of a wetland such as the presence of reeds and rushes. Lateral connectivity improves slightly downstream of the A29 Moneymore Road culvert outfall, where features such as low sediment berms promote hydraulic connectivity and improved riparian functionality.	Medium

6.11.2.5. Hydrogeology and Groundwater Vulnerability

The route options fall within groundwater water bodies 'Cookstown' (UKGBNI4NB003), and 'Moneymore' (UKGBNI4NB004). Both groundwater water bodies are designated as having 'Poor' chemical and 'Good' quantitative status with an Overall 'Poor' Status (see Figure 6.11.4 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0170)). The vulnerability of both groundwater water bodies is dependent on the presence of permeable, water-bearing superficial deposits, or the occurrence of bedrock close to the surface.

Recharge to these groundwater water bodies is direct via infiltrating rainfall where bedrock is at or close to surface or where permeable superficial deposits are present.

The NIEA designates Alluvium and River Terrace Deposits as superficial deposit aquifers deemed capable of providing water supply on a local, rather than strategic scale[68]. The Glaciofluvial Ice Contact Deposits and Devensian Till hold no current aquifer designation from the NIEA (2019).

The NIEA designates the Sherwood Sandstone Formation as a high productivity fracture/intergranular flow aquifer which also exhibit dual porosities. These aquifers can provide high to moderate yields but are dependent on fracture flow and include an element of regional flow.

The Rockdale Limestone and Derryloran Formations are designated moderate potential productivity fracture flow aquifers[68]. These aquifers can provide high to moderate yields, but yield is dependent on fracture flow. These aquifers may provide regional flow and provide significant local flow.

The Rossmore Mudstone Formation is designated a limited productivity fracture flow aquifer[68] that can provide moderate yields, although low yields are more common. Regional flow is limited and shallow. Localised flow in these aquifers are dominant.

Groundwater vulnerability is defined as the tendency and likelihood for general contaminants to reach the watertable within the uppermost aquifer after introduction at the ground surface. The groundwater vulnerability classifications are derived from datasets that are primarily based upon the assumed permeability and thickness of geological deposits. The datasets do not consider the nature of the underlying receiving aquifer with respect to resource value or significance of pollution occurring[68].

The NIEA defines groundwater vulnerability into five (5 no.) classes with one (1 no.) having the lowest groundwater vulnerability. Class 4 can be subdivided (4a to 4e) according to the nature of the pathway i.e. 4e identifies superficial deposits are present and 4a identifies sand and gravel cover (non-aquifer) as defined by NIEA. Groundwater vulnerability across the study area is classified as 'Low to Moderate', and 'Moderate to High' (see Figure 6.11.2 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0168)).

The northern and north-eastern part of the Study Area is generally rated as being of Moderate vulnerability, though there are three (3 no.) localised areas of Moderate to High groundwater vulnerability (Class 3 and Class 4e). Most of the central part and much of the western part of the Study Area is rated as being of Low to Moderate groundwater vulnerability (Class 2 and Class 3). The southern part of the Study Area, (including the corridors of the Ballinderry River and its tributaries), is rated as being of Low to Moderate and High groundwater vulnerability (Class 2 and Class 4e).

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[68] EA/DEFRA, (2004). Model Procedures for the Management of Contaminated Land. Contaminated Land Report 11.

Groundwater Level

Preliminary and a more detailed GI were completed in 2008 and 2011, respectively, along the route options. The purpose of the work was to investigate ground conditions and provide information for the design of the route options and to assess the contamination status of the site.

In general, groundwater levels relating to the 2008 and 2011 GI were shallow (within 1 metre below ground level (mbgl) and 4 mbgl), relative to the ground surface along the route options. Borehole locations are specified in the A29 Cookstown Bypass GI Final Report[69] and should be read in conjunction with this report.

Due to the variability in lithology of the superficial deposits the presence of perched watertables is possible. Initial water strikes for borehole BH29-11 and BH34-11 (2011 GI) recorded both shallow and deep groundwater levels. BH29-11 recorded an initial water strike at 1.30 mbgl (within sand and gravels) and a second water strike at 3.10 mbgl within weathered sandstone (suspected bedrock Sherwood Sandstone Formation). BH34-11 recorded an initial water strike at 3.0 mbgl within gravelly clay and a second water strike at 8.0 mbgl, also within gravelly clay, including sandstone and limestone. No evidence of artesian groundwater conditions was observed during the 2011 GI.

No groundwater water quality or in-situ permeability testing were completed during the 2008 and 2011 GI. Further targeted GI is proposed as part of the Ground Investigation Scoping Report[70] and will collate additional groundwater monitoring data, in-situ permeability testing and groundwater water quality (where required) to confirm ground conditions and to inform further assessments as part of Stage 3 Assessment.

Groundwater Flooding

No data are available on the potential risk of groundwater flooding within the Study Area however, based on the recorded depth to groundwater level from the historical GI (within 1mbgl and 4mbgl) and underlying geological conditions, risks from groundwater flooding cannot be excluded for all potential route options.

Additional GI is proposed within the Study Area (commenced November 2020) and will include continuous groundwater level monitoring for the duration of the GI will further inform the risks from groundwater flooding as part of the Stage 3 Assessment.

Groundwater Abstractions

Seven (7 no.) public groundwater abstractions are identified within the Study Area and provided by DAERA upon consultation. No data on private groundwater abstractions is provided to date and further consultation will be sought as the proposed scheme progresses.

Table 6-80 provides a summary of the groundwater abstractions identified. The abstraction licence borehole construction details are unknown, and no licence status information were provided i.e. active licence or historic. It is assumed that these abstractions are active until additional information becomes available. The abstractions are shown on Figure 6.11.2 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0169)).

[69] Soil Mechanics, (2008 and 2011). A29 Cookstown Bypass Factual Report on Ground Investigation. Report No: Y1901.
[70] WSP, (2019). Ground Investigation Scope Report [draft]. September 2019.

Table 6-80 – Public groundwater abstractions within the study area

Licence No.	Easting	Northing	Licence Date	Purpose	Yield (m^3/d)	Location	Sensitivity
AIL/2007/0078	282184	376796	08/02/011	Golf Club - irrigation	57.0	Castle Road tie-in at Killymoon Golf Club approx. 300 m east of Red, Purple A, Purple B and Green routes centre line	HIGH
AIL/207/0107	280200	376520	Unknown	Food and Drink	25.0	Derryloran Industrial Estate approx. 220 m west of SHLR***	HIGH
AIL/2007/0131*	281925	377941	23/06/2011	Food and Drink	999.0	Molesworth Road tie-in approx. 18 m west and 35 m west of Red route centre line	HIGH
AIL/2014/0014**	282446	380084	08/08/2016	Food and Drink	620.0	Moneymore Road within footprint of roundabout (north) and approx. 430 m north-east of Purple B route approx. Ch4350 m	HIGH
AIL/2007/0076	281800	380350	Unknown	Agricultural – livestock	25.0	Tamlaghtmore Road approx. 700 m north-west of Purple B route	HIGH
AIL\2009\0041	280304	375847	25/09/2012	Industrial	15.0	Ballyreagh Industrial Estate 450 m south west of SHLR***	HIGH

Notes: * two licences associated with abstraction at Molesworth Road (Red route). ** two licences associated with abstraction at Moneymore Road (Purple B route). ***SHLR is the Sandholes Link Road

Groundwater Dependent Terrestrial Ecosystems (GWDTE)

GWDTE are types of wetland which are specifically protected under the WFD and can include springs, fens, flushes, seepages, wet woodland, marshy grassland and some types of wet heath (reedbed and swamp).

NVC surveys were carried out in 2019, with NVC and Phase 1 Habitat Surveys presented in Section 6.5 Biodiversity. The survey identified a small number of NVC communities (W4, W6, MG8 and MG10) considered to have typically low ecological value but potentially groundwater dependent. Details are provided in Section 6.5 Biodiversity and relate to habitats located along the Ballinderry River which is crossed by all route options. For further details, please refer to Appendix B-10 Figures 7.1, 7.2 and 7.3 of the PEA for Proposed A29 Cookstown Bypass Scheme.

6.11.2.6. Future Baseline

Climate change is expected to influence hydrological processes in the region, both in rainfall intensity and peak river flows. The effects of climate change may also lead to higher groundwater levels in the study area, due to hydraulic connectivity to local groundwater levels. The combined climate change effects may lead to greater interaction between surface waters and groundwater in the future.

Based on currently available information, no other changes are expected in baseline conditions for groundwater. Although further assessment is recommended moving to Stage 3 Assessment as more information becomes available from additional GI and consultation.

6.11.2.7. Receptor Sensitivity

Receptor sensitivity has been evaluated on the basis of the baseline data available. Given data limitations at Stage 2, as previously outlined, a precautionary approach has been adopted. Table 6-81 and Table 6-82 present a summary of the sensitivity of surface water and groundwater receptors respectively.

Table 6-81 – Summary of Surface Water Receptors Sensitivity

Receptor	WFD Catchment	Attribute	Comment	Sensitivity
Fairy Burn	Ballinderry River (Cookstown)	Surface Water Quality and Biodiversity	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
		Fluvial Geomorphology	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s. Watercourse exhibits some natural functionality in terms of sediment dynamics, fluvial processes and morphology, despite being significantly modified.	Medium
		WFD	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium

Receptor	WFD Catchment	Attribute	Comment	Sensitivity
Ballinderry River	Ballinderry River (Cookstown)	Surface Water Quality and Biodiversity	Watercourse having WFD status in a RBMP and a Q_{95} of <1.0 m^3/s. Upper Ballinderry River ASSI and SAC.	High – Very High
		Fluvial Geomorphology	Watercourse having WFD status in a RBMP and a Q_{95} of <1.0 m^3/s. Watercourse exhibits some natural functionality in terms of sediment dynamics, fluvial processes and morphology, despite being modified.	High
		WFD	Watercourse having WFD status in a RBMP and a Q_{95} of <1.0 m^3/s.	High
Fountain Road Stormwater Drain	Ballinderry River (Derrygonnigan)	Surface Water Quality and Biodiversity	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
		Fluvial Geomorphology	Watercourses not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s. Watercourse exhibits degraded geomorphological form and function.	Low
		WFD	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
Molesworth Road Stormwater	Ballinderry River (Derrygonnigan)	Surface Water Quality and Biodiversity	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
		Fluvial Geomorphology	Watercourses not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s. Watercourse exhibits degraded geomorphological form and function.	Low
		WFD	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium

Receptor	WFD Catchment	Attribute	Comment	Sensitivity
Undesignated Drain	Lissan Water	Surface Water Quality and Biodiversity	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
		Fluvial Geomorphology	Watercourses not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s. Watercourse exhibits degraded geomorphological form and function.	Low
		WFD	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
Undesignated Drain	Lissan Water	Surface Water Quality and Biodiversity	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
		Fluvial Geomorphology	Watercourses not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s. Watercourse exhibits degraded geomorphological form and function.	Low
		WFD	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
Undesignated Drain	Lissan Water	Surface Water Quality and Biodiversity	Watercourse not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s.	Medium
		Fluvial Geomorphology	Watercourses not having WFD status in a RBMP and a Q_{95} of >0.001 m^3/s. Watercourse exhibits some natural functionality in terms of sediment dynamics, fluvial processes and morphology despite being degraded in its upper reaches.	Medium
		WFD	Watercourse not having WFD status in a	Medium

Receptor	WFD Catchment	Attribute	Comment	Sensitivity
			RBMP and a Q_{95} of >0.001 m^3/s.	

Table 6-82 – Summary of Groundwater Receptors Sensitivity

Feature	Attribute	Comment	Sensitivity
Cookstown (WFD ID: UKGBNI4NB003)	Water Resource	Public water supplies (assumed active) are highly significant	High
	Groundwater Quality	Existing status of water bodies classed 'Poor' under WFD and may support major public and private abstractions locally and regionally.	Very High
	Water dependent biodiversity (GWDTE)	Biodiversity sites (of local significance such as NVC communities) are likely to be supported by local perched / drift aquifers	Medium
Moneymore (WFD ID: UKGBNI4NB004)	Water Resource	Public water supplies (assumed active) are highly significant	High
	Groundwater Quality	Existing status of water bodies classed 'Poor' under WFD and may support major public and private abstractions locally and regionally.	Very High
	Water dependent biodiversity (GWDTEs)	Although not certain the biodiversity (of local significance) is not thought to be supported by the underlying bedrock aquifer.	Low

6.11.3. ASSESSMENT OF ENVIRONMENTAL EFFECTS

6.11.3.1. Construction Phase Impacts (Surface Water)

Pollution from Construction

Silt and sediment laden site runoff generated during construction activities, such as soil stripping and earthworks can have a detrimental impact if allowed to enter watercourses untreated. Fine sediments can increase water turbidity and smother stream beds, affecting water quality and causing harm to fish, aquatic invertebrates and plants by interfering with feeding, respiration and spawning. The effects of sediment release can extend considerable distances downstream.

In addition, spillages of potential pollutants such as oils, fuels, concrete, cement and sewage from construction staff welfare facilities can potentially occur during construction. Oils form a film on the water surface and can coat organisms, blocking respiration, photosynthesis and feeding. Biodegradation of oils in aquatic systems can lead to oxygen depletion and many hydrocarbons are toxic, persistent and bio-accumulate in the environment i.e. they build-up in the body tissue both directly and from feeding on other contaminated organisms. Concrete and cement is highly alkaline and can harm aquatic organisms if the pH of the receiving waters are affected.

The highest risk of sedimentation or spillage affecting water bodies, and dependent private water supplies would be at locations where construction would be required alongside and within 50 m of a watercourse and also at locations where direct interaction with the water environment occurs, such as bridge and culvert crossing structures, where watercourse diversions are required and at drainage discharge outfalls.

The number of crossings of designated and undesignated watercourses required for each of the route options is detailed in Section 5 with details of preliminary design assumptions relating to the sizing and length of culverts, and the length of watercourse diversions specific to each route option. The tables indicate that all route options provide for an open span structure crossing the designated Ballinderry River.

Based on the preliminary road drainage design, it is anticipated that there would be seven road drainage outfalls for the Red route, eight for Purple A route, eight for Purple B route, and six for Green route, associated with the combined mainline and junction drainage networks discharging to surface waters. These outfalls would require construction activity on channel banks, including pipe-laying and installation of appropriate outfall structures. Sandholes Link Road will utilise the existing outfalls. Details of the watercourses affected by outfall construction are provided in Table 6-83 to Table 6-87.

Construction Impacts on Fluvial Geomorphology

For the assessment of construction impacts, fluvial geomorphology has been separated into three elements, the sediment regime, channel morphology and fluvial processes. The main potential impacts relate to an increase in fine sediment delivery, localised reduction in morphological diversity, a change in natural fluvial processes and degradation of downstream water quality and potential smothering of habitats.

Sediment Regime

Construction impacts could include fine sediment release, which may cause detrimental impact. The risk of this occurring should be minimal if best practice and GPP/PPG are followed. Potential impacts include changes to the water quality due to sediment release and smothering of ecological habitats. For the watercourse diversions, the channels would be created offline where practicable and the water diverted once constructed. Banks should be planted/seeded prior to diverting the water into the new channel. This would manage the risk of sediment release when flow is re-directed into the realigned channel.

Natural Fluvial Processes

The above-mentioned potential fine sediment release during construction could be sufficient to impact upon natural fluvial processes. Increased bare earth surfaces and changes to flow pathways could result in alterations to the quantity of flow entering the channel with potential to locally alter flow processes. This could lead to changes in erosion and deposition and sediment processes with additional knock-on effects that could influence channel morphology. Channel instability could be introduced through channel straightening and improper design of channel dimensions. Works on floodplains could influence the prevailing channel-floodplain interactive processes.

Channel morphology

Local changes to Natural Fluvial Processes could have wider implications for the general morphology of water features. A reduction in hydraulic heterogeneity due to fine sediment loading supplied from bare earth and construction activities (such as vegetation clearance) could occur. This may change the composition of bedforms and features such as exposed gravels, pools and riffles could be lost or adversely affected through smothering. Loss of riparian habitat could occur as a result of vegetation clearance activities which would diminish the ecological functioning of water features as well as influencing channel morphology. Bank stability may be compromised as a result of construction activities resulting in increased bank erosion and alterations to channel dynamics.

Based on the information discussed above and presented from Table 6-83 to Table 6-87 the magnitude and significance of the potential construction pollution impact on each affected water body has been determined for each route option using the criteria provided in the Section 6.11.3. The sensitivity ratings used in the assessment of construction pollution impacts are those associated with the surface water quality and biodiversity attribute.

Table 6-83 – Potential Construction Impacts for Red Route

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
0	Fairy Burn	Surface Water Quality and Biodiversity	Medium	Box culvert 260 m diversion length No outfalls	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Major Adverse	Large
		WFD	Medium		Major Adverse	Large
180	Ballinderry River	Surface Water Quality and Biodiversity	High	Underbridge 30 m span Three outfalls 250 m length of Red route within 50m	Minor Adverse	Slight
		Fluvial Geomorphology	High		Minor Adverse	Slight
		WFD	High		Minor Adverse	Slight
1350	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Surface Water Quality and Biodiversity	Medium	Box culvert 60 m diversion length one outfall 150 m length of Red route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
1800	Molesworth Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Surface Water Quality and Biodiversity	Medium	Two pipes culvert 30 m diversion length One outfall 100 m length of Red route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
2650	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert	Minor Adverse	Slight

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
		Fluvial Geomorphology	Low	520 m diversion length No outfalls	Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
2780	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert Two outfalls 100 m length of Red route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
3550	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert 290 m diversion length One outfall 400 m length of Red route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Minor Adverse	Slight
		WFD	Medium		Minor Adverse	Slight

Table 6-84 – Potential Construction Impacts for Purple A Route

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
0	Fairy Burn	Surface Water Quality and Biodiversity	Medium	Box culvert 260 m diversion length No outfalls	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Major Adverse	Large
		WFD	Medium		Major Adverse	Large
180	Ballinderry River	Surface Water Quality and Biodiversity	High	Underbridge 30 m span Three outfalls 250 m length of Purple A route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	High		Minor Adverse	Slight
		WFD	High		Minor Adverse	Slight
1350	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Surface Water Quality and Biodiversity	Medium	Box culvert 155 m diversion length One outfall 150 m length of Purple A route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
1800	Molesworth Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Surface Water Quality and Biodiversity	Medium	50 m length of Purple A route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
2150	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	70 m length of Purple A route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
2535	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert Two outfalls 100 m length of Purple A route within 50m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
3120	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert 290 m diversion length One outfall 400 m length of Purple A route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Major Adverse	Slight/moderate
		WFD	Medium		Minor Adverse	Slight
3975	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert 285 m diversion length One outfall 100 m length of Purple A route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Minor Adverse	Slight
		WFD	Medium		Minor Adverse	Slight

Table 6-85 – Potential Construction Impacts for Purple B Route

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
0	Fairy Burn	Surface Water Quality and Biodiversity	Medium	Box culvert	Minor Adverse	Slight

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
		Fluvial Geomorphology	Medium	260 m diversion length No outfalls	Major Adverse	Large
		WFD	Medium		Major Adverse	Large
180	Ballinderry River	Surface Water Quality and Biodiversity	High	Underbridge 30 m span Three outfalls 250 m length of Purple B route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	High		Minor Adverse	Slight
		WFD	High		Minor Adverse	Slight
1350	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Surface Water Quality and Biodiversity	Medium	Box culvert 155 m diversion length One outfall 200 m length of Purple B route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
1800	Molesworth Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Surface Water Quality and Biodiversity	Medium	80 m length of Purple B route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
2150	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	100 m length of Purple B route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
2535	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert No outfalls	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Major Adverse	Slight/moderate
		WFD	Medium		Minor Adverse	Slight
3120	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert Two outfalls 200 m length of Purple B	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Minor Adverse	Slight

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
		WFD	Medium	route within 50 m	Minor Adverse	Slight
4300	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert One outfall 200 m length of Purple B route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Minor Adverse	Slight
		WFD	Medium		Minor Adverse	Slight

Table 6-86 – Potential Construction Impacts for Green Route

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
0	Fairy Burn	Surface Water Quality and Biodiversity	Medium	96 m Box culvert 151 m diversion length No outfalls	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Major Adverse	Large
		WFD	Medium		Major Adverse	Large
175	Ballinderry River	Surface Water Quality and Biodiversity	High	Underbridge 30 m span Three outfalls 250 m length of Green route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	High		Minor Adverse	Slight
		WFD	High		Minor Adverse	Slight
1375	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Surface Water Quality and Biodiversity	Medium	31 m Box culvert 150 m length of Purple A route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
2550	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	Pipe culvert Two outfalls 100 m length of Green route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Minor Adverse	Neutral
		WFD	Medium		Minor Adverse	Slight
3175	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	142 m Pipe culvert 400 m length of Green	Minor Adverse	Slight
		Fluvial Geomorphology	Low		Major Adverse	Slight/moderate

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
		WFD	Medium	route within 50 m	Minor Adverse	Slight
3975	Undesignated (Lissan Water Catchment)	Surface Water Quality and Biodiversity	Medium	158 Pipe culvert 100 m length of Purple A route within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Major Adverse	Slight/moderate
		WFD	Medium		Minor Adverse	Slight

Table 6-87 – Potential Construction impacts for Sandholes Link Road

Ch. (m)	Receptor	Attribute	Sensitivity	Interactions	Magnitude	Significance
0	Ballinderry River	Surface Water Quality and Biodiversity	High	110 m length of Sandholes within 50 m No new outfalls	Minor Adverse	Slight
		Fluvial Geomorphology	High		Negligible	Slight
		WFD	High		Minor Adverse	Slight
420	Fairy Burn	Surface Water Quality and Biodiversity	High	Pipe culvert 15 m length New culvert box 13 m length No new outfalls 120 m length of Sandholes within 50 m	Minor Adverse	Slight
		Fluvial Geomorphology	Medium		Minor Adverse	Slight
		WFD	Medium		Minor Adverse	Slight

Construction Impacts on WFD

The WFD screening assessment identified that, out of the 17 potential watercourse interaction points identified at the desk study phase, nine are screened in for further scoping assessment. These interactions could result in fragmentation, loss of habitat and impact a range of WFD quality elements.

The preferred route option, based on the WFD screening assessment, would be the Green route.

For further details on the potential construction impacts on WFD, please refer to Appendix B-14 – WFD Screening Assessment.

6.11.3.2. Construction Phase Impacts (Groundwater)

Based on the preliminary design for each of the route options, construction activities have potential to impact groundwater receptors, relating to the removal of surface cover including soils and superficial deposits during the creation of cuttings and potential excavation close to or below the groundwater table. Spillages in these areas could introduce pollutants directly into the groundwater aquifers and/or establish pathways for pollutants to migrate within and between receptors.

All route options directly overlie, and would therefore directly interact with, superficial aquifers hosting secondary and/or minor aquifers deemed to have a Low significance though the underlying bedrock aquifers are deemed to have a Very High significance in respect of water resources and water quality. None of the route options directly overlies, and would therefore not directly interact with, the bedrock aquifers (Sherwood Sandstone, Rockdale Limestone and Derryloran Formations).

Road cuttings are proposed along all the route options and have the potential to increase groundwater vulnerability as they reduce the thickness of drift deposits or expose the underlying bedrock aquifers, as well as potentially affecting groundwater flow and levels as a result of dewatering during excavation. The construction of embankments and associated pre-earthworks drainage could also alter local groundwater flow and levels, increasing flows in some catchments with associated reductions elsewhere.

Groundwater levels are expected to be shallow (within 1.0 mbgl and 4.0 mbgl) relative to the ground surface along all route options and due to variability in lithology of the superficial deposits, the presence of perched watertables may also exist. Where cuttings penetrate in to or are close to the watertable this may lead to a permanent change to local groundwater levels and flows affecting local receptors. At present, the depth to base of cut areas of each of the route options are unavailable and will be made available as part of the Stage 3 Assessment. A Very High sensitivity is assigned to groundwater receptors along all route options. Table 6-88 below summarises the total length of cuttings per route option.

Table 6-88 – Total cut length along each route option alignment

Route Option	Total Cut Length (m)
Purple A route and Sandholes Link Road	2540
Purple B route and Sandholes Link Road	2540
Red route and Sandholes Link road	1835
Green route and Sandholes Link Road	3710

Less cuttings will reduce the risks of dewatering and drainage impacts on groundwater receptors (aquifers/public and private abstractions) and reduce the significance of potential effects on groundwater receptors along the route options. Based on the total cut lengths calculated for each route option a Minor to Moderate magnitude of impact is assigned to the Red route and Sandholes Link Road, and a Major to Minor magnitude of impact assigned to the Purple A route and Sandholes Link Road, Purple B route and Sandholes Link Road, Green route and Sandholes Link Road, respectively. At present no specific proposal have been made to undertake any dewatering along each of the route options as part of construction. This will be further considered (as appropriate) at Stage 3.

For each of the route options, the total length of cutting within each groundwater vulnerability class (see Figure 6.11.2 (Appendix A Drawing Reference 718314-WSP-B-D-3000-0168)) has been calculated to provide an indication of the risk of pollution to groundwater quality associated with each route option (Table 6-89).

Table 6-89 – Summary of impacts from cutting on aquifers by groundwater vulnerability class

Route Option	Total length of cutting (m) within each groundwater vulnerability class				
	Class 1	Class 2	Class 3	Class 4 (4a to 4e)	Class 5
Purple A	0.0	820.0	960.0	300.0	0.0

Route Option	Total length of cutting (m) within each groundwater vulnerability class				
	Class 1	Class 2	Class 3	Class 4 (4a to 4e)	Class 5
Purple B	0.0	270.0	1400.0	410.0	0.0
Red	0.0	500.0	755.0	120.0	0.0
Green	0.0	1525	1145	580.0	0.0
Sandholes Link Road	0.0	230.0	0.0	230.0	0.0

Based on the information discussed above and presented in Table 6-89 the magnitude and significance of the potential construction pollution impact on each affected groundwater water body has been determined for each route option using the criteria provided in the Section 6.11.3 Assessment of Environmental Effects.

Long-term impacts on groundwater levels and flow affecting aquifers, groundwater abstractions (public and private) and GWDTEs may arise from road cuttings or below ground structures that are close to or potentially penetrates the watertable. For all route options, the potential impact from construction related pollution is considered to be Large where depth to groundwater level are shallow and within 1.0 mbgl and 4.0 mbgl, relative to the ground surface along all route options.

6.11.3.3. Operational Phase Impacts (Surface Water)

Pollution from Routine Runoff and Surface Water Quality

During operation, a broad range of potential pollutants, such as hydrocarbons i.e. fuel and lubricants, fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving water bodies. Routine runoff from road drainage networks can result in both acute and chronic impacts on water quality and subsequently on the biodiversity of the receiving watercourses, due to both soluble (in particular, dissolved copper and dissolved zinc) and sediment bound pollutants.

A preliminary drainage design has been developed for the proposed scheme. A number of outfall locations for the networks are common for all route options. The area draining to several of these outfalls varies between the route options, however the differences are small and have no effect on the routine runoff assessment calculation results.

The drainage design for each mainline and junction network includes one level of treatment, in the form of SuDS, as standard. The extents of these zones will be subject to further verification during Stage 3, and contributions to compensatory floodplain storage will be considered, where required. As these measures are considered as embedded design features and not as additional mitigation, the routine runoff calculations have been undertaken assuming these features are included on each network, as appropriate.

All of the proposed surface water outfalls have been subject to the HEWRAT and EQS assessments, including the cumulative assessments. At Stage 3 a Tier 2 detailed assessment will be carried out which will utilise more detailed site specific survey data for each receiving watercourse. The results of the assessments are provided in Appendix B-13 – Water Quality Calculations and are summarised in Table 6-90, Table 6-91, Table 6-92 and Table 6-93, below. It should be noted that the receptor sensitivity quoted relates to the surface water quality and biodiversity attribute of each watercourse.

HEWRAT was developed to be used for highways with AADT ranging from 10,000 to 159,000. However, the majority of the A29 AADT values are below 10,000, therefore the results are considered conservative.

At Stage 2 there was no information available on the permeable area discharging to the outfalls, this information will be confirmed at Stage 3.

HEWRAT recommends undertaking Groundwater Assessments for watercourses with a Q_{95} of 0.001 m^3/s or less. These assessments will be completed at Stage 3 when a final drainage design is available.

The proposed drainage design for side roads and accommodation tracks was not available while producing this report, therefore no assessment of routine runoff impacts has been carried out at this stage. Assessment of side road and accommodation track drainage proposals will be carried out at Stage 3; however, it is not anticipated that this will have a major influence on the overall significance of effects associated with the proposed scheme.

Red Route

As displayed in Table 6-90, all individual outfalls proposed for Red route pass all elements of the routine runoff assessment. Consequently, the impact magnitude for all individual outfalls have been assessed as Negligible. As a result, the significance is Slight for the individual outfalls.

The impact magnitude for cumulative outfalls have been assessed as Negligible for all outfalls except for OF-RR-04 / OF-RR-05, which are assessed as Minor Adverse. As a result, the significance is Moderate for the cumulative assessment of OF-RR-04 / OF-RR-05 and, Slight for the rest of the cumulative outfalls.

For the location of the Red route outfalls, see Figures Stage 2 - Red Route Preliminary Drainage Design Sheets 1, 2 and 3 [718314-WSP-B-D-0500-0018], [718314-WSP-B-D-0500-0019] and [718314-WSP-B-D-0500-0020].

Table 6-90 – Summary of Routine Runoff Assessment for Red Route

Drainage Network ID	Receptor	Sensitivity	Routine Runoff Result	Magnitude	Significance
OF-RR-01	Ballinderry River	High	Pass	Negligible	Slight
OF-RR-02	Ballinderry River	High	Pass	Negligible	Slight
OF-RR-03	Ballinderry River	High	Pass	Negligible	Slight
OF-RR-04	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)	Medium	Pass	Negligible	Slight
OF-RR-05	Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)	Medium	Pass	Negligible	Slight
OF-RR-06	Undesignated	Medium	Pass	Negligible	Slight
OF-RR-07	Undesignated	Medium	Pass	Negligible	Slight
OF-RR-08	Undesignated	Medium	Pass	Negligible	Slight
Cumulative	Ballinderry River	High	Pass	Negligible	Slight

Drainage Network ID	Receptor	Sensitivity	Routine Runoff Result	Magnitude	Significance
OF-RR-01 / OF-RR-02 / OF-RR-03					
Cumulative OF-RR-04 / OF-RR-05	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment) and Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)	High	Fail	Minor Adverse	Moderate
Cumulative OF-RR-06 / OF-RR-07	Undesignated	Medium	Pass	Negligible	Slight

Purple A Route

As can be seen on Table 6-91, of all individual outfalls proposed for Purple A route, six of seven outfalls pass all elements of the routine runoff assessment. A failure is registered for OF-PA-07. Of the cumulative assessments, one of the two pass all elements, with OF-PA-04 / OF-PA-05 registered as a failure. Consequently, the impact magnitude for outfalls have been assessed as Negligible expect for OF-PAP07, and OF-PA-04 / OF-PA-05, which have been assessed as Minor Adverse. As a result, the significance is Moderate for the cumulative assessment of OF-PA-04 / OF-PA-05 and, Slight for the other outfalls.

For the location of the Purple A route outfalls, see Figures Stage 2 – Purple A Route Preliminary Drainage Design Sheets 1, 2 and 3 [718314-WSP-B-D-0500-0021], [718314-WSP-B-D-0500-0022] and [718314-WSP-B-D-0500-0023].

Table 6-91 – Summary of Routine Runoff Assessment for Purple A Route

Drainage Network ID	Receptor	Sensitivity	Routine Runoff Result	Magnitude	Significance
OF-PA-01	Ballinderry River	High	Pass	Negligible	Slight
OF-PA-02	Ballinderry River	High	Pass	Negligible	Slight
OF-PA-03	Ballinderry River	High	Pass	Negligible	Slight
OF-PA-04	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)	Medium	Pass	Negligible	Slight
OF-PA-05	Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)	Medium	Pass	Negligible	Slight
OF-PA-06	Undesignated	Medium	Pass	Negligible	Slight
OF-PA-07	Undesignated	Medium	Fail	Minor Adverse	Slight
Cumulative	Ballinderry River	High	Pass	Negligible	Slight

Drainage Network ID	Receptor	Sensitivity	Routine Runoff Result	Magnitude	Significance
OF-PA-01 / OF-PA-02 / OF-PA-03					
Cumulative OF-PA-04 / OF-PA-05	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment) and Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)	High	Fail	Minor Adverse	Moderate

Purple B Route

As can be seen on Table 6-92, all individual outfalls proposed for Purple B route pass all elements of the routine runoff assessment. Of the cumulative outfalls, one of the two pass the assessment. Consequently, the impact magnitude for all individual outfalls have been assessed as Negligible. As a result, the significance is Slight for the individual outfalls.

The impact magnitude for cumulative outfalls have been assessed as Negligible, except for OF-PB-04 / OF-PB-05, which have been assessed as Minor Adverse. As a result, the significance is Moderate for the cumulative assessment of OF-PB-04 / OF-PB-05 and, Slight for the other cumulative outfalls.

For the location of the Purple B route outfalls, see Figures Stage 2 – Purple B Route Preliminary Drainage Design Sheets 1, 2 and 3 [718314-WSP-B-D-0500-0024], [718314-WSP-B-D-0500-0025] and [718314-WSP-B-D-0500-0026].

Table 6-92 – Summary of Routine Runoff Assessment for Purple B route

Drainage Network ID	Receptor	Sensitivity	Routine Runoff Result	Magnitude	Significance
OF-PB-01	Ballinderry River	High	Pass	Negligible	Slight
OF-PB-02	Ballinderry River	High	Pass	Negligible	Slight
OF-PB-03	Ballinderry River	High	Pass	Negligible	Slight
OF-PB-04	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Slight
OF-PB-05	Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Slight
OF-PB-06	Undesignated	Medium	Pass	Negligible	Slight
OF-PB-07	Undesignated	Medium	Pass	Negligible	Slight

Drainage Network ID	Receptor	Sensitivity	Routine Runoff Result	Magnitude	Significance
Cumulative OF-PB-01 / OF-PB-02 / OF-PB-03	Ballinderry River	High	Pass	Negligible	Slight
Cumulative OF-PB-04 / OF-PB-05	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)) and Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	High	Fail	Minor Adverse	Moderate

Green Route

As can be seen in Table 6-93, six of the eight individual outfalls proposed for Green route pass all elements of the routine runoff assessment. Of the cumulative outfalls, one of the three pass the assessment. Consequently, the impact magnitude for six individual outfalls have been assessed as Negligible, with two assessed as Major Adverse. As a result, the significance is Slight for five individual outfalls and Moderate for two individual outfalls.

The impact magnitude for cumulative outfalls have been assessed as Negligible, except for OF-GR-03 / OF-GR-04 and OF-GR-07 / OF-GR-08, which have been assessed as Minor Adverse. As a result, given the sensitivity of the receptors, the significance is Slight for the cumulative outfalls.

For the location of the Green route outfalls, see Figures Stage 2 – Green Route Preliminary Drainage Design Sheets 1, 2 and 3 [718314-WSP-B-D-0500-0028], [718314-WSP-B-D-0500-0029] and [718314-WSP-B-D-0500-0030].

Table 6-93 – Summary of Routine Runoff Assessment for Green route

Drainage Network ID	Receptor	Sensitivity	Routine Runoff Result	Magnitude	Significance
OF-GR-01	Ballinderry River	High	Pass	Negligible	Slight
OF-GR-02	Ballinderry River	High	Pass	Negligible	Slight
OF-GR-03	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Slight
OF-GR-04	Fountain Road Stormwater Drain (Ballinderry River	Medium	Pass	Negligible	Slight

Drainage Network ID	Receptor	Sensitivity	Routine Runoff Result	Magnitude	Significance
	(Derrygonnigan Catchment))				
OF-GR-05	Undesignated	Medium	Pass	Negligible	Slight
OF-GR-06	Undesignated	Medium	Fail	Major Adverse	Moderate
OF-GR-07	Undesignated	Medium	Fail	Major Adverse	Moderate
OF-GR-08	Undesignated	Medium	Pass	Negligible	Slight
Cumulative OF-GR-01 / OF-GR-02	Ballinderry River	High	Pass	Negligible	Slight
Cumulative OF-GR-03 / OF-GR-04	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Fail	Minor Adverse	Slight
Cumulative OF-GR-07 / OF-GR-08	Undesignated	Medium	Fail	Minor Adverse	Slight

Sandholes Link Road

Sandholes Link Road drainage will utilise the existing outfall locations. At Stage 2, there is no information available regarding discharge quantities from the existing outfalls. This information will be confirmed at Stage 3 once a route is confirmed, and assessment then carried out.

Sandholes Link Road is common to all the proposed route options, therefore it is deemed not to be a critical parameter for route selection.

Pollution from Spillage and Water Quality

During operation, there is a risk that road traffic accidents or vehicle fires may result in spillage of potential pollutants on the road surface. Pollutants may then enter the road drainage network and subsequently be discharged to the water environment, causing an acute pollution event.

Red Route

The results of the calculations relating to spillage during operation demonstrate that, whilst applying conservatively high traffic data, the Red route surface water discharge networks meet the minimum DMRB standard for sensitive watercourses of a 1 in 200 year return period (0.5% probability), with preliminary outcomes estimating 1 in 2,271 year return period for the worst-performing drainage network (Cumulative Drainage Network OF-RR-04/OF-RR-05). These outcomes determine that no further mitigation would be required, although the application of embedded SuDS elements shall reduce potential for spillage impacts in each drainage network in any case. Outcomes for individual drainage networks are provided in Table 6-94 below.

Table 6-94 – Summary of Spillage Assessment for Red route

Drainage Network ID	Receptor	Sensitivity	Spillage Result	Magnitude	Significance
OF-RR-01	Ballinderry River	High	Pass	Negligible	Slight
OF-RR-02	Ballinderry River	High	Pass	Negligible	Slight
OF-RR-03	Ballinderry River	High	Pass	Negligible	Slight
OF-RR-04	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Neutral
OF-RR-05	Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Neutral
OF-RR-06	Undesignated	Medium	Pass	Negligible	Neutral
OF-RR-07	Undesignated	Medium	Pass	Negligible	Neutral
OF-RR-08	Undesignated	Medium	Pass	Negligible	Neutral
Cumulative OF-RR-01 / OF-RR-02 / OF-RR-03	Ballinderry River	High	Pass	Negligible	Slight
Cumulative OF-RR-04 / OF-RR-05	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)) and Molesworth Stormwater Drain	High	Pass	Negligible	Slight

Drainage Network ID	Receptor	Sensitivity	Spillage Result	Magnitude	Significance
	(Ballinderry River (Derrygonnigan Catchment))				
Cumulative OF-RR-06 / OF-RR-07	Undesignated	Medium	Pass	Negligible	Neutral

Purple A Route

The results of the calculations relating to accidental spillage during operation demonstrate that, whilst applying conservatively high traffic data, the Purple A route surface water discharge networks meet the minimum DMRB standard for sensitive watercourses of a 1 in 200 year return period (0.5% probability), with preliminary outcomes estimating 1 in 2,645 year return period for the worst-performing drainage network (Cumulative Drainage Network OF-PA-04/OF-PA-05). These outcomes determine that no further mitigation would be required, although the application of embedded SuDS elements shall reduce potential for spillage impacts in each network in any case. Outcomes for individual drainage networks are provided in Table 6-95 below.

Table 6-95 – Summary of Spillage Assessment for Purple A route

Drainage Network ID	Receptor	Sensitivity	Spillage Result	Magnitude	Significance
OF-PA-01	Ballinderry River	High	Pass	Negligible	Slight
OF-PA-02	Ballinderry River	High	Pass	Negligible	Slight
OF-PA-03	Ballinderry River	High	Pass	Negligible	Slight
OF-PA-04	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Neutral
OF-PA-05	Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Neutral
OF-PA-06	Undesignated	Medium	Pass	Negligible	Neutral

Drainage Network ID	Receptor	Sensitivity	Spillage Result	Magnitude	Significance
OF-PA-07	Undesignated	Medium	Pass	Negligible	Neutral
Cumulative OF-PA-01 / OF-PA-02 / OF-PA-03	Ballinderry River	High	Pass	Negligible	Slight
Cumulative OF-PA-04 / OF-PA-05	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)) and Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	High	Pass	Negligible	Slight

Purple B Route

The results of the calculations relating to accidental spillage during operation demonstrate that, whilst applying conservatively high traffic data, the Purple B route surface water discharge networks meet the minimum DMRB standard for sensitive watercourses of a 1 in 200 year return period (0.5% probability), with preliminary outcomes estimating 1 in 2,642 year return period for the worst-performing drainage network (Cumulative Drainage Network OF-PB-04/OF-PB-05). These outcomes determine that no further mitigation would be required, although the application of embedded SuDS elements shall reduce potential for spillage impacts in each network in any case. Outcomes for individual drainage networks are provided in Table 6-96 below.

Table 6-96 – Summary of Spillage Assessment for Purple B route

Drainage Network ID	Receptor	Sensitivity	Spillage Result	Magnitude	Significance
OF-PB-01	Ballinderry River	High	Pass	Negligible	Slight
OF-PB-02	Ballinderry River	High	Pass	Negligible	Slight
OF-PB-03	Ballinderry River	High	Pass	Negligible	Slight
OF-PB-04	Fountain Road Stormwater	Medium	Pass	Negligible	Neutral

Drainage Network ID	Receptor	Sensitivity	Spillage Result	Magnitude	Significance
	Drain (Ballinderry River (Derrygonnigan Catchment)				
OF-PB-05	Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)	Medium	Pass	Negligible	Neutral
OF-PB-06	Undesignated	Medium	Pass	Negligible	Neutral
OF-PB-07	Undesignated	Medium	Pass	Negligible	Neutral
Cumulative OF-PB-01 / OF-PB-02 / OF-PB-03	Ballinderry River	High	Pass	Negligible	Slight
Cumulative OF-PB-04 / OF-PB-05	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment) and Molesworth Stormwater Drain (Ballinderry River (Derrygonnigan Catchment)	High	Pass	Negligible	Slight

Green Route

The results of the calculations relating to accidental spillage during operation demonstrate that, whilst applying conservatively high traffic data, the Green route surface water discharge networks meet the minimum DMRB standard for sensitive watercourses of a 1 in 200 year return period (0.5% probability), with preliminary outcomes estimating 1 in 1,443 year return period for the worst-performing drainage network (Cumulative Drainage Network OF-GR-01/OF-GR-02). These outcomes determine that no further mitigation would be required, although the application of embedded SuDS elements shall reduce potential for spillage impacts in each network in any case. Outcomes for individual drainage networks are provided in Table 6-97 below.

Table 6-97 – Summary of Spillage Assessment for Green route

Drainage Network ID	Receptor	Sensitivity	Spillage Result	Magnitude	Significance
OF-GR-01	Ballinderry River	High	Pass	Negligible	Slight
OF-GR-02	Ballinderry River	High	Pass	Negligible	Slight
OF-GR-03	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Neutral
OF-GR-04	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Neutral
OF-GR-05	Undesignated	Medium	Pass	Negligible	Neutral
OF-GR-06	Undesignated	Medium	Pass	Negligible	Neutral
OF-GR-07	Undesignated	Medium	Pass	Negligible	Neutral
OF-GR-08	Undesignated	Medium	Pass	Negligible	Neutral
Cumulative OF-GR-01 / OF-GR-02	Ballinderry River	High	Pass	Negligible	Slight
Cumulative OF-GR-03 / OF-GR-04	Fountain Road Stormwater Drain (Ballinderry River (Derrygonnigan Catchment))	Medium	Pass	Negligible	Neutral
Cumulative OF-GR-07 / OF-GR-08	Undesignated	Medium	Pass	Negligible	Neutral

Impacts on Fluvial Geomorphology

The following section describes potential operational impacts on fluvial geomorphology receptors. To avoid repetition, a single description of impacts is first provided for the region where route options

(Red route, Purple A route, Purple B route and Green route) overlap. Each route option is then treated individually where they diverge.

The Red route, Purple A route, Purple B route and Green route completely overlie the Fairy Burn watercourse downstream of the roundabout outfall for the remainder of its length towards the main Ballinderry river. This would either result in the watercourse being culverted, or completely and permanently shaded by a bridge (Ch0 m – 180 m). Both of these options would permanently alter the prevailing geomorphic functioning (sediment dynamics, natural fluvial processes and channel morphology) and thus the ecological functioning of the reach. It is entirely feasible that the Fairy Burn is utilised as spawning/nursery habitat for a range of species, including brown trout and, if present, Atlantic salmon, particularly as the main Ballinderry River was noted to be relatively lacking in suitable spawning gravels.

The route options would cross the Ballinderry River via a bridge (Ch180 m). Here, the river's left bank appears to have undergone a phase of erosion, with evidence of cantilever failure. The product of this process (slumped material at the base of the bank) probably acts as natural toe protection, particularly as the material is colonised with vegetation which provides greater structural integrity and resistance to further basal erosion. Construction of a bridge would prevent the plant growth that is currently stabilising the bank toe material. This would potentially trigger accelerated erosional processes as the existing plant growth died back and potential for scour around the structure.

In addition, construction of bridge abutments would potentially lead to hydraulic constriction at the bridge crossing. This could similarly trigger erosion and scour around the structure, which, when acting in combination with the aforementioned changes to the composition of bank and toe vegetation, could be significant. Construction of a bridge would also adversely impact the condition of the riparian zone beneath the deck. Shading cast by the bridge would limit vegetation growth, thereby destroying the existing riparian habitat.

The Red route diverges from the Purple A route, Purple B route and Green route for approximately 775 m before briefly converging again at the Fountain Road interaction point with an unnamed watercourse. The stream displays very poor geomorphic functioning and is therefore assigned Low sensitivity. Construction of a culvert would have minimal impact on the sediment dynamics of the reach since its morphological character is that of a heavily modified ditch. Similarly, channel morphology and natural fluvial processes are grossly modified, with no evidence of desirable morphological features. Despite this, the culvert would be designed as far as practical to minimise impacts upon the water environment, taking into account the need for fish passage and allowing for a natural bed.

Following divergence of the Red route, the Purple A route, Purple B route and Green route follow broadly the same course for approximately 775 m where upon the Green route diverges from the Purple A and Purple B routes. The Purple A and B routes cross an unnamed watercourse at Ch2650 m whilst the Green route crosses at Ch3000 m. The watercourse is degraded in terms of fluvial geomorphology and thus has been assigned a Low sensitivity. The channel was noted to exhibit poor channel morphology due to its significantly modified character at its upstream reaches. However, at the Purple A route and Purple B route location the channel exhibits slightly improved geomorphic functioning.

Red Route

There are number of potentially significant fluvial geomorphological impacts that would arise from construction of the Red route. Whilst the unnamed watercourse at the Molesworth Road interaction point has poor geomorphological form and function, sediment transport and flow processes would be taken into account in the culvert design. The watercourse is heavily modified to the point it resembles a man-made ditch, so the existing channel morphology and natural fluvial processes would be minimally impacted by the proposed Red route option.

Towards the northern end of the Red route, the proposed alignment crosses an unnamed watercourse at Ch2650 m. The watercourse is degraded in terms of fluvial geomorphology and thus has been assigned a Low sensitivity. The channel was noted to exhibit poor channel morphology due to its significantly modified character, which serves to curtail natural fluvial processes. Nevertheless, the proposed culvert, if improperly designed could impact upon sediment delivery processes and ecological connectivity.

The final watercourse potentially impacted by the Red route is an unnamed watercourse that currently flows adjacent to an unnamed road just off the A29. The watercourse is very degraded in terms of sediment dynamics, channel morphology and natural fluvial processes, therefore the impacts of the proposed culvert would be minimal.

Purple A Route

No other watercourse are impacted solely by the Purple A route.

Purple B Route

The Purple B route would potentially significantly impact the fluvial geomorphology of the unnamed watercourse at the northern end of the alignment. The watercourse at the proposed crossing point (Ch4300 m), whilst somewhat degraded in terms of sediment dynamics, natural fluvial processes and channel morphology, exhibits some desirable features that would be destroyed by the Purple B route. Construction of a culvert structure would potentially limit transfer of sediment and encumber natural fluvial processes. The prevailing riffle-pool morphology of the reach would be disrupted and natural fluvial processes would become limited.

Green Route

No other watercourses are impacted solely by the Green route over and above those impacted by the Red, Purple A and Purple B routes.

Sandholes Link Road

The Sandholes Link Road route crosses the Fairy Burn watercourse (Ch420 m). In contrast to the lowermost reaches of the steam, Fairy Burn is extremely degraded in terms of fluvial geomorphology at the proposed crossing location and therefore potential impacts of the proposed culvert are not considered to be significant with appropriate mitigation in place. The watercourse has very poor sediment dynamics, with an excessive build-up of silt and other fines choking the natural substrate of the channel. In addition, natural fluvial processes are restricted by the channel's modified character, which also impacts upon channel morphology.

Impacts on WFD

The following section describes potential operational impacts on WFD receptors. To avoid repetition, a single description of impacts is first provided for the region where route options (Red route, Purple A route, Purple B route and Green route) overlap. Each route option is then treated individually where they diverge.

As stated above within the Impacts of Fluvial Geomorphology, the Fairy Burn may provide important fish habitat, albeit at a local scale; consequently, the proposed box culvert would not be compliant under the WFD without appropriate mitigation.

The route options would cross the Ballinderry River via a bridge (Ch180 m). The bridge would be designed as far as practical to minimise impacts upon the water environment, taking into account the need for fish passage and allowing for a natural bed.

Red Route

Embedded mitigation within the design of the culvert would be required for the unnamed watercourse at the Molesworth Road from a WFD perspective, so as to offset any potential impacts to sediment transport processes and the natural hydrological regime and ensure no deterioration in status of the Ballinderry River (Derrygonnigan) WFD water body.

Purple A Route

No other WFD watercourse are impacted solely by the Purple A route.

Purple B Route

No other WFD watercourse are impacted solely by the Purple B route.

Green Route

No other WFD watercourses are impacted solely by the Green route over and above those impacted by the Red, Purple A and Purple B routes.

Sandholes Link Road

No other WFD watercourse are impacted solely by the Sandholes Link Road.

Loss of Standing Water

There are no standing water bodies (loughs and ponds) within the 250 m buffer of the route options.

6.11.3.4. Operational Phase Impacts (Groundwater)

The operational impacts of route options have the potential to impact groundwater receptors via pollution from routine runoff. A broad range of pollutants such as hydrocarbons i.e. fuel and lubricants, fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, potentially polluting the groundwater.

Drainage infrastructure requirements include infiltration (in the form of filter drains) proposed to intercept flows arising from natural catchments surrounding all route options at cut locations. These measures are likely to require multiple stages of treatment prior to discharge in accordance with best practice and SuDS design manual. At this stage, there is no fundamental difference between route options and risks will be managed to avoid any groundwater water quality impacts.

Attenuation basins are proposed along the route options for discharge to designated and undesignated watercourses. This is discussed in the Drainage Assessment. It is assumed that these attenuation basins will be lined but this will be confirmed moving in to Stage 3 to inform detailed design of the preferred route.

At Stage 2 no groundwater water quality data are available along each of the route options from consultation with DfI or NIEA. Further consultation moving into Stage 3 will be sought to inform the design of the preferred route and as more GI data becomes available.

Long term impacts on groundwater levels and flow affecting the aquifer, groundwater abstractions and GWDTE may arise from road cuttings or below ground structures which extend below the groundwater table. These impacts are very similar to the construction stage; hence assessment conclusions can be transferred.

The length and consequently total hard surface area of the route options affect the ability for groundwater recharge to occur. Differences between the options can potentially be offset by the drainage design (SuDS) but the Red route and Sandholes Link Road offers a slightly smaller footprint in comparison to Purple A route, Purple B route, Green route with Sandholes Link Road.

Loss or Change to Water Supplies

Water supplies with surface water sources located downstream of the proposed scheme could potentially be impacted by disruption to surface water flow paths. The construction of cuttings and embankments, and the associated pre-earthworks drainage, across a surface water catchment could alter the local drainage regime, increasing flows in some sub-catchments with associated reductions elsewhere. These factors may reduce yields for local private water supplies downstream of the proposed scheme. Sources abstracting from larger watercourses or located some distance downstream of the proposed scheme are less likely to be impacted as the proportion of the contributing catchment disrupted by the scheme will be relatively small.

Disruption of supply infrastructure, such as pipework conveying water from a source located on one side of the proposed scheme to a property located on the other, is considered as part of the Engineering Assessment.

No surface water private water supplies have been noted within 5 km of the proposed scheme.

Loss or change to groundwater aquifers

Construction impacts on groundwater aquifers and groundwater dependent abstractions could potentially disrupt groundwater flow paths. The construction of cuttings and embankments, and the associated pre-earthwork drainage, could alter local drainage regime, increasing flows in some catchments with associated reductions elsewhere. These factors may reduce yields for local public and private water supplies and GWDTE along the proposed scheme. Sources abstracting or dependent from regional groundwater supplies or those located some distance from the proposed scheme that no localised effects are recognised, are less likely to be impacted.

Six (6 no.) are located along the Purple A route and Sandholes Link Road, Purple B route and Sandholes Link Road, Green route and Sandholes Link Road and Red Route and Sandholes Link Road. The six abstractions are within 300 m of each of the proposed route options. Three (3 no.) public abstractions will be lost under the proposed scheme (AIL\2007\0131 and AIL\2014\0014 – 2 abstractions associated to licences), one is located within the footprint of the Purple B route and Sandholes Link Road roundabout to the north of the proposed scheme and two in the footprint of Molesworth Road realignment (Red Route and Sandholes Link Road) and centre line of the Red Route and Sandholes Link Road. These are assigned an impact magnitude of Major and an impact significance of Very Large where the status (historical or active) of these abstractions are unknown, a worst case scenario has been applied on this basis.

As the impacts on the supplies identified are common to all route options, there is no differentiation between the route options.

6.11.4. COMPARISON OF ROUTE OPTIONS AND PROPOSED MITIGATION

6.11.4.1. Proposed Mitigation

Mitigation during Construction

Construction Pollution

There are a number of GPPs, PPGs and good practice guidance documents available from NIEA and organisations such as CIRIA for site environmental management, as listed in Section 6.11.1. From such documents there are a number of mitigation measures which would be applied in all cases and some which are specific to particular design features and locations. These mitigation measures would be anticipated to be collated within the CEMP for the proposed scheme.

Pollution prevention planning prioritises prevention at source, followed by mitigation measures local to source. Pollution incident management would operate on two main principles:

- Reducing the likelihood of an incident occurring; and
- Minimising the magnitude (or severity) of any incident that does occur.

In tandem, these principles would reduce the potential for contamination of surface water and associated habitats and groundwater receptors. To achieve this, the following principles would be expected to be included:

- Preparation of method statements and environmental incident response plans, including staff training, with specific additional detail for all locations where working is required within 50 m of existing watercourses;
- Secure storage of fuels and other potentially hazardous construction materials;
- Good practice earthworks, structural and drainage installation to minimise and treat sediment-laden runoff;
- Where feasible, new culverts and diversions to be constructed offline, with water diversion to the new channel timed to allow for the establishment of vegetation within the channel. Construction would proceed from the low end of the newly constructed watercourse channels, to minimise sedimentation, with 'breakthrough' of upper end of the channel and release of flow only when new channel is suitably prepared;
- Use of pre-cast concrete structural materials, where feasible, to minimise use of wet concrete in near-channel or in-channel works;
- Watercourse monitoring at locations where construction activity has reasonable potential to affect water quality;
- If any works are deemed to require significant dewatering (groundwater control) operations, further consideration will be given to potential impacts and requisite mitigations; and
- Under the various actions and regulations listed in the legislation section, all relevant consents will be sought from NIEA for any temporary abstractions, impoundments and in-channel works related to construction and operational activities.

Mitigation during Operation

Pollution from Routine Runoff

Considered as embedded mitigation inherent within the drainage design, a minimum of one level of treatment to remove contaminants will be provided on each drainage network, with a further level of treatment to potentially be provided should preliminary HEWRAT and EQS calculations indicate that any road drainage outfall would fail these assessments and that a significant adverse impact would result.

There are two primary options for the mitigation of acute impacts from soluble pollutants: flow attenuation which ensures there is sufficient dilution in the receiving watercourse, or treatment to reduce the concentration of soluble pollutants in the road runoff before discharge. The principal processes that would remove soluble metal pollutants from road runoff are adsorption, where pollutants bind to soil particles, or uptake by plants. There are a variety of sustainable drainage techniques and specialist proprietary systems that can provide varying levels of treatment for soluble pollutants.

Pollution from Spillage

The Stage 2 spillage calculations have indicated that there is no requirement for mitigation, specifically for spillage. However, ponds and other sustainable drainage techniques, which may be proposed as required for each drainage network to address routine runoff impacts, would also provide containment and treatment following a spillage incident.

Alterations to Fluvial Geomorphology

The mitigation measures presented in this section refer to best practice methodologies for standard assets such as culverts, outfalls and river crossings. The proposed schemes incorporate a number of these features, with proposals of up to three box culverts, four pipe culverts and a bridge crossing. The final design methodologies shall be developed at Stage 3. The DMRB guidance recommends that, where there is no alternative to culverting, structures should be designed to match flow dynamics of neighbouring watercourse. No specific guidance is provided for closed culvert design in Northern Ireland; however, SEPA[71] recommend that closed culverts should:

- Minimise the potential for localised bed and bank erosion (scour) or excessive sediment deposition at the crossing structure;
- Remain passable to fish, even if they are not present;
- Maintain natural river bed and slope, bury the culvert below the natural bed level;
- Maintain natural channel width;
- Ensure no physical barrier to fish passage; avoid perching brought about by poor design and/or downstream bed scour;
- Ensure adequate water depth;
- Ensure appropriate velocity;
- Ensure fish refuge places above and below the structure; longer structures may require fish refuge within the structure; and
- Provide mammal passage.

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[71] SEPA, 2010. Engineering in the Water Environment: Good Practice Guide: River Crossings. [online] Available at: https://www.sepa.org.uk/media/151036/wat-sg-25.pdf [Accessed 03/08/2020].

Specific Mitigation

Specific mitigation would be required at distinct locations where the potential impacts could not be fully resolved with standard best design practices and would instead require a more holistic approach founded in fluvial design principles to tackle site-specific issues. The Fairy Burn reach that would be affected by the Red route, Purple A route, Purple B route and Green route would require a significant realignment to offset the impacts of the proposed scheme. Channel realignments would be designed to perform optimally in terms of sediment dynamics, natural fluvial processes and channel morphology. An appropriately sized and correctly distributed substrate would be required to ensure no loss of available spawning habitat; riffles and pools would be incorporated into the design to mimic the baseline conditions and sustain natural fluvial processes.

The channel dimensions would be appropriately sized so that lateral connectivity would be initiated under flows exceeding Qmed (median flood), thus promoting a functioning riparian zone (also to be incorporated into the design). Additional hydraulic variability would be introduced through features such as: enhanced sinuosity (matching that of the channel prior to human intervention); gravel point bars; lowered berms; and appropriate planting, all of which would contribute to WFD objectives. In addition, an Invasive Non-Native Species (INNS) management plan would be implemented to control the considerable giant hogweed population in the vicinity of the proposed scheme. These enhancement features will be discussed further at Stage 3.

The considerable bank erosion that has taken place on the left bank of the Ballinderry would also require mitigation. As previously discussed, construction of a bridge deck would result in the local vegetation assemblage dying back, thus potentially leaving the riverbank susceptible to accelerated erosion. The historical mapping record suggests the channel is morphologically stable at this location, which may be due to the regulating effects of a large weir structure located approximately 400 m downstream. However, subtle changes to the fluvial environment, such as removal of bank vegetation, can trigger geomorphic processes. Appropriate riverbank protection would be required under the bridge on left bank. This should be designed to avoid out-flanking and vertical scour. Measures to prevent accelerated erosion downstream of the bridge structure should consider green techniques first, this may include riparian planting to provide improved riparian vegetation structure along the river banks and/or other green approaches.

- The bridge crossing over Ballinderry River shall also follow best practice guidance to avoid significant impacts to the geomorphic functioning of the reach. Standard design practice would avoid in-channel piers and ensure that flow conveyance would not exacerbate or trigger erosional processes. Measure should include:
- Minimise the potential for localised bed and bank erosion (scour) or excessive sediment deposition at the crossing structure through careful consideration of the location and alignment;
- Set abutments back from the river channel and banks to allow the continuation of the riparian
- corridor underneath the structure. This helps to minimise or prevent the need for bed and bank
- reinforcement, reduces the risk of creating a barrier to fish passage and allows mammal passage under the structure;
- Make the distance between the bridge abutments as wide as possible and maintain the bank habitat, maximising the riparian corridor and allowing the river some space to move;
- Ensure the natural channel width is maintained and provide mammal passage if bank habitat cannot be retained and abutments cannot be set back;

- Bury foundations (of abutments and in-stream piers) deep enough to minimise or prevent the need for bed or bank reinforcement or bridge weirs or aprons. This maintains the natural bed material and bed levels, protecting habitat and allowing fish passage. The foundations should be buried deep enough to allow for scour during high flows. A suitably qualified engineer or geomorphologist should be consulted to advise on an appropriate depth;
- Design the structure including in-stream piers to facilitate the passage of woody debris; and
- Consider requirements for bed and bank reinforcement only if the risk of erosion cannot reasonably be eliminated through the above measures.

Loss or Change to Water Supplies (surface and groundwater)

The owners of private surface water and groundwater abstractions located within 1 km of the proposed scheme, or within 5 km downstream of the proposed scheme, shall be consulted at the detailed design stage to establish specific information on existing supply infrastructure, exact supply location, water resource requirements and, if applicable, an appropriate monitoring strategy commencing pre-construction, to ensure continuity of supply. Potential temporary and permanent substitution of supply options shall be identified as contingency measures, should monitoring confirm reduced resource availability.

The flow patterns of the drainage design shall take account of downstream abstractions (groundwater and surface water), with an objective to minimise alterations to baseline flow conditions.

6.11.4.2. Potential Residual Effects

A summary of the impact assessment for each of the four proposed routes is provided in Table 6-98. It should be noted that the impact significance stated in the table represents the residual impact, taking into account the mitigation discussed above. As such there may be differences in the significance ratings listed compared with those discussed in Section 6.11.3 Assessment of Environmental Effects.

Table 6-98 – Overall Summary of Residual Effects* for Road Drainage and Water Environment

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Consultation Phase Impacts					
Fluvial Geomorphology	Slight	Slight	Slight	Slight	None
Surface Water Quality	Slight	Slight	Slight	Slight	None
Groundwater Level and Flow	Slight	Slight	Moderate	Moderate	Total cut lengths for the Green route are more significant than all other route options. Based on preliminary designs the footprint of these features are also quite large in comparison indicating deeper cuttings

Feature / asset	Red Route	Purple A Route	Purple B Route	Green Route	Differentiator
Groundwater quality and routine runoff	Slight	Slight	Slight	Slight	None
Groundwater abstractions	Moderate	Slight	Moderate	Slight	Purple B route and Sandholes Link Road and the Red route and Sandholes Link Road would directly impact three (3 no.) Public Water Supply (PWS) wells, however the status of these PWS wells is unknown at this stage
GWDTE	Neutral	Neutral	Neutral	Neutral	None
Operational Phase Impacts					
Surface Water Quality	Moderate	Moderate	Moderate	Moderate	None
Spillage and Water Quality	Slight	Slight	Slight	Slight	None
Fluvial Geomorphology	Slight	Slight	Slight	Slight	None
Standing Waters	Neutral	Neutral	Neutral	Neutral	None
Private Water Supplies	Neutral	Neutral	Neutral	Neutral	None
Groundwater level and flow	Slight	Slight	Slight	Moderate	The length and consequently total hard surface area of the route options affect the ability for groundwater recharge to occur. Differences can be offset by the drainage design (SuDS) but the Red route and Sandholes Link Road offers a slightly smaller footprint
Groundwater quality and routine runoff	Slight	Slight	Slight	Moderate	
GWDTE	Neutral	Neutral	Neutral	Neutral	None

*Summary of Effects includes Sandholes Link Road for each route.

6.12. ASSESSMENT OF IN-COMBINATION AND CUMULATIVE EFFECTS

6.12.1. ASSESSMENT SCOPE

An assessment of intra and inter cumulative effects has been made in alignment with the criteria outlined in the DMRB LA 104 Environmental Assessment and Monitoring[72]. Interactions of factors have been assessed in Sections 6.2 to 6.11 of this report. Professional judgement has been used to determine the significance of intra and inter cumulative effects. This section should be read in conjunction with Sections 6.2 to 6.11.

The following types of cumulative effects are defined by the DMRB for consideration in this section:

- Type 1 – single project (intra-project) effects: are "*numerous different effects impacting a single receptor*"; and
- Type 2 – multiple projects (inter-project) effects: are those that occur "*from different projects together with the project being assessed*". For example construction traffic effects of the proposed scheme combined with the construction traffic effects of another major development using the same access routes may result in cumulative effects on the surrounding highways network.

6.12.1.1. Legislative and Policy Framework

Details of the relevant guidance considered in the in-combination and cumulative effects assessment are provided in Environmental Appendix B.

6.12.1.2. Study Area

Intra-project effects

The study area for the assessment of intra-project effects reflects the largest study area of topic specific sections being compared (identified within the topic specific sections of this report in Sections 6.2 to 6.11) as representing the largest area within which intra-project effects are reasonably likely to occur.

Inter-project effects

The study area for inter-project effects reflects the traffic modelling assumptions for the proposed scheme, encompassing Cookstown and an approximate 10 km buffer area surrounding Cookstown.

6.12.1.3. Methodology

Detail on methodology for in-combination and cumulative effects assessment are provided in Environmental Appendix B.

6.12.1.4. Consultation

Consultation has been undertaken with DfI to agree the list of applications to be considered within the traffic model. The same list of developments has been used to inform the cumulative effects assessment to ensure consistency.

Topic specific consultation is summarised in the preceding Sections 6.2 – 6.11 of this report.

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72 Highways England, (2020). DMRB Volume 11, Section 2, LA 104 Environmental Assessment and Monitoring. [online] Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section2/la104.pdf. [Accessed 06/02/2020].

6.12.1.5. Assumptions and Limitations

Details of assumptions and limitations for in-combination and cumulative effects assessment are provided in Environmental Appendix B.

6.12.2. TYPE 1 - INTRA-PROJECT EFFECTS

6.12.2.1. Baseline Condition

The environmental baseline for each topic is summarised in Sections 6.2 to 6.11 of this report.

6.12.2.2. Assessment of Environmental Effects - Intra – Project

Table 6-99 below provides details on the potential intra-project effects applicable to all route options, outlining the main interactions identified with a likelihood for significant effects rather than outline every potential interaction. A detailed assessment of intra-project effects will be developed as applicable in Stage 3 following the selection of a preferred route.

Where no post mitigation effects are identified as likely to occur for a topic (and therefore present no intra-project cumulative effect); these have been marked within the table as 'no likely significant cumulative effects anticipated'.

Table 6-99 – Anticipated Intra-Project Effects (Post Mitigation)

Topic	Air Quality	Cultural Heritage	Landscape and Visual	Biodiversity	Geology and Soils	Material Assets and Waste	Noise and Vibration	Climate	Population and Health	Hydrogeology / Water Quality
Air Quality		Potential for residual intra-project cumulative effects on the setting of heritage assets as a result of deterioration in air quality during construction and operation.	Potential for residual intra-project cumulative effects on a singular sensitive receptor such as a residential building, during both construction and operation.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	No residual intra-project cumulative effects (not significant) as a result of the proposed scheme are anticipated during construction or operation. Any potential construction effects from the mobilisation of dust forming an effect pathway to sensitive receptors would be sufficiently mitigated.	No residual intra-project cumulative effects (not significant) as a result of the proposed scheme are anticipated during construction or operation. Any potential pollution pathways during construction would be mitigated through the CEMP.	Potential for residual intra-project cumulative effects on a singular sensitive receptor such as a residential building, during both construction and operation.	Potential for residual intra-project cumulative effects during construction and operation on emissions of particulate, exacerbated by increasing temperatures.	Potential for residual intra-project cumulative effects during construction and operation on WCH and health receptors due to increased pollutant concentrations of NO_2, PM_{10} and $PM_{2.5}$ and noise levels.	Potential for residual intra-project cumulative effects to watercourses and where/if these features are in hydraulic continuity with underlying groundwater body as a result of a pollution pathway associated with dust generated during construction. No operational residual intra-project cumulative effects are anticipated.
Cultural Heritage			Potential for residual intra-project cumulative effects during	No residual intra-project cumulative effects (not significant) anticipated	No residual intra-project cumulative effects (not significant) anticipated	No residual intra-project cumulative effects (not significant) anticipated	Effect interactions are possible between noise and the setting	Potential for residual intra-project cumulative effects during construction	No residual intra-project cumulative effects (not significant) anticipated	No residual intra-project cumulative effects (not significant) anticipated

Topic	Air Quality	Cultural Heritage	Landscape and Visual	Biodiversity	Geology and Soils	Material Assets and Waste	Noise and Vibration	Climate	Population and Health	Hydrogeology / Water Quality
			construction and operation on cultural heritage assets.	during construction or operation.	during construction or operation.	during construction or operation.	of cultural heritage assets.	and operation on identified heritage assets due to increased extreme weather events.	during construction or operation.	during construction or operation.
Landscape and Visual				Potential for residual intra-project cumulative effects during construction from loss of habitat in addition to the potential effects on landscape character from the removal of vegetation and its contribution to the local landscape character. No residual intra-project cumulative effects are anticipated	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	Potential for residual intra-project cumulative effects on a singular sensitive receptor such as a residential building, during both construction and operation.	Potential for residual intra-project cumulative effects during construction and operation on landscape planting due to increased extreme weather events.	Potential for residual intra-project cumulative effects during construction and operation on WCH routes where they cross the proposed scheme or have exposed views.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.

Topic	Air Quality	Cultural Heritage	Landscape and Visual	Biodiversity	Geology and Soils	Material Assets and Waste	Noise and Vibration	Climate	Population and Health	Hydrogeology / Water Quality
				during operation.						
Biodiversity					Potential for residual intra-project cumulative effects on ecological features associated with mobilisation of contaminated material during construction. No residual intra-project cumulative effects anticipated during operation.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	Potential for residual intra-project cumulative effects from construction noise and increase noise level from the operation of the proposed scheme to disturb biodiversity receptors.	No residual intra-project cumulative effects (not significant) anticipated during construction. Potential for residual intra-project cumulative effects during operation on biodiversity receptors due to changing climatic conditions.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	Potential for intra-project cumulative effects during construction from changes in water quality (surface water and groundwater) and groundwater water levels as a result of the proposed scheme impacting water dependent species (including GWDTEs) and associated / reliant habitats. No residual intra-project cumulative effects are anticipated during operation.

Topic	Air Quality	Cultural Heritage	Landscape and Visual	Biodiversity	Geology and Soils	Material Assets and Waste	Noise and Vibration	Climate	Population and Health	Hydrogeology / Water Quality
Geology and Soils						No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	Potential for residual intra-project cumulative effects during construction and operation on geology and soils due to increased extreme weather events.	Potential for residual intra-project cumulative effects during construction on human receptors as a result of disturbance of contaminated land No residual intra-project cumulative effects are anticipated during operation.	Potential for residual intra-project cumulative effects on groundwater resources as a result of disturbance of contaminated land during construction. No residual intra-project cumulative effects are anticipated during operation.
Materials							No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.
Noise and Vibration								No residual intra-project cumulative effects (not significant)	Potential for residual intra-project cumulative effects during	No residual intra-project cumulative effects (not significant)

Topic	Air Quality	Cultural Heritage	Landscape and Visual	Biodiversity	Geology and Soils	Material Assets and Waste	Noise and Vibration	Climate	Population and Health	Hydrogeology / Water Quality
								anticipated during construction or operation.	construction and operation on WCH from a reduction in amenity and on human health receptors from a deterioration in the noise environment.	anticipated during construction or operation.
Climate									No residual intra-project cumulative effects (not significant) anticipated during construction or operation.	No residual intra-project cumulative effects (not significant) anticipated during construction or operation.
Population and health										Potential for residual intra-project effects during construction and operation on human health receptors due to increased flood risk.
Hydrology / Water Quality										

6.12.3. TYPE 2 – INTER-PROJECT EFFECTS

6.12.3.1. Baseline Condition

The baseline for each environmental topic is summarised in Sections 6.2 to 6.11 of this report.

6.12.3.2. Assessment of Environmental Effects – Inter - Project

Table 6-100 presents a list of identified committed developments considered for the inter-project cumulative effects assessment, the location of these developments is shown on Figure 6.12.1 (Appendix A Figure 6.12.1: Drawing Reference 718314-WSP-B-D-3000-0211). This table contains relevant available information on each of the identified committed developments outlined.

Table 6-100 – Identified Committed Developments

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
Residential					
R1	Rear of No 72 Coolreaghs Road, Cookstown	LA09/2016/0233/F LA09/2018/0282/F	Change of house types from previously approved types (32 no semi-detached dwellings in total)	1,250 m (west of the proposed scheme)	07 Mar 2017
R2	Land to the rear of Coolreaghs Road and Claggan Lane	Cookstown Area Plan 2010 Phase 1 Housing – H02	This backland site of 6.68 ha is located to the rear of the housing on Coolreaghs Road and Claggan Lane and has views across the open countryside to the Sperrins.	863 m (west of the proposed scheme)	21 Jun 2018
R3	North of 3 Coolreaghs Road, Cookstown	LA09/2019/0994/F	Proposed development of 39 units consisting of two-storey detached and semi-detached dwellings with open space and temporary wastewater treatment works	460 m (west of the proposed scheme)	N/A
R4	Lands to the rear of 42-56 Moneymore Road including no. 40 Moneymore Road and lands to the South West of No 40 Moneymore Road, Cookstown	I/2008/0111/F	Residential development to include amendments to application previously approved I/2008/0111/F, which include amendments to nursing home, re-orientation of apartments (Moneymore House) reduction by one unit in which sites 7-9 is amended from a terrace row to a pair of semi-detached units, changes in levels throughout the	850 m (west of the proposed scheme)	N/A

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
			site and an additional 23 units comprising of three detached units, and 20 semi-detached units, realignment of the existing laneway (Old Coach Lane) between 46-50 Moneymore Road at its junction with Moneymore Road and relocation of existing drive to no 46 Moneymore Road.		
R5	Land to the rear of 19 Moneymore Road	Cookstown Area Plan 2010 Phase 1 Housing – H06	This 2.13 ha site is situated south of Moneymore Road.	730 m (west of the proposed scheme)	14 May 2012
R6	Land to the north of Beechway	Cookstown Area Plan 2010 Phase 1 Housing – H07	This 2.47 ha site is situated next to the completed Phase 1 of the Eastern Distributor Road and can be accessed from either Beechway or off the Moneymore Road.	418 m (west of the proposed scheme)	N/A
R7	Land to the rear of Ferguy Heights and Oldtown Street	Cookstown Area Plan 2010 Phase 1 Housing – H08	This 2.32 ha site is located to the rear of Ferguy Heights and is part of a drumlin, which falls away in a northern direction. Access to the site is currently via Ferguy Heights. However, it should be noted that this access is only adequate to serve a maximum of 100 dwellings, including the existing housing. Alternative access is possible	762 m (west of the proposed scheme)	N/A

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
			from the Moneymore Road through housing zoning H 06.		
R8	Land to the south of The Dales and north of Old Coagh Road	Cookstown Area Plan 2010 Phase 1 Housing – H09	This 7.68 ha site is located next to the completed Phase 1 of the Eastern Distributor Road. The site slopes away from the new road before falling to the east. A pedestrian underpass links the site to Beechway. Access to this land will need to be taken from Old Coagh Road, although it should be noted that access for a limited number of dwellings is available from The Dales.	240 m (west of the proposed scheme)	N/A
R9	Land to the north of Fountain Road	Cookstown Area Plan 2010 Phase 1 Housing – H10	This 3.91 ha site is located adjacent to the entrance to Cookstown Leisure Centre and backs onto the playing fields of Cookstown High School.	260 m (west of the proposed scheme)	N/A
R10	Land north of Fountain Road (west of entrance to Cookstown Leisure Centre)	Cookstown Area Plan 2010 Phase 1 Housing – H11	This 0.76 ha site is located next to Cookstown Leisure Centre and contains an electricity substation.	410 m (west of the proposed scheme)	N/A
R11	Land adjacent and to the north of Lomond Heights, Cookstown, Co Tyrone	I/2010/0050/F	Housing Development to include 22 No. Two storey semi-detached units and one detached unit.	330 m (west of the proposed scheme)	N/A

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
R12	100m south of 2 Westbury Drive, Westland Road South, Cookstown, Co Tyrone	LA09/2017/0313/F	Proposed 10 three storey townhouses.	360 m (west of the proposed scheme)	20 Jul 2018
R13	Land to the south of Tullaville and West of Westland Road	Cookstown Area Plan 2010 Phase 1 Housing – H15	This 2.41 ha site currently contains two dwellings and associated outbuildings.	961 m (west of the proposed scheme)	14 Jan 2011
R14	Land south of Tullagh View	Cookstown Area Plan 2010 Phase 1 Housing – H16	This 0.91 ha site is accessible via Tullagh View and contains an electricity substation.	1,070 m (west of the proposed scheme)	N/A
R15	Land to the north of Tullagh Road	Cookstown Area Plan 2010 Phase 1 Housing – H17	This 4.38 ha green field site rises steadily from Tullagh Road in a northerly direction.	1,330 m (west of the proposed scheme)	N/A
R16	Housing zone H18 Lands North of 99 - 117 Orritor Road, Cookstown	I/2003/0181/F LA09/2016/0857/F LA09/2017/1580/F	Proposed amended house types of previously approved housing development Ref: I/2003/0181/F at plots 15-32 and minor alterations to internal road layout. Removal of three dwellings to provide maintained green space for phases 1 and 2. Variation of conditions 3-5 of approval I/2003/0181/F. Where only identified green space for phases 1 and 2 will be managed and maintained	1,825 m (west of the proposed scheme)	N/A

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
R17	Land south of Lissan Road and north of Windsor Crescent	Cookstown Area Plan 2010 Phase 1 Housing – H20	This 0.98 ha site is located north of Windsor Crescent and Woodglen Crescent residential developments on the north western edge of Cookstown. There is an existing area of open space to the southeast of the site at Woodglen Crescent.	1,240 m (west of the proposed scheme)	N/A
R18	Site adjacent to Castle Road, Cookstown and to the rear of 1-13 Castle Road and 6-12 Dungannon Road, Cookstown	LA09/2015/1259/NMC I/2008/0773/F	Proposed residential development comprising detached dwellings, semi-detached dwellings and townhouses, associated landscaping, site works and upgrading of Castle Road (as per previous approval I/2001/0862/F) (total 67 units).	340 m (west of the proposed scheme)	N/A
R19	20 Dungannon Road, Cookstown	LA09/2017/1366/F	Residential Development for 52 units	80 m (west of the proposed scheme)	23 Oct 2014
R20	Lands to rear of No's 52 & 54 Fountain Road, Cookstown, Co Tyrone	I/2008/0273/F	Proposed new residential development comprising of two apartment blocks (holding four apartments each) and three terraced houses with alteration to existing dwelling (demolition of existing side extension).	555 m (west of the proposed scheme)	N/A
R21	Land adjacent to 249 Orritor Road, Cookstown	LA09/2016/0857/F	Proposed seven detached and 20 No. semi- detached dwellings	4,500 m (west of the proposed scheme)	30 Dec 2009

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
			with 18 No. garages and estate roadway.		
R22	67 Molesworth Street, Cookstown	LA09/2017/1554/F	Demolition of existing dwelling and erection of 24 Units (18 semi-detached units and six apartments)	680 m (west of the proposed scheme)	27 Jul 2017
R23	New Development at Carndaisy Lane, Moneymore, Magherafelt	LA09/2017/1566/F	Proposed Development of 10 No Semi-Detached Dwellings (Nos 10, 12, 14, 16, 18, 20, 24, 26 and 28 Carndaisy Lane) in Lieu of nine. Dwellings (Sites Nos 5 to 13) as previously approved under I/2008/0769/F Revised Proposal Description.	5,110 m (north-east of the proposed scheme)	23 Jul 2019
R24	16-20 Lawford Street, Moneymore	LA09/2018/0394/F	Development of three terrace dwellings and two apartments.	4,710 m (north-east of the proposed scheme)	06 Jun 2018
R25	Minister's Walk, Moneymore (50M North of Junction with Cookstown Road).	LA09/2018/1106/F	Proposed Housing Development to include four Pairs of Semi Detached Dwellings and one Detached Dwelling.	4,420 m (north-east of the proposed scheme)	12 Jun 2018
R26	Land adjacent to 32 Magherafelt Road, Moneymore	LA09/2018/1332/F	Proposed housing development of 10 detached dwellings with associated site works.	5,380 m (north-east of the proposed scheme)	N/A

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
R27	The rear of 27 William Street, Cookstown.	LA09/2018/1312/F	Proposed part demolition of existing outbuildings to allow for three storey apartment scheme consisting of one, one bed & nine No. two bed apartments with five insitu parking and amenity spaces.	1,090 m (east of the proposed scheme)	N/A
R28	54 North Street, Stewartstown, Dungannon	LA09/2019/0444/F	Proposed housing development consisting of one block of six dwellings (four two storey, two three storey), one block of three (two storey) dwellings (total of nine dwellings, reduced scheme from that approved under I/2011/0427/F).	6,765 m (south-east of the proposed scheme)	01 Oct 2019
R29	6 Tullyodonnell Road, Rock	LA09/2019/0823/F	Residential development consisting of 13 no dwellings (nine detached & four semi-detached) & five no garages & associated siteworks.	6,340 m (south-west of the proposed scheme)	22 Aug 2019
R30	80A Fairhill Road, Cookstown	LA09/2019/0438/F	Erection of new two storey accommodation block to provide six, two bed apartments	1,060 m (west of the proposed scheme)	
R31	Land to the rear of 65 – 69 Oldtown Street, Cookstown	LA09/2019/0232/F	Proposed eight semi-detached dwellings	865 m (west of the proposed scheme)	06 Sep 2019
R32	2 4 6 and 8 Loy Street and lands to	LA09/2019/0305/O	Proposed health care facility to provide accommodation for	850 m (west of the proposed scheme)	

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
	the rear of Nos 4 to 12 Loy Street and existing Loy Street public car park.		multiple doctor surgeries and ancillary uses commonly associated with a medical centre (circa 2500 m^2). The proposed health care building to also accommodate complementary uses including retail (Circa 400sqm) cafe (circa 100 m^2) and apartments (circa eight). New car parking to be provided, primarily accessed off existing Loy Street public car park. (traffic impact assessment submitted)		
Economic					
E1	Site 50m West of entrance to G1 Kilcronagh Business Park, Cookstown, BT80 9HJ	LA09/2019/0566/F	Proposed provision of three. units (two B2: Light Industrial and one B4: Storage and distribution all with associated B1: Offices) Landscaping and vehicular parking.	725 m (south-west of the proposed scheme)	N/A
E2	Site at the corner of Kilcronagh Business Park and the Sandholes Road, Cookstown	LA09/2018/0520/F	Provision of a single storey research and development facility with associated office and welfare accommodation for CDE Global Ltd. Using a previously approved access point to a public road.	650 m (south-west of the proposed scheme)	N/A
E3	Site 20m East of unit 7-11 Kilcronagh	LA09/2018/1119/F LA09/2019/0766/F	Erection of cafe (Amended description).	710 m (south-west of the proposed scheme)	03 Apr 2019

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
	Business Park, Cookstown				
E4	Southeast of Sandholes Road	Cookstown Area Plan 2010 Cookstown Industry and Mixed Business Zonings – I3	This 6.6 ha site is located adjacent to the Blue Circle cement works and quarry and is made up of the work's Social Club building, a car park, tennis courts and playing fields. To the south, the site is bounded by quarry spoil heaps that have been landscaped.	620 m (south-west of the proposed scheme)	N/A
E5	Land between Coagh and Old Coagh Road	Cookstown Area Plan 2010 Cookstown Industry and Mixed Business Zonings – I4	This 17.85 ha site consists of a farm group and two dwellings, the remains of the railway embankments, and agricultural fields. The land at present is undulating with steep slopes to the eastern boundary and will need substantial levelling. Before development of the site can take place Stage Two of the Eastern Distributor Road (Coagh Road to Fountain Road) will need to have been implemented.	160 m (west of the proposed scheme)	N/A
E6	50m east of 41 Old Coagh Road, Cookstown, Co. Tyrone	I/2013/0175/F	Erection of light industrial and storage units with office accommodation	230 m (west of the proposed scheme)	23 Dec 2013

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
E7	Land South of Coagh Road	Cookstown Area Plan 2010 Cookstown Industry and Mixed Business Zonings – I5	This 4.9 ha site is located off Coagh Road and consists of a farm group and agricultural fields. Development is dependent on implementation of Stage Two of the Eastern Distributor Road (Coagh Road to Fountain Road).	20 m (west of the proposed scheme)	N/A
E8	Land East of Unipork Factory, Molesworth Road	Cookstown Area Plan 2010 Cookstown Industry and Mixed Business Zonings – I6	This 6.3 ha site is located to the east of the Unipork Factory. Development is dependent on implementation of Stage Two of the Eastern Distributor Road (Coagh Road to Fountain Road). A town walkway is also proposed through the site to link the town centre with the Ballinderry River walkway.	315 m (in-between red and purple routes)	N/A
E9	135 Dungannon Road, Cookstown	LA09/2017/1655/RM	ECO Car valet preparation building (including electricity battery vault, car charging stations and roof mounted PV panels).	3,750 m (west of the proposed scheme)	09 May 2018
E10	84 Magherafelt Road, Moneymore	LA09/2017/1588/F	Erection of storage units within curtilage of existing storage units, office, dwelling house, agricultural storage and animal housing, with retention of existing access and splays	6,990 m (south-west of the proposed scheme)	N/A

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
E11	Approx. 200m North East of 27 Killygarvin Road, Dungannon	LA09/2018/0085/F	Proposed free range poultry shed with two feed bins a storage shed and a standby generator building (Poultry shed to contain 16,000 free range egg laying hens.	4,460 m (south of the proposed scheme)	22 Oct 2018
E12	Approximately 95 meters NE of 6 Terrywhinny lane, Terrywhinny, Cookstown, BT80 9EF.	LA09/2018/0204/F	Erection of free range poultry house with two feed bins, washing collection tank, standby generator building, litter storage shed and associated site works. (to contain 16,000 free range egg laying hens).	4,760 m (west of the proposed scheme)	N/A
E13	Approx. 200m NE of 72 Sessiagh Scott Road, Dungannon, BT70 3JU	LA09/2018/0211/F	Proposed free range organic poultry shed with two. feed bins and a standby generator building (poultry shed to contain 6,000 free range organic egg laying hens).	7,890 m (south-west of the proposed scheme)	N/A
E14	Land approx. 350m South West of 75 Moneyhaw Road, Moneymore	LA09/2018/1366/F	Proposed free range poultry shed with four feed bins, a standby generator building and associated site works (poultry shed to contain 32,000 free range egg laying hens).	3,400 m (east of the proposed scheme)	N/A
E15	32-38 Molesworth Street, Cookstown	LA09/2018/1444/F	Change of use from vacant retail unit to apartments at the rear of the ground floor and entire first, second and third floors. The two	810 m (west of the proposed scheme)	03 Sep 2019

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
			existing retail/office units on the ground floor, fronting onto Molesworth Street will include a new brick facade and glazed front.		
E16	84a Cookstown Road, Dungannon	LA09/2019/0012/F	Erection of a 1,240 m^2 building, associated yard area and site works for use as ancillary storage to existing wholesale, storage, packaging and trade distribution business.	7,270 m (south-west of the proposed scheme)	31 Jul 2019
E17	16 and 18 Burn Road, Cookstown, BT80 8AG	LA09/2019/0942/F	Demolition of No.16 and 18 Burn Road and erection of proposed Credit Union Building	1,055 m (west of the proposed scheme)	N/A
E18	2 4 6 and 8 Loy Street and lands to the rear of Nos 4 to 12 Loy Street and existing Loy Street public car park.	LA09/2019/0305/O	Demolition of existing school building construction of new 16,000 m^2, 1300 pupil school building and associated works on the existing school site to accommodate in-curtilage bus, car park drop offs and turning areas, 3G synthetic pitch and Multi-Use games area.	835 m (west of the proposed scheme)	N/A
E19	Holy Trinity College, 9-29 Chapel Street, Cookstown, BT80 8QB.	LA09/2019/0665/F	Demolition of existing school building construction of new 16,000 m^2, 1,300 pupil school building and associated works on the existing school site to accommodate in-curtilage bus, car park drop offs and turning	910 m (west of the proposed scheme)	N/A

Reference Number	Development	Planning Application Reference or Local Plan Reference	Description	Approximate Distance from the proposed scheme	Date Approved
			areas, 3G synthetic pitch and Multi-Use games area.		
E20	Units 8 and 9, Ballyreagh Business Park, Sandholes Road, Cookstown	LA09/2018/1514/F	Proposed extension to existing workshop and replacement storage unit	110 m (south-west of the proposed scheme)	03 Sep 2019
E21	Land South of Desertcreat Road East of A29 Dungannon Road and NW of Downs Road, Desertcreat, Cookstown	LA09/2017/0439/F	Provision of a training and support building, a revised internal single carriageway access road and car parking on behalf of Northern Ireland Fire and Rescue Services (NIFRS) as part of Desertcreat Phase 1 (approved under planning application I/2012/0240/F).	3,920 m (south of the proposed scheme)	14 Nov 2018

6.12.4. ASSESSMENT OF ENVIRONMENTAL EFFECT – INTER-PROJECT

This section provides a review of the identified committed developments presented within Table 6-100 for each technical discipline to determine the level of inter-project cumulative effects. Each topic section identifies committed developments which are likely to present a significant inter-project cumulative effect based on qualitative review and based on professional judgement. The significance of the inter-project effects will be considered in Stage 3 Preliminary Design following selection of the preferred route.

A summary of committed developments which are likely to result in inter-project cumulative effects with the proposed scheme is presented in Table 6-101.

6.12.4.1. Air Quality

Construction

A number of the identified committed developments involve demolition and will require construction activities which can generate construction dust emissions. As the potential risk of a significant air quality effect at sensitive receptor locations is considered unlikely for the proposed scheme and as the Contractor will be committed to ensuring appropriate mitigation is applied throughout the construction stage; then the potential risk of the proposed scheme causing a significant inter-project cumulative effects will also be unlikely.

Operation

Any cumulative operational road vehicle exhaust effects arising from additional developments introduced both prior to the opening of the proposed scheme and between the scheme opening year and design/future year scenarios are assumed to be incorporated within the modelled traffic data provided by the WSP Transport Planning team. As such they have not been assessed individually but are included within the predicted annual mean concentrations reported in this assessment.

However, four of the identified committed developments are poultry farm facilities comprising E11, E12, E13 and E14. These identified committed developments have the potential to be considered as ammonia emissions sources for consideration in Stage 3 assessment and may present residual inter-project cumulative effects with the proposed scheme upon designated ecological sites.

6.12.4.2. Cultural Heritage

Construction

Four of the identified committed developments (R18, E5, E7 and E8) are in close proximity to the route options and of a sufficient size to be considered to have the potential for inter-project cumulative effects. The assessment has been focused on the residual operational impacts on the setting of cultural heritage assets, alongside with the landscape and visual, and the noise and vibration assessments. None of the potential cumulative effects are expected to be significant.

Operation

Potential operational residual inter-project effects are as identified above.

6.12.4.3. Landscape and Visual

The majority of the identified committed developments for consideration listed in Table 6-100 are expected to result in non-significant residual inter-project cumulative effects when considered with the proposed scheme either because of their small scale, low anticipated magnitude of impacts or isolation from the route options.

Construction

Significant inter-project cumulative effects are anticipated on LLCA4 – Cookstown Settled Farmland due to impacts associated with the introduction of the Red route in close proximity to the eastern edge of Cookstown with the consideration of committed development R8. Significant inter-project cumulative effects are also anticipated due to impacts associated with all four route options within the Ballinderry River LLPA1 and LLCA6 – Rural River Corridor with the consideration of committed development R18 and R19.

Inter-project cumulative effects are anticipated to be greater with the consideration of both the Red route and committed development R8 when compared to effects associated with the other three route options. This is as a result of the other three route options being set further to the east of Cookstown with intervening landform obstructing combined views and perception of the local landscape where the identified committed developments are located.

No significant inter-project cumulative effects are anticipated with any economic related identified committed developments.

Operation

Potential operational residual inter-project effects are as identified for construction (above).

6.12.4.4. Biodiversity

The majority of the identified committed developments are expected to result in non-significant inter-project effects when considered in combination with those associated with the proposed scheme either because of their small scale, low anticipated magnitude of impacts or isolation from the proposed route options.

Construction

While several identified committed developments may contribute to residual inter-project cumulative effects in combination with those from the proposed scheme during construction (particularly the Red route), these are not anticipated to be significant based on their comparatively small scale, low magnitude of impacts and low (local) value of predicted ecological receptors.

Six identified committed developments (R12, R13, R14, R15, R18 and R19) are however identified which could potentially result in significant residual inter-project cumulative effects. These are all located in close proximity to the Ballinderry River, which is designated as Upper Ballinderry River SAC upstream of the Derryloran Bridge at the northern extent of the Sandholes Link Road section. These identified committed developments have the potential to give rise to residual inter-project cumulative effects of habitat deterioration (pollution) of Ballinderry River and disturbance / displacement of associated fauna with those associated with all route options, including the Sandholes Link Road section during construction.

Operation

No significant residual inter-project effects have been identified for any of the proposed route options.

6.12.4.5. Geology and Soils

Construction

The majority of the identified committed developments are unlikely to pose significant residual inter-project cumulative effects during construction. There are seven identified committed developments (R6, R8, R19, E5, E6, E7 and E8) which are likely to experience a significant residual inter-project cumulative effect during construction with respect to loss of Grade 2 agricultural land.

Operation

Potential operational residual inter-project effects are as per construction phase.

6.12.4.6. Materials

Construction

No significant residual inter-project cumulative effects are anticipated from the construction of the proposed scheme. Inter-project cumulative effects from material consumption and waste generation / disposal may occur where construction periods for different developments overlap. Where effects do coincide, it is reasonable to presume that good practice construction techniques (that align with the highest tiers of the Waste Hierarchy, and to the Proximity Principle, for example) will be applied, and will be sufficient to mitigate the risk of significant adverse effects on sensitive receptors. This assertion has (necessarily, at the time of publication) been made using professional judgement based on the size, nature and timing of planned developments.

Operation

No significant residual inter-project cumulative effects are anticipated from the operation of the proposed scheme.

6.12.4.7. Noise

The majority of the identified committed developments will not cause significant changes in local road traffic noise levels. Neither will they change the proposed scheme road traffic flows such that the noise impacts predicted for the proposed scheme will be affected.

Construction

Should the construction phases of the proposed scheme and the identified committed developments overlap, there is potential for inter-project cumulative effects with a number of the identified committed developments (R4, R6, R8, R9, R11, R19, E5, E7, E8, E19 and E20) during construction although it is likely mitigation measures would limit the significance.

There are two residential identified committed developments that may cause changes to the local road traffic noise levels, R19 and H04. These developments would potentially require an associated transport assessment and noise assessment which may include the need for noise mitigation measures to reduce road traffic noise levels from the proposed scheme at the proposed dwellings.

Operation

The three largest industrial developments (E4, E5 and E6) may cause significant changes to local road traffic flows (including HGV movements) depending on the proposed use of the development sites. These changes in local flows may cause increased flows on the proposed scheme such that operational road traffic noise levels on the proposed scheme could increase.

It is assumed that any increases in road traffic flow anticipated from the identified committed developments would be incorporated into the future year predicted road traffic flows. As such the individual noise levels effect on the existing noise sensitive receptors assessed due to those increased flows would be incorporated in the long term noise assessment of the proposed scheme undertaken at Stage 3.

6.12.4.8. Population and Health

The majority of the identified committed developments listed in Table 6-100 are expected to result in non-significant inter-project cumulative effects (pre-mitigation) when considered with the proposed scheme.

Construction

There is potential for significant cumulative effects (pre-mitigation) on agricultural land holdings from the Red route option during construction, in conjunction with three identified committed developments (E5, E7 and E8), on six land parcels from impacts on severance and land take. No other significant cumulative effects are anticipated for population and human health during construction.

Operation

Potential operational residual inter-project effects are as per construction phase.

6.12.4.9. Climate

The impacts of greenhouse gases (GHG) emissions, in terms of their contribution to climate change, are global and cumulative in nature, with every tonne of GHG emissions contributing to impacts on natural and human systems.

There is an overwhelming scientific consensus that the major increase in the atmospheric concentration of GHGs since the industrial revolution, is contributing to climate change. It is the increase in concentrations of GHGs in the global atmosphere due to all GHG causing human activities that cause climate change. As such it is the cumulative effect of all GHG-emitting human activities that cause climate change, and therefore the assessment of the GHGs due to the proposed scheme implicitly assesses the cumulative effect of GHG emissions.

The climate vulnerability assessment considers the impacts of climate change on the proposed scheme and as such, the receptors for the assessment are the proposed scheme and its users. The changes in climate variables described in the baseline section will be experienced by all developments in the vicinity of the proposed scheme. However, the potential impacts from climate change associated with changes to precipitation, temperature and extreme weather events (as the proposed scheme has been assessed against above) may alter as a result of the identified committed developments.

Effects associated with flooding and surface water runoff as a result of higher winter rainfall and extreme rainfall events may be exacerbated by the identified committed developments which increase the impermeable area in the vicinity of the proposed scheme.

6.12.4.10. Road Drainage and the Water Environment

Construction

Construction impacts are generally limited to the immediate vicinity of construction activities or short distances downstream of such activities. Good practice measures to limit construction pollution would be expected to be followed during the construction phase at all local developments. These will include appropriate measures to manage sediment, hydrocarbons and waste.

Potable/domestic water has the potential to be negatively affected by spills associated with construction works, exposure of groundwater and contaminated soils, change in the demand on network / catchment and the addition to further hardstanding.

Whilst the construction programme for all developments is unknown, it is unlikely that these shall occur concurrently. As a result, it is unlikely that there will be any significant residual inter-project cumulative effects on the receiving waterbodies (surface water and groundwater) during the construction phase of the proposed scheme.

Operation

It is less likely that any inter-project cumulative effects will occur during the operational phase. Mitigation, such as SUDS, will be in installed to ensure that water quality and flow (both surface water and groundwater) is managed appropriately and to meet stakeholders' requirements. No significant residual inter-project cumulative effects are anticipated during the operational phase of the proposed scheme.

Similarly, appropriate mitigation and good practice for culverts and outfalls, in addition to adherence to the WFD, would ensure that no deterioration in WFD status (to surface water waterbodies and groundwater waterbodies) would ensue during the construction and operational phases. Thus, the WFD status of the waterbodies would be maintained at pre-development levels.

6.12.4.11. Summary of Inter-Project Cumulative Effects

Table 6-101 below provides a summary of the identified committed developments which have potential for a pre-mitigation / residual inter-project cumulative effect with the proposed scheme. For each identified committed development, the topic that has potential for a cumulative effect is shown and for what route option this is associated with. The final column identifies which of these identified committed developments should be taken forwards for consideration within SAR 3 based on the above sections.

Table 6-101 – Summary of Inter-Project Cumulative Effects

	Development	Red Route plus Sandholes Link Road	Purple A Route plus Sandholes Link Road	Purple B Route plus Sandholes Link Road	Green Route plus Sandholes Link Road	Include in shortlist to progress to Stg 3
Residential						
R1	Rear of No 72 Coolreaghs Road, Cookstown	None identified				No
R2	Land to the rear of Coolreaghs Road and Claggan Lane	None identified				No
R3	North of 3 Coolreaghs Road, Cookstown	None identified				No
R4	Lands to the rear of 42-56 Moneymore Road including no. 40 Moneymore Road and lands to the South West of No 40 Moneymore Road, Cookstown	Air Quality, Biodiversity, and Noise and Vibration				Yes
R5	Land to the rear of 19 Moneymore Road	Air Quality				Yes
R6	Land to the north of Beechway	Air Quality, Biodiversity, Geology and Soils, and Noise and Vibration		Air Quality and Biodiversity		Yes
R7	Land to the rear of Ferguy Heights and Oldtown Street	None identified				No

	Development	Red Route plus Sandholes Link Road	Purple A Route plus Sandholes Link Road	Purple B Route plus Sandholes Link Road	Green Route plus Sandholes Link Road	Include in shortlist to progress to Stg 3
R8	Land to the south of The Dales and north of Old Coagh Road	Air Quality, Landscape and Visual, Biodiversity, Geology and Soils, and Noise and Vibration		Biodiversity		Yes
R9	Land to the north of Fountain Road	Biodiversity, and Noise and Vibration		Biodiversity		Yes
R10	Land north of Fountain Road (west of entrance to Cookstown Leisure Centre)	None identified				No
R11	Land adjacent and to the north of Lomond Heights, Cookstown, Co Tyrone	Air Quality, and Noise and Vibration				Yes
R12	100m south of 2 Westbury Drive, Westland Road South, Cookstown, Co Tyrone	Biodiversity				Yes
R13	Land to the south of Tullaville and West of Westland Road	Biodiversity				Yes
R14	Land south of Tullagh View	Biodiversity				Yes
R15	Land to the north of Tullagh Road	None identified				No
R16	Housing zone H18 Lands North of 99 - 117 Orritor Road, Cookstown	None identified				No

	Development	Red Route plus Sandholes Link Road	Purple A Route plus Sandholes Link Road	Purple B Route plus Sandholes Link Road	Green Route plus Sandholes Link Road	Include in shortlist to progress to Stg 3
R17	Land south of Lissan Road and north of Windsor Crescent	None identified				No
R18	Site adjacent to Castle Road, Cookstown and to the rear of 1-13 Castle Road and 6-12 Dungannon Road, Cookstown	Landscape and Visual, and Biodiversity				Yes
R19	20 Dungannon Road, Cookstown	Air Quality, Landscape and Visual, Biodiversity, Geology and Soils, and Noise and Vibration				Yes
R20	Lands to rear of No's 52 & 54 Fountain Road, Cookstown, Co Tyrone	None identified				No
R21	Land adjacent to 249 Orritor Road, Cookstown	None identified				No
R22	67 Molesworth Street, Cookstown	Air Quality				Yes
R23	New Development at Carndaisy Lane, Moneymore, Magherafelt	None identified				No
R24	16-20 Lawford Street, Moneymore	None identified				No

	Development	Red Route plus Sandholes Link Road	Purple A Route plus Sandholes Link Road	Purple B Route plus Sandholes Link Road	Green Route plus Sandholes Link Road	Include in shortlist to progress to Stg 3
R25	Minister's Walk, Moneymore (50 m North of Junction with Cookstown Road).	None identified				No
R26	Land adjacent to 32 Magherafelt Road, Moneymore	None identified				No
R27	The rear of 27 William Street, Cookstown.	None identified				No
R28	54 North Street, Stewartstown, Dungannon	None identified				No
R29	6 Tullyodonnell Road, Rock	None identified				No
R30	80A Fairhill Road, Cookstown	None identified				No
R31	Land to the rear of 65 - 69 Oldtown Street, Cookstown	None identified				No
R32	2 4 6 and 8 Loy Street and lands to the rear of Nos 4 to 12 Loy Street and existing Loy Street public car park.	None identified				No
Economic						
E1	Site 50 m West of entrance to G1 Kilcronagh Business Park, Cookstown, BT80 9HJ	None identified				No

	Development	Red Route plus Sandholes Link Road	Purple A Route plus Sandholes Link Road	Purple B Route plus Sandholes Link Road	Green Route plus Sandholes Link Road	Include in shortlist to progress to Stg 3
E2	Site at the corner of Kilcronagh Business Park and the Sandholes Road, Cookstown	None identified				No
E3	Site 20m East of unit 7-11 Kilcronagh Business Park, Cookstown	None identified				No
E4	Southeast of Sandholes Road	Air Quality				Yes
E5	Land between Coagh and Old Coagh Road	Air Quality, Biodiversity, Geology and Soils, Noise and Vibration, and Population and Health		Air Quality and Biodiversity		Yes
E6	50m east of 41 Old Coagh Road, Cookstown, Co. Tyrone	Air Quality, Biodiversity, and Geology and Soils		Air Quality and Biodiversity		Yes
E7	Land South of Coagh Road	Air Quality, Biodiversity, Geology and Soils, Noise and Vibration, and Population and Health		Air Quality, Biodiversity, and Geology and Soils		Yes
E8	Land East of Unipork Factory, Molesworth Road	Air Quality, Biodiversity, Geology and Soils, Noise and Vibration, and Population and Health	Air Quality, Biodiversity, Geology and Soils, and Noise and Vibration	Air Quality, Biodiversity, and Geology and Soils	Air Quality, Biodiversity, Geology and Soils, and Noise and Vibration	Yes

	Development	Red Route plus Sandholes Link Road	Purple A Route plus Sandholes Link Road	Purple B Route plus Sandholes Link Road	Green Route plus Sandholes Link Road	Include in shortlist to progress to Stg 3
E9	135 Dungannon Road, Cookstown	Air Quality				Yes
E10	84 Magherafelt Road, Moneymore	None identified				No
E11	Land approx. 200m North East of 27 Killygarvin Road, Dungannon	Air Quality				Yes
E12	Approximately 95 meters NE of 6 Terrywhinny lane, Terrywhinny, Cookstown, BT80 9EF.	Air Quality				Yes
E13	Land approx. 200m NE of 72 Sessiagh Scott Road, Dungannon, BT70 3JU	Air Quality				Yes
E14	Land approx. 350m South West of 75 Moneyhaw Road, Moneymore	Air Quality				Yes
E15	32-38 Molesworth Street, Cookstown	Air Quality				Yes
E16	84a Cookstown Road, Dungannon	None identified				No
E17	16 and 18 Burn Road, Cookstown, BT80 8AG	None identified				No

	Development	Red Route plus Sandholes Link Road	Purple A Route plus Sandholes Link Road	Purple B Route plus Sandholes Link Road	Green Route plus Sandholes Link Road	Include in shortlist to progress to Stg 3
E18	2 4 6 and 8 Loy Street and lands to the rear of Nos 4 to 12 Loy Street and existing Loy Street public car park.	None identified				No
E19	Holy Trinity College, 9-29 Chapel Street, Cookstown, BT80 8QB.	Noise and Vibration				Yes
E20	Units 8 and 9, Ballyreagh Business Park, Sandholes Road, Cookstown	Noise and Vibration				Yes
E21	Land South of Desertcreat Road East of A29 Dungannon Road and NW of Downs Road, Desertcreat, Cookstown	None identified				No

6.12.5. CUMULATIVE EFFECTS SUMMARY

6.12.5.1. Intra-Project Effects

There are potential residual intra-project effects between the environmental topics for all route options. Detail intra-project cumulative effects would be assessed in Stage 3 once a preferred option has been selected.

6.12.5.2. Inter-Project Effects

There are 12 residential and 13 economic related identified committed developments to be taken forwards for consideration in Stage 3. A further review of the identified committed developments would be undertaken in Stage 3, where appropriate.

7. TRAFFIC AND ECONOMICS ASSESSMENT

7.1. BASE YEAR MODELLING

7.1.1. METHODOLOGY

The traffic model for A29 Cookstown Bypass was developed using the SATURN suite of software (version 11.4.07H) for a base year of 2019. Survey data collected between March 2019 and April 2019 was used to calibrate and validate the model.

The model study area was defined to capture the likely impacts of the proposed A29 Cookstown Bypass as well as the impacts of any other proposed local interventions within Cookstown and its immediate surroundings. The model study area centres on Cookstown, with the model network extending across a wider area to ensure that all relevant local and strategic alternative routes are included.

The traffic model is set up to model highway assignment only. Due to the nature and the objectives of the proposed scheme, the traffic model is not set up to model public transport demand nor to assess the variable demand impacts of the proposed scheme.

This section presents a summary of the model specification and model performance. The scheme has produced 'A29 Cookstown Bypass, Local Model Validation Report – Ref 718314-2700-R-0004' (LMVR), which describes in detail the work carried out in the development and validation of the Base Year traffic model. It presents the various data sources used for the model development and explains the methods used for the development of the trip matrices and highway network. The LMVR presents the results of the model calibration and validation with reference to the UK Department for Transport's (DfT) Transport Analysis Guidance (TAG) - https://www.gov.uk/guidance/transport-analysis-guidance-webtag and demonstrates that the model produces an accurate representation of existing traffic conditions in Cookstown, including the routes most likely to be impacted by the proposed scheme in future scenarios. The model is suitable for evaluating the impacts of the proposed bypass scheme as well as other proposed local highway network interventions and land use changes within Cookstown.

7.1.2. MODELLED PERIODS

The model reflects the typical traffic conditions during the morning, average inter-peak and evening peak hours. The peak hour with respect to both the AM peak and PM peak period were established with reference to traffic flow profiles. The traffic flow dataset was drawn from the Automatic Traffic Counters (ATCs) carried out as part of the 2019 survey programme. On the basis of this analysis, and in keeping with national methodologies for forecasting which usually operate on whole hour periods, the following three time periods were identified for the model development:

- AM Peak hour: 08:00 – 09:00.
- PM Peak hour: 17:00 – 18:00.
- Average Inter-peak hour: 10:00 - 16:00.

7.1.3. VEHICLE CLASSES AND TRIP PURPOSES

Separate matrices were developed for various combinations of vehicle type and trip purpose. This recognises the different characteristics of trips and facilitates distinction in some of the modelling processes.

The combination of vehicle types and trip purposes are known as user classes and are defined as follows:

- Cars – Commute (representing the journey from home to work and vice versa)
- Cars – Employers Business
- Cars – Other trip purposes
- Light Goods Vehicles (LGVs)
- Heavy Goods Vehicles (including Medium Goods Vehicles) (HGVs)

The disaggregation of trip demands to different user classes was undertaken based on journey purpose data collected in Roadside Interview Surveys (RSI) and Car Park Interview (CPI) surveys. This disaggregation of trips provides insights on the demand matrices in varying spatial, temporal and purpose/segment resolution.

Standard values of Passenger Car Unit (PCU) were obtained from TAG Unit M3.1 D.7.2 (January 2014) and used within the model (presented in Table 7-1) .

Table 7-1 - PCU Value by Vehicle Type

Vehicle Type	PCU Value
Car	1.00
LGV	1.00
HGV	2.00
Bus	2.25

7.1.4. MODEL ZONING SYSTEM

A detailed zone system was developed for Cookstown town centre and for the road network within the detailed study area. Zones were then drawn progressively larger and less detailed further away from the study area and represent the remainder of Northern Ireland.

The model zone system is based on the Northern Ireland Small Area (SA) and Super Output Area (SOA) boundaries. The zoning system follows the classifications with the smallest zones within the fully modelled area becoming increasingly coarse further away from the area of interest.

The zone system was designed to be consistent with the NI District boundaries and the census zoning system at SOA level. Within Cookstown, the finer SA boundaries were adopted where practical. Where necessary these were broken down further, based on the local land use and suitable loading points from the zone onto the highway network. Immediately outside of the study area, SOA boundaries were adopted. The model zones are illustrated in Figure 7-1

There are 200 zones within the model, with 123 that constitute the study area and 53 external zones representing the rest of the country. One zone was used to represent trips from the Republic of Ireland. The remaining 23 zones are ‘empty’, with no assigned trips or defined geographical coverage. These were reserved for representing any significant proposed developments in the forecast scenarios and their inclusion in the base model serves to ensure consistency between the base and forecast future year networks.

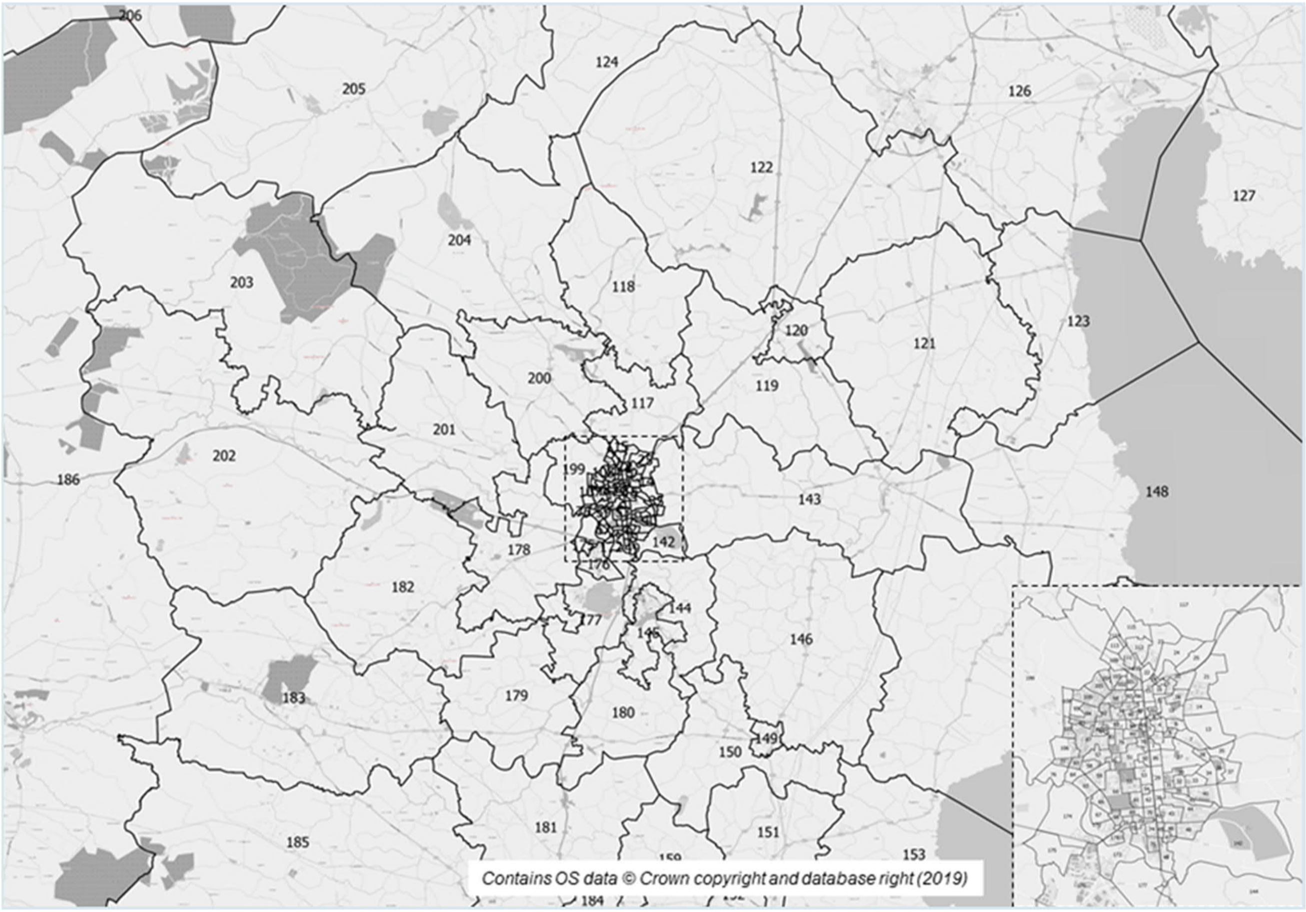


Figure 7-1 - Model Zones

7.1.5. MODEL NETWORKS

The network is a representation of the transport highway system within the study area. The network comprises a system of nodes connected by links. The nodes mostly represent junctions and the links represent homogenous stretches of road between junctions.

The existing Cookstown traffic model provided the starting point for developing the 2019 base model network. This was verified against the network information provided within the OSNI Road Network database and any updates to network structure or network representation were implemented based on the information from the database.

The model network incorporates major and principle routes within the study area, local roads within Cookstown and local routes within the wider study area. As such, the model network provides an accurate representation of the existing highway network in Cookstown and the surrounding area. The extent of the highway network is shown in Figure 7-2.

The model comprises a simulation network to cover the entire study area (shown as the Area of Detailed Modelling in Figure 7-2); and a buffer network covering the wider external area. The simulation area encompasses the entire study area, whilst the external area has been represented within the buffer network. The simulation area incorporates detailed representation of junctions to facilitate the modelling of queues and delays and to take account of roads that are used as alternatives (rat-runs).

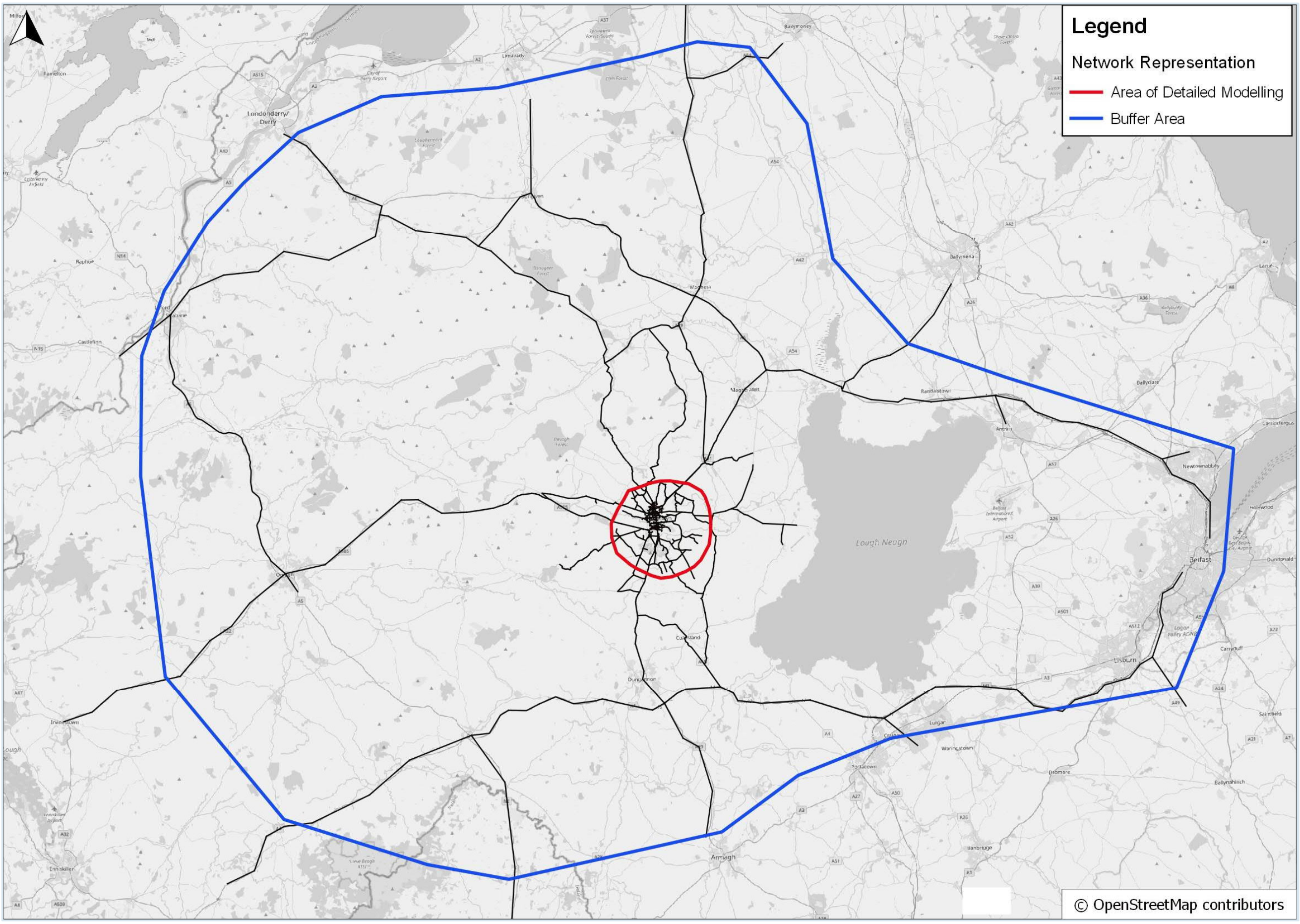


Figure 7-2 - Model Network Representing Level of Detail

In order to verify that the modelled network correctly represents the current base year, a number of checks were undertaken, including:

- Correct loading of zone centroids to the network.
- Link length checks.
- Routeings through the network.
- Network hierarchy and speed flow definition.
- Lane sharing and lane use.

7.1.6. CODING OF SPEEDS

The roads were modelled as links in SATURN. Based on the information in the OSNI Road Network database, all the links within the study area were assigned accurate distances together with a link category to define its characteristics.

In accordance with guidance set out in TAG Unit M3.1 (January 2014), highway links within the central urban area of Cookstown, were coded with fixed cruise speeds as shown in Figure 7-3. Other links were allocated speed-flow curves. Speed-flow curves are used to describe a link in terms of its capacity and associated traffic speeds and are therefore used to determine the link speed based on the traffic flow. Speed-flow curves used in the traffic model do not include any junction delays, these are calculated within the simulation module of SATURN, based on junction capacities and assigned flows routeing through the junction.

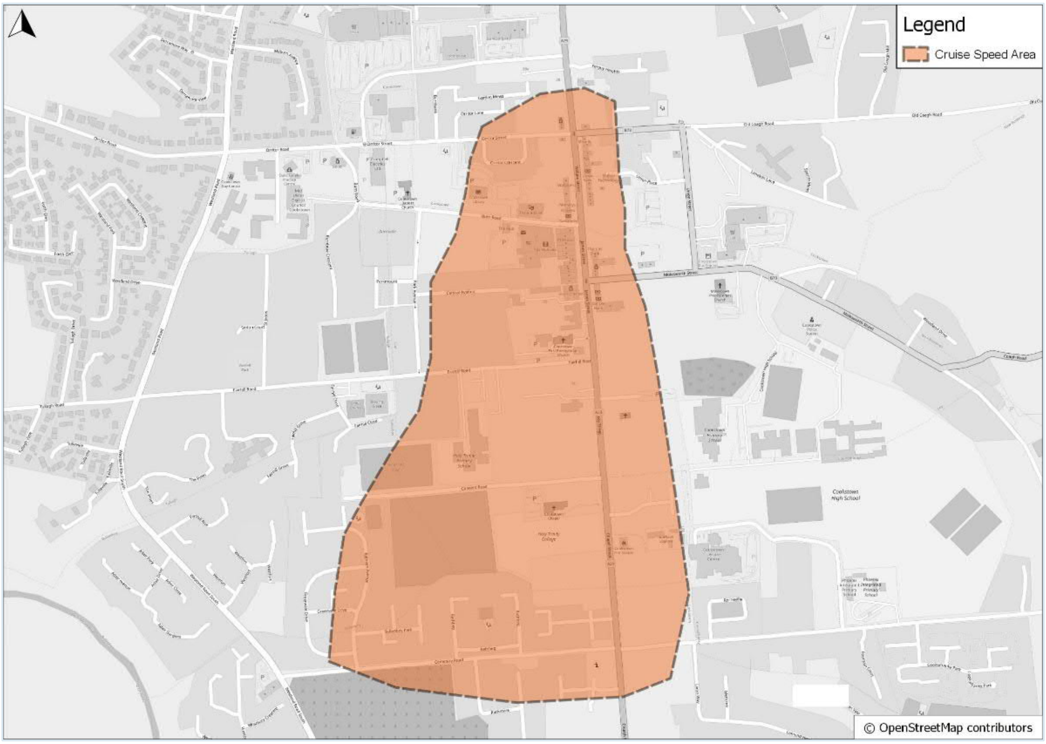


Figure 7-3 - Cruise Speed Area

7.1.7. JUNCTION CODING

Within the simulation area, junctions were modelled in detail to represent the effects of traffic flows on delays and queues. Each junction was coded by using detailed information which included:

- junction type (signalised, priority, roundabout)
- number of arms
- allowed / banned turns
- turning capacities based on geometric parameters
- traffic signal details (stage/phase arrangements and timings)
- vehicle circulating capacity and travel time (for roundabouts).

Data for junction layouts was obtained from a visual network inventory surveys, Google Earth and site visits.

Approximately 270 priority junctions were coded in the simulation network. These include the Loughry Roundabout, which was modelled as a series of priority nodes to ensure that correct lane use and turn capacities are represented on each of the approaches. There are a further 5 roundabouts within the model simulation area which were represented as a single roundabout node in SATURN.

There is a total of 9 signalised junctions modelled within the study area. The signal data (provided by DfI) included details of minimum and maximum green times, inter-green time and junction layouts with turning allocations, phases and stages. This information was input into SATURN for the three time periods (AM peak, Inter peak and PM peak).

7.1.8. BUS ROUTES

Bus routes information was obtained from the websites of public transport operators Ulsterbus and Goldline Express together with bus service frequencies. Within the A29 Cookstown Bypass model, buses are represented explicitly as fixed flows along the defined bus routes based on the bus service frequencies. A total of 11 bus routes were defined within the model.

7.1.9. DEVELOPMENT OF BASE YEAR MATRIX

The base matrices were developed using RSI and CPI as the primary source. The locations of these are shown in Figure 7-4 and Figure 7-5.

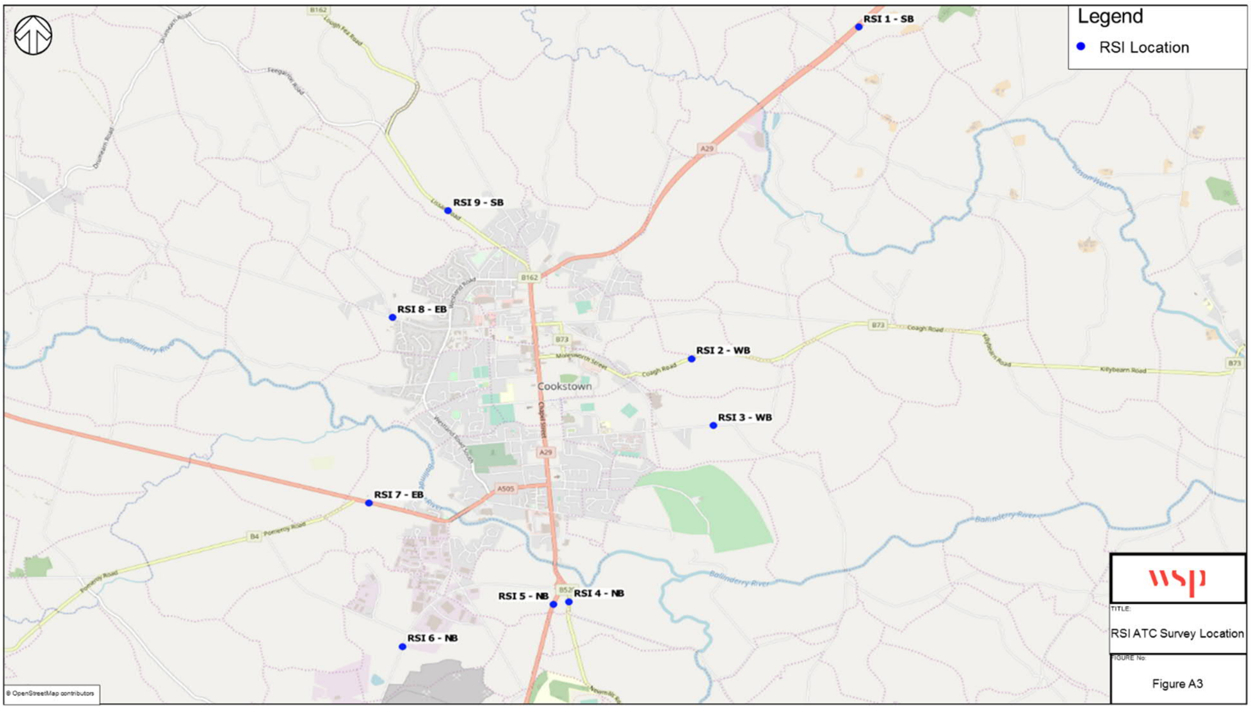


Figure 7-4 - RSI Survey Locations

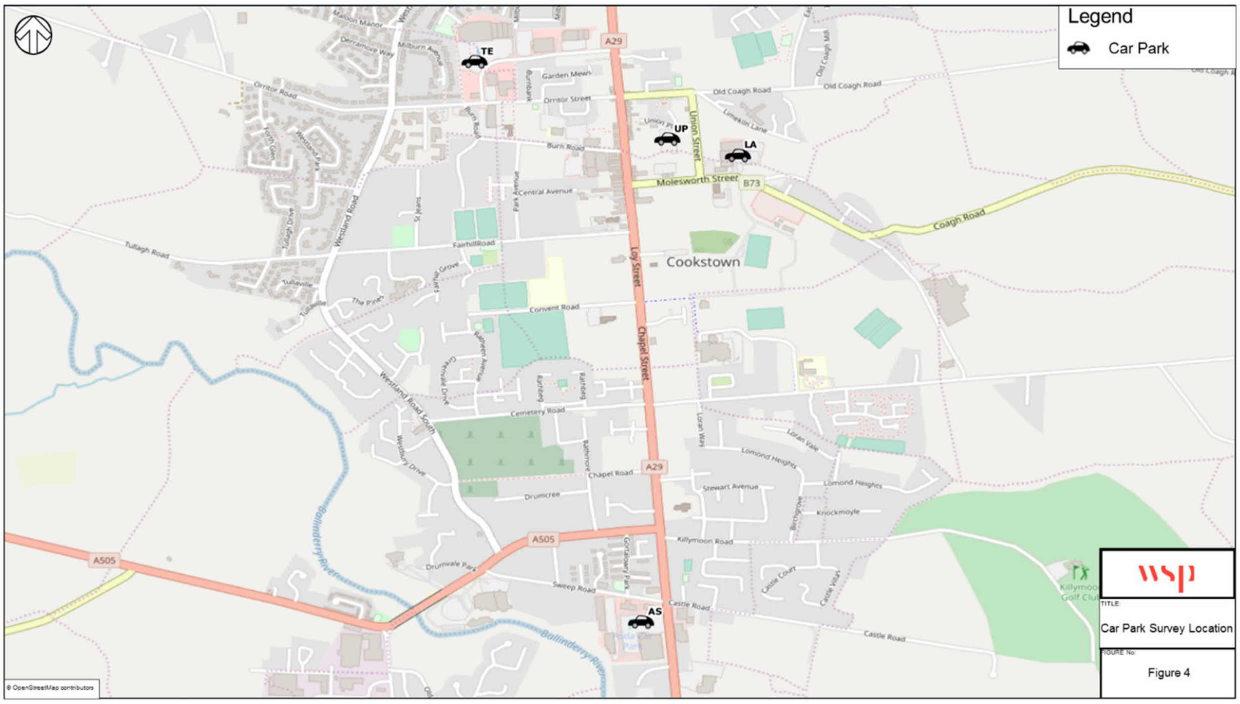


Figure 7-5 - CPI Survey Locations

The RSI and CPI provided origin / destinations (O/Ds) for trips to and from the study area. The RSI data also provided partial information on trips passing through the study area.

Due to potential overlap between elements of the RSI and CPI data with an internal trip-end, measures to avoid any double counting were implemented during matrix merging.

Junction Turning Count (JTC) data and ATC data were also utilised for model calibration and validation. The JTC data was also used to identify the proportion of LGV and HGV trips from the RSI and CPI datasets. The locations of these surveys are shown in Figure 7-6 and Figure 7-7.

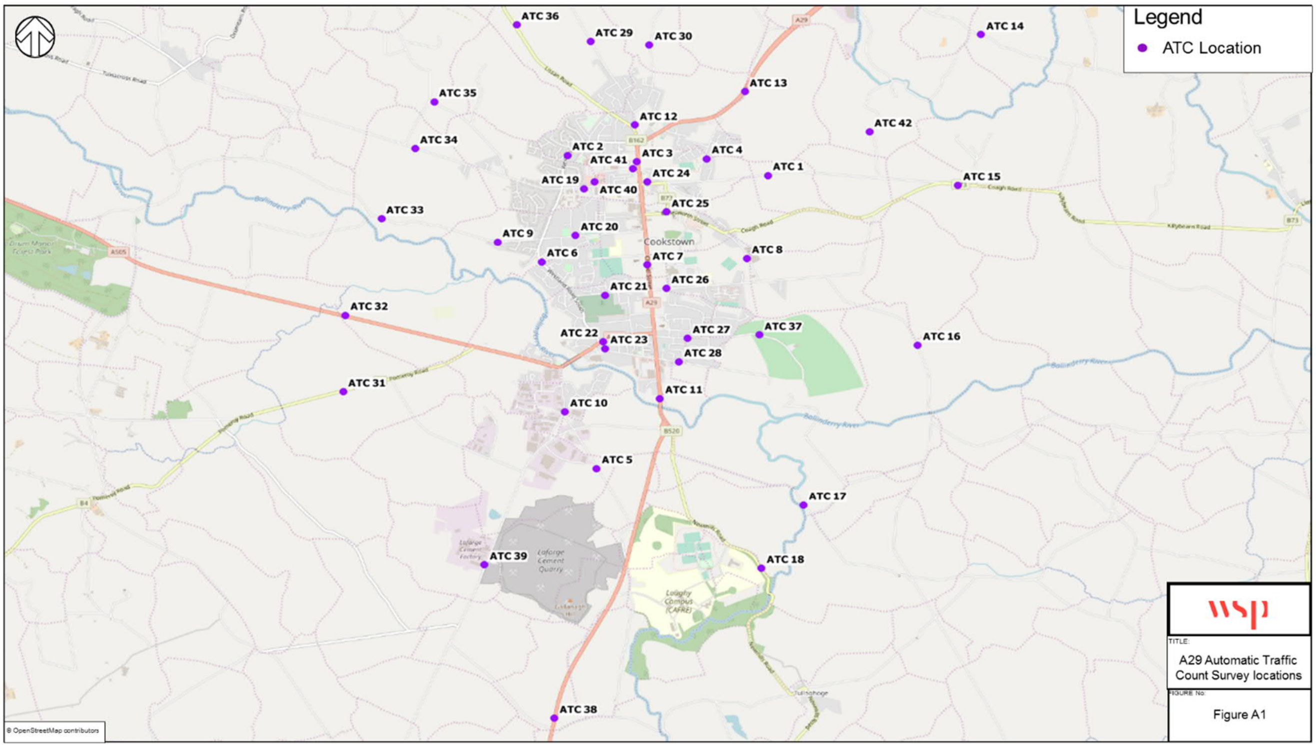


Figure 7-6 - ATC Survey Locations

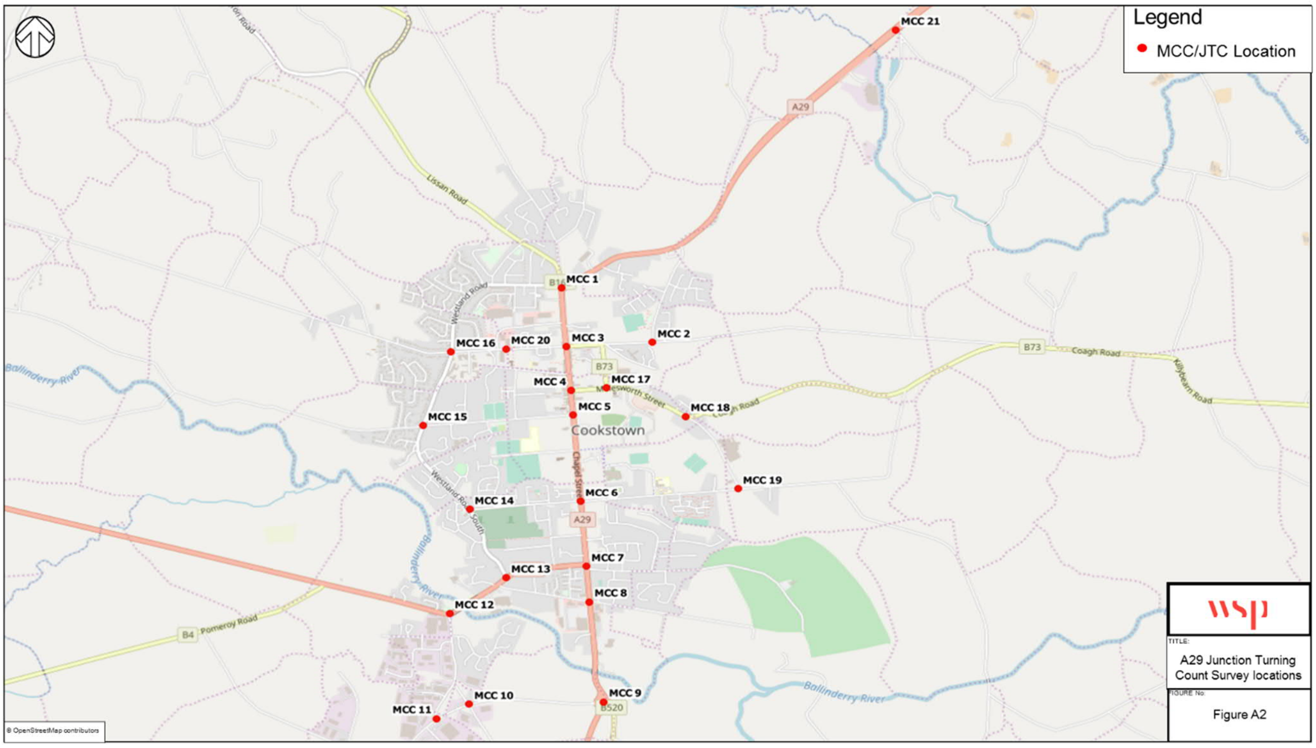


Figure 7-7 - JTC Survey Locations

It is acknowledged that there were some unobserved elements within the RSI and CPI data, such as data on shorter distance internal to internal movements - particularly within Cookstown town centre. A synthetic matrix was developed based on TEMPRO-NI v.7.3 to infill the unobserved internal to internal trips.

The matrix development process is visualised in Figure 7-8.

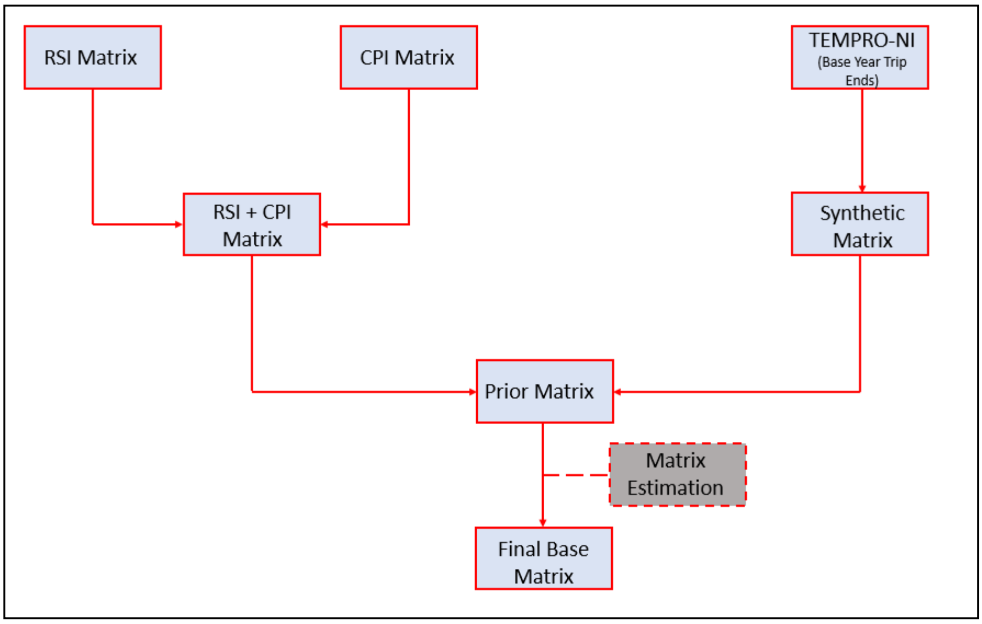


Figure 7-8 - Base Matrix Development Process

The resulting prior matrix totals, for each of the modelled peak hours are presented in Table 7-2.

Table 7-2 - Prior Matrix Summary by Purpose and Period (pcu/h)

Vehicle Class	AM peak	Inter peak	PM peak
Commute	3,005	629	2,082
Business	505	317	343
Other	1,686	3,450	3,624
LGV	431	358	618
HGV	374	443	281
Total	**6,001**	**5,197**	**6,948**

This set of base year 'prior' matrices provided an input for further refinement through matrix estimation. Matrix estimation is a process that adjusts the travel pattern for compatibility with the observed traffic counts to produce a matrix which 'best fits' the observed counts. The matrix estimation procedure was undertaken within SATURN on individual vehicle types that comprised of Cars (UC1, UC2, UC3), light goods vehicles (UC4) and heavy goods vehicles (UC5) matrices in accordance with TAG Unit M3.1 (January 2014).

7.1.10. TRAFFIC ASSIGNMENT

The traffic model has been constructed in the SATURN modelling suite using an assignment process based upon Wardrop's Equilibrium Theory. The principle behind the Theory states that traffic arranges itself on a network so that the cost of travel on a route between an origin and destination is equal to or less than all other potential but unused routes. This applies to all trips in the network such that the lowest overall or aggregate cost within the network extents can be achieved.

Model convergence has been assessed against criteria as set out in TAG Unit M3-1 'Highway Assignment Modelling' (January 2014), Section 2. Model convergence guidance, also outlined in TAG Unit M3-1, seeks to ascertain the stability of the assignment. Essentially this means that as SATURN loops between assignment and convergence, gradually getting closer to convergence, the assignment of trips to links between loops becomes more consistent and less likely to be re-assigned.

Ultimately, a model is therefore considered 'converged' when it reaches a point in the assignment process where it obeys Wardrop's First Principle of Traffic Equilibrium (that the generalised cost for any chosen route is equal or less than the generalised cost on alternative non-chosen routes).

7.1.11. MODEL CALIBRATION

Model calibration is the iterative process of reviewing and adjusting the model's network and/or trip matrices so that modelled traffic flows, speeds, junction delays and routeings through the network provide a reliable match to observed data. The calibration procedure involved the following processes:

- Checks to ensure that link speeds, capacities and number of lanes on the network were realistic.
- Checks to ensure that junction attributes matched on-ground conditions and that delay calculations at junctions were realistic
- Adjustment and checking of the network to ensure plausible routeing of traffic (HGV restrictions)
- Refinement of network parameters (e.g. capacities) to match modelled data e.g. traffic flows and journey times, to observed data

- Use of matrix estimation (ME) to adjust the prior trip matrices to match observed traffic counts.

Matrix estimation is a process that adjusts the travel pattern for compatibility with the observed traffic counts to produce a matrix which 'best fits' the observed counts. The matrix of trips input to matrix estimation is known as the 'prior' matrix and the matrix of trips output from matrix estimation is termed the 'post' matrix. The post matrix will therefore contain a better representation of the individual trip movements on counted links, compared to the prior matrix.

The matrix estimation process utilised observed traffic count data derived from the ATC data collected in 2019. In accordance with guidance set out in section 8.3.5 of TAG Unit M3 (January 2014), the counts used for ME were grouped and applied at the screenline level (screenlines would generally intercept trip movements between sectors). The model calibration and validation screenlines are shown in Figure 7-9.

TAG guidance on the application of matrix estimation, set out in Section 8.3 of TAG Unit M3.1, advises that the changes brought about by matrix estimation should not be significant.

The prior and post ME matrix totals for the AM, Inter-Peak and PM Peak are presented below.

Table 7-3 - Matrix Totals Before and After Matrix Estimation

PCU Totals	Prior	Post	Abs Change	Percentage Change
AM peak	6,001	6,685	684	+11.4%
Inter-Peak	5,197	5,736	539	+10.4%
PM Peak	6,948	7,540	592	+8.5%

The matrix estimation is shown to increase total demands by around 600 PCUs in each modelled period. A more detailed analysis of the changes in trip patterns was carried out through a sector to sector analysis. More than 90% of all sector to sector movements across all three time periods show a change of less than 15 PCUs or 5% as presented in Table 7-4.

Table 7-4 - Summary of Sector to Sector Comparison

Time Period	Number of sector movements with <5% change or <15 PCUs change	% of sector movements with <5% change or <15 PCUs change
AM peak	361	90%
Inter-Peak	379	95%
PM Peak	366	92%

Although the matrix estimation increases the trips over 10% to matrix totals in the AM peak and Inter peak periods, the sector to sector changes brought about by matrix estimation are relatively small. This analysis indicates that the matrix estimation has most likely infilled the unobserved short-distance trips, rather than significantly altered the quantum and distribution of the observed through trips. Notably, the medium to long distance trips which are expected to use the A29 Cookstown Bypass scheme, have not been significantly affected by matrix estimation. More comprehensive results are presented in the 'A29 Cookstown Bypass, Local Model Validation Report – Ref 718314-2700-R-0004' (LMVR).

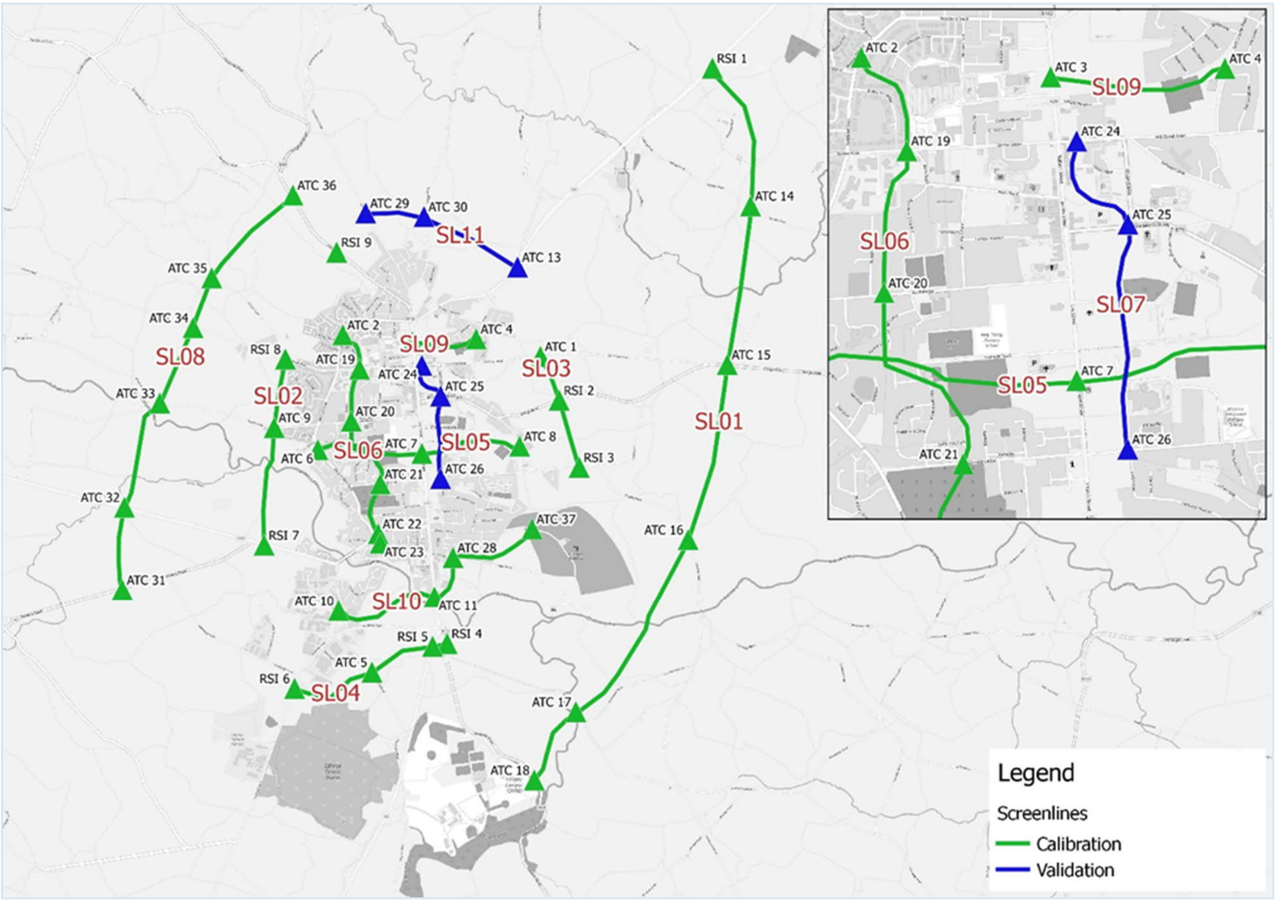


Figure 7-9 - Study Screenlines

Table 7-5 presents the TAG acceptability guidance for individual links.

Table 7-5 - TAG Calibration Criteria

Criteria	Description of Criteria	Acceptability Guideline
1	Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases
	Individual flows within 15% of counts for flows from 700 veh/h to 2,700 veh/h	> 85% of cases
	Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases
2	GEH* < 5 for individual flows	> 85% of cases

* GEH error statistic is a non-linear formula used to compare two sets of traffic volumes

There were 74 calibration counts used in the base year model for the AM and PM peaks as well as inter-peak. Table 7-6 shows that in all time periods, the model meets the TAG criteria for flow calibration.

Table 7-6 - Number/Percentage of Links Meeting WebTAG Criteria

Measure	AM Peak	IP Peak	PM Peak
No. of links meeting criteria 1	71	68	68
% links meeting criteria 1	96%	92%	92%
No. of links meeting criteria 2	67	62	59
% links meeting criteria 2	91%	84%	80%
No. of links meeting either criteria	**72**	**68**	**68**
% links meeting either criteria	**97%**	**92%**	**92%**

Table 7-6 shows that in all time periods, the model meets the TAG criteria for flow calibration. 91% of links meet the TAG GEH criteria in the AM peak, but the inter peak and PM peak are just short of meeting the TAG GEH criteria. In the interpeak, five links achieve GEH < 5.5 and in the PM peak, four links achieve GEH < 5.5, if we considered these links are close to meeting the GEH requirements then all three-time period would also meet the TAG GEH criteria.

Overall, by considering either criterion a high level of matrix calibration has been achieved across all three modelled time periods following the application of matrix estimation.

7.1.12. MODEL VALIDATION

Validation of the model was based upon a comparison of observed and modelled traffic flow and journey time data. It is important to note that the data used to validate the model is entirely independent from data used to calibrate the model.

The validation of traffic flows involved a comparison of observed and modelled flows across two screenlines. These were designed to capture traffic movements likely to be affected by the proposed scheme and focused on the north and east parts of the study area. They therefore represent a robust test of the trip matrix and model assignment. These screenlines used independent data for model validation and were separate from the screenlines used for the model calibration described in the earlier section. For validation of the trip matrix, TAG advises that comparisons of modelled flows and counts should be taken at screenline level. The validation screenline locations are displayed in Figure 7-9 above.

The TAG guidance advises that the modelled flow should be within 5% of the observed counts for "all or nearly all" screenlines.

A summary of screenline validation statistics are presented in Table 7-7. As shown in the table, many of the screenlines do not pass the 5% flow criteria. But it should be noted that, the absolute differences in total screenline flows are less than 100 vehicles, so when assessed against the relevant link validation criteria of 15% difference, all screenlines would pass.

The link validation criteria would not usually be appropriate for assessing screenlines with relatively low flows, as a small absolute trip difference can result in a disproportionately large percentage difference. Considering this, GEH statistics have also been reported in Table 7-7. In terms of GEH, all screenlines are within GEH < 4 criteria for AM peak, Inter peak and PM peak. GEH could be considered to be a better metric in models with relatively low vehicle numbers.

Table 7-7 – Summary of Screenline Validation

Time Period	Screenline	Direction	Observed	Modelled	Mod - Obs	% Diff	GEH
AM Peak	SL 07	Eastbound	660	623	-37	-6%	1.452
	SL 07	Westbound	795	809	13	2%	0.470
	SL 11	Southbound	797	806	9	1%	0.303
	SL 11	Northbound	626	638	12	2%	0.466
Inter Peak	SL 07	Eastbound	617	710	92	15%	3.591
	SL 07	Westbound	724	646	-79	-11%	3.001
	SL 11	Southbound	540	585	44	8%	1.875
	SL 11	Northbound	561	577	16	3%	0.684
PM Peak	SL 07	Eastbound	712	789	78	11%	2.830
	SL 07	Westbound	857	785	-72	-8%	2.504
	SL 11	Southbound	760	738	-22	-3%	0.792
	SL 11	Northbound	836	852	17	2%	0.578

The validation criterion and acceptability guidelines for link flows and turning movements are defined in section 3.2.8 of TAG Unit M3.1 (January 2014) as per Table 7-5 above.

There were 12 validation counts used in the base year model for the AM, PM and inter-peak. The results presented in Table 7-8 show that, for the AM peak and PM peak, 100% of links meet the TAG link flow criteria. In the interpeak only one link does not meet the TAG link flow criteria.

Table 7-8 - Summary of Validation for Links on Screenlines

Measure	AM Peak	IP Peak	PM Peak
No. of links meeting criteria 1	12	11	12
% links meeting criteria 1	100%	92%	100%
No. of links meeting criteria 2	12	8	9
% links meeting criteria 2	100%	67%	75%
No. of links meeting either criteria	**12**	**11**	**12**
% links meeting either criteria	**100%**	**92%**	**100%**

100% of links meet the TAG GEH criteria in the AM peak but only eight links in the interpeak and 9 links in the PM peak meeting the GEH < 5 criteria. In the interpeak, three of these links achieve GEH

< 6 and can be considered close to meeting the GEH requirement. In the PM peak, two links meet GEH < 6 and the third link achieved GEH of 6.4. Considering either criterion, the model is considered to achieve a high level of link validation across all time periods.

7.1.13. JOURNEY TIME VALIDATION

Validation of journey time is carried out to determine how well model journey times match observed times. The observed data gathered during the Journey Time Survey, using a moving observer GPS methodology, was used to for the validation process.

The validation was assessed using the TAG validation guidelines as set out in section 3.2.10 of TAG Unit M3.1 (January 2019). The TAG guidance advises that modelled times along 85% of routes should be within 15% of surveyed times (or 1minute, if higher than 15%).

In terms of journey time validation, the TAG guidelines have been satisfied for all the modelled time periods. The AM peak and the inter-peak both achieved 100% compliance with PM peak passing at 88%, with one journey time route marginally failing to meet the TAG criteria.

Further details about the base year model calibration and validation has been reported in the 'A29 Cookstown Bypass, Local Model Validation Report' – Ref 718314-2700-R-0004, dated November 2019.

7.2. FORECASTING

7.2.1. METHODOLOGY

The 2019 base year traffic model formed the basis for the development of the future year traffic models to support the design and appraisal of the Bypass Route Options. The future year models were developed for a scheme opening year of 2025 and a design year of 2040. The development of the forecast models has been documented in the 'A29 Cookstown Bypass, Traffic Forecasting Report' – Ref 718314-2700-R-0005, dated January 2020.

At the time of this assessment, 2025 was anticipated as the opening year with construction commencing in 2023. The timeframe will be reviewed at Stage 3 depending on available government funding, proposed construction techniques and / or constraints encountered.

The forecast model comprises a process of predicting the future flows on the highway network across the study area and includes the following main components:

- Estimate of future highway supply
- Estimate of future travel demand
- A mechanism of assigning demand to the highway network

A series of different forecast scenarios were produced to assess the range of likely future supply and demand combinations. Table 7-9 outlines the different scenarios used during the forecasting process, including a brief description of the assumed future demand.

Table 7-9 – Forecast Scenarios Outline

Scenario	Scheme	Abbreviation*	Years	Description
Do-Minimum	No Scheme	DM	2025, 2040	As per the existing highway network.

Scenario	Scheme	Abbreviation*	Years	Description
Do-Something-1	Red with Sandholes Link Road	DS-1	2025, 2040	Addition of Red scheme along with improvement of Sandholes Link Road, assigned to 2025 and 2040 demands.
Do-Something-2	Purple A with Sandholes Link Road	DS-2	2025, 2040	Addition of Purple A scheme along with improvement of Sandholes Link Road, assigned to 2025 and 2040 demands.
Do-Something-3	Purple B with Sandholes Link Road	DS-3	2025, 2040	Addition of Purple B scheme along with improvement of Sandholes Link Road, assigned to 2025 and 2040 demands.
Do-Something-4	Green with Sandholes Link Road	DS-4	2025, 2040	Addition of Green scheme along with improvement of Sandholes Link Road, assigned to 2025 and 2040 demands.

**These abbreviations have been used in the remainder of this chapter to refer to these schemes*

The traffic forecasts were prepared in accordance with the advice set out in TAG Unit M4 and were principally determined using local information collected from Mid Ulster Council on proposed and committed transport interventions and development growth combined with factors obtained from TEMPro-NI v7.3.

For this Stage 2 assessment, traffic forecasts were prepared only for the central growth scenario i.e. Core scenario, utilising a 'fixed demand' modelling approach.

7.2.2. FUTURE YEAR NETWORK

The forecast highway networks were developed following the methodology set out in TAG Unit M4. The two key factors affecting the future supply are:

- Network wide changes in transport costs represented by economic parameters (including values of time, vehicle operating costs and vehicle occupancies)
- Local network changes resulting from other transport interventions identified within the Uncertainty Log

The Uncertainty Log is a record of assumptions made in the model that will affect travel demand and supply such as local highways improvement schemes or proposed residential, commercial or industrial developments. The Uncertainty Log has been developed in consultation with the development team at Mid Ulster Council.

Do-Minimum networks were created for two forecast years, 2025 and 2040. Analysis of the Uncertainty Log revealed that there are no committed or proposed schemes which are more than likely to be implemented within the model study area, therefore no explicit highway interventions due to existing background assumptions were made to the calibrated base year model for the Do-Minimum.

Background growth in traffic and the resulting re-routings due to demand changes led to the need to optimise some signals for predicted 2025 and 2040 traffic flow levels. The same optimised signal timing has been carried out from DM through all DS scenarios for both model years. Economic parameters are updated for each user class by modelled time period and by each forecast years.

Do-Something networks were developed from the Do-Minimum networks, adding the respective schemes accordingly. These scheme descriptions are presented in section 4 of this report and summarised in Table 7-9 above.

7.2.3. FUTURE YEAR DEMANDS

The future year demand matrices were developed based on local information on expected traffic generation from the proposed developments within Cookstown, constrained to the appropriate national and regional traffic growth estimates. For LGV and HGV growth, use was made of Road Transport Forecasts 2018 (RTF- 2018) produced by the Department for Transport. For car user classes, growth in demand was aligned to TEMPRO-NI demand forecasts.

Details of prospective developments were collated from the relevant documentation published by the local planning authorities (http://epicpublic.planningni.gov.uk/publicaccess/ and https://apps.infrastructure-ni.gov.uk/PSepicdataextract/) and captured within the Uncertainty Log, along with their prescribed level of uncertainty.

The developments identified from the above websites (approximately 25,000 entries between 2017-2019) were categorised based on following criteria:

- Only applications within Mid Ulster Council area were considered
- Applications outside a 10km radius of Cookstown were discarded
- Applications not relevant to the study area were removed based on application status and type codes
- Applications for individual developments consisting of less than 5 dwellings were not considered

Based on the above criteria, a total of 32 residential and 16 commercial / industrial applications were recorded in the Uncertainty Log for further analysis. In addition to these sites, development zones allotted by the council for future development within the current adopted Cookstown Area Plan 2010 were also included in the Uncertainty Log. This consisted of 29 residential zones and 7 economic zones. A proportion of the recorded planning applications were associated with the development zones. Contributions to the final demand took account of any overlap to remove potential for 'double counting' of data.

In line with guidance from WebTAG unit M4 Table A1, only those developments located within the core study area and whose likelihood was assessed to be either 'near certain' or 'more than likely' were considered in the demand forecasts.

Figure 7-10 shows the significant new development zones considered exclusively based on development trips from the Uncertainty Log. These zones were added to the model to accurately account for the large increase of trips and ensure trips are added to the network in the correct location.

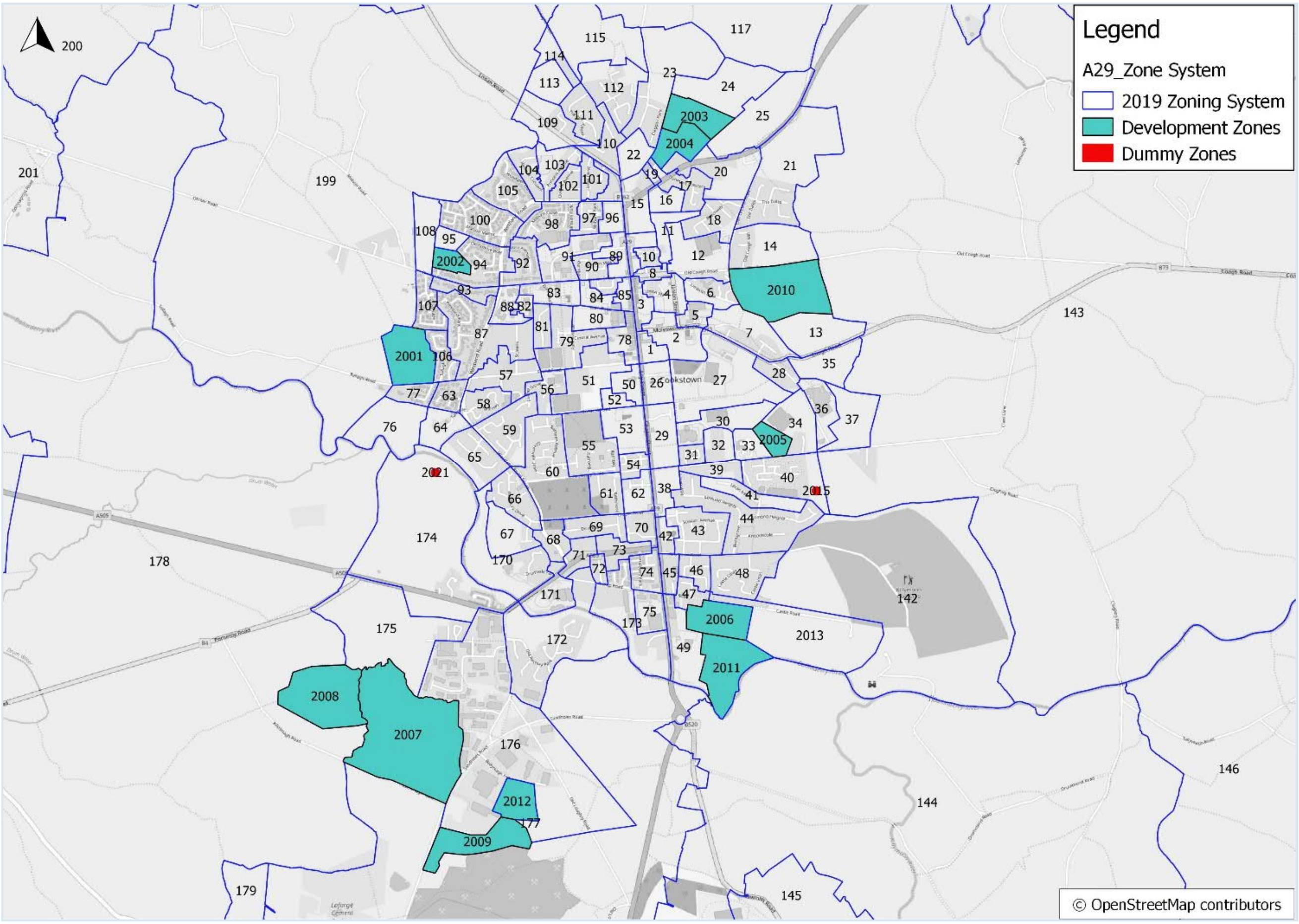


Figure 7-10 – New Development Zones in SATURN Model

For each proposed development, TRICS database (the UK and Ireland's national system of trip generation analysis) was used to estimate trip generation and, arrival and departure profiles. For the economic developments, "Employment Density Guide 2015" by Homes & Communities Agency has been used to estimate employment density and the resulting trip generation was calculated based on TRICS data. The total trips generated (residential and economic developments) from the new developments are presented in Table 7-10 and

Table 7-11 respectively for 2025 and 2040.

Table 7-10 – Development Trip Generation – 2025

Time Period	Trips Generated (PCUs/Hr) – 2025						
	Car		LGV		HGV		Total
	Origin	Destination	Origin	Destination	Origin	Destination	
AM	317	193	2	6	1	4	**523**
IP	164	161	2	2	10	10	**349**
PM	206	285	7	2	2	1	**503**

Table 7-11 – Development Trip Generation – 2040

Time Period	Trips Generated (PCUs/Hr) – 2040						
	Car		LGV		HGV		Total
	Origin	Destination	Origin	Destination	Origin	Destination	
AM	619	374	8	19	5	12	**1037**
IP	345	343	6	5	35	33	**767**
PM	435	569	21	6	7	2	**1040**

7.2.4. TRAFFIC GROWTH AND FUTURE YEAR MATRICES

The trip end growth forecasts from TEMPRO-NI were used to factor the base year trip matrices using growth factors for each time period, trip purpose, and vehicle type, through a furnessing procedure. The final forecast matrices were produced using trip generation from new developments constrained to TEMPRO-NI traffic growth. This ensured that all new trip generation was accurately allocated to new developments within Cookstown, but overall growth was controlled to TEMPRO-NI and therefore aligned to the national growth projections.

Impacts of future fuel pricing and income changes on car user demand were incorporated through the application of fuel and income factors, derived from table M4.2.1 in the TAG Data Book produced by the Department for Transport.

LGV and HGV growth was based on projections of goods vehicle growth for England published by the Department for Transport, as RTF-2018. To account for variation in demand growth between Northern Ireland and England, a secondary factor was applied to RTF-2018 LGV and HGV growth factors, based on a comparison of TEMPRO-NI total vehicle growth projections with the equivalent TEMPRO (GB) projections.

Table 7-12 shows the resulting hourly matrix totals for each forecast year. The matrix totals are presented for each purpose, vehicle category and time period for the opening and design year. The 2019 base year totals are also presented for comparison. Total percentage growth relative to 2019 is included for each time period.

Table 7-12 – Summary of Matrix Totals

Time Period	Model Year	Total Trips PCUs/Hr					
		Commute	Business	Other	LGV	HGV	TOTAL
AM Peak	Base 2019	3236	594	1859	529	467	**6685**
	2025	3379	624	1988	575	468	**7034**
	2040	3774	698	2313	677	471	**7933**
Average Inter Peak	Base 2019	680	334	3687	488	547	**5736**
	2025	706	349	3966	531	548	**6099**
	2040	788	387	4680	624	545	**7025**
PM Peak	Base 2019	2243	391	3889	680	338	**7540**
	2025	2344	410	4161	739	339	**7993**
	2040	2611	458	4858	869	337	**9132**

7.2.5. ANALYSIS OF FORECAST RESULTS

This section presents comparisons of the predicted scheme impacts for the four DS options tested, compared against the DM case. These include comparisons of traffic flows along the key links, journey times and network wide performance (in terms of average speed, PCU kilometres and vehicle hours). The full analysis of forecast impacts of the Do-Minimum and the Do-Something scheme options are reported in the 'A29 Cookstown Bypass, Traffic Forecasting Report' – Ref 718314-2700-R-0005, January 2020.

7.2.5.1. Flow Difference Summary

The proposed schemes attract traffic away from Westlands Road and the A29 between Loughry Roundabout and A29/B162 (Lissan Road)/Moneymore Road junction. This reduction in traffic via the key / complex junctions in the town centre helps to reduce the delays and queues, thereby improving the overall network performance.

Figure 7-11 and Figure 7-12 show the comparison of flows (PCU's/hr) between the base model, Do-Minimum models and the various Do-Something models.

The forecast flows on the proposed routes are predicted to range between 10,100PCU and 17,400PCU in the opening year, and range between 11,900PCU and 20,400PCU in the design year. The design year flow represents an increase of approximately 17% compared to the opening year forecast flows.

Red Route Option attracts the highest traffic and provides maximum relief to the town centre movement. Purple B Route Option is the least attractive. The relief provided by Purple A and Green Route Options are similar.

Flows on the existing A29 (via the town centre) show a pattern of relief in the opening year forecasts with a flow reduction of 28%-40% on the northern section (between Moneymore Road and Orritor Road), and a reduction of 48%-59% on the southern section (between A505 Drum Road and Loughry Roundabout) with the proposed bypass in place. In the design year, the flow reductions are estimated to be 25%-40% on the northern section, and 52%-60% on the southern section.

In the opening year, the traffic flow on Sandholes Link Road is predicted to increase by approximately 14%-21%. By the design year, the increase is approximately 15%-18%.

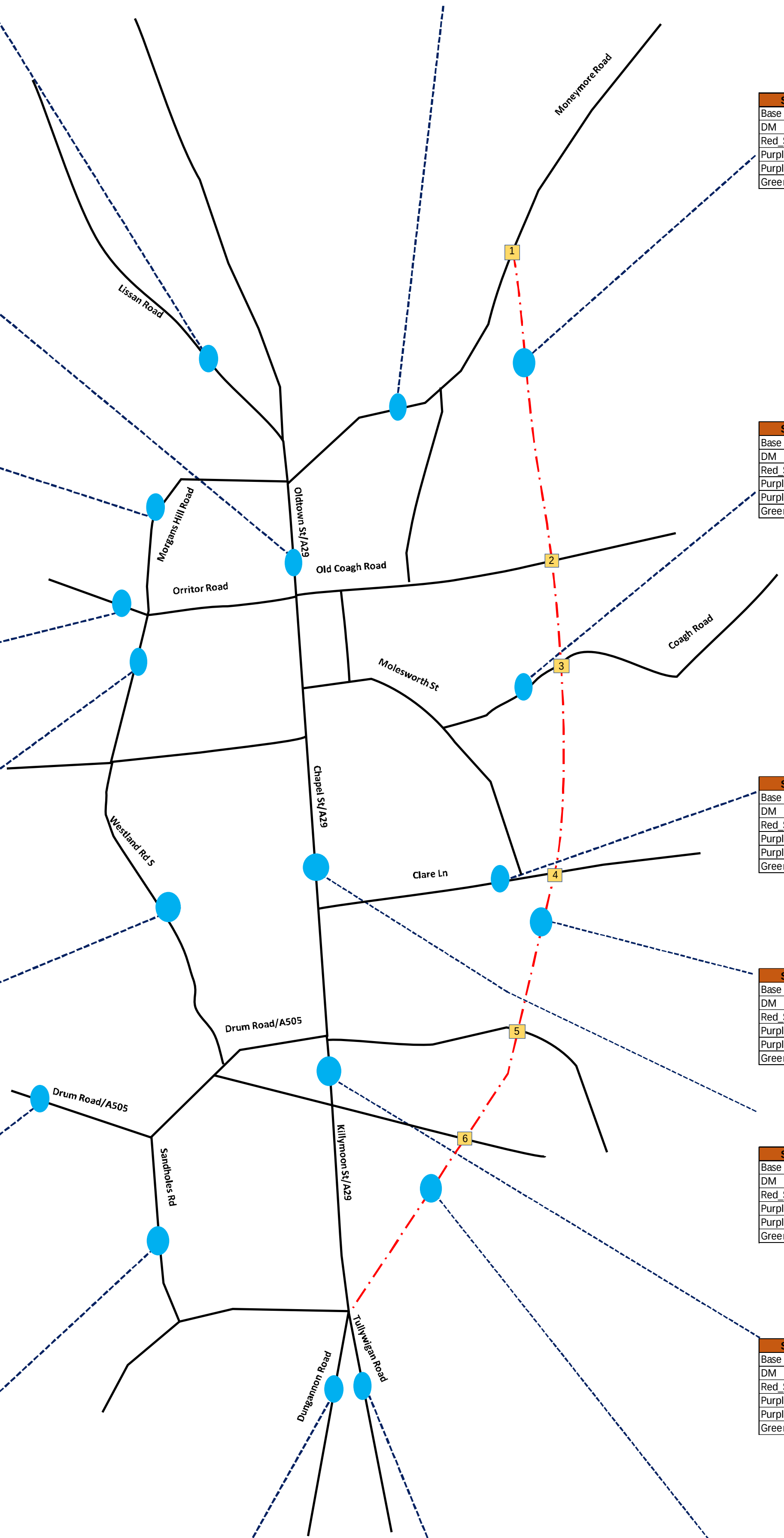
The proposed bypass also results in a flow reduction on Westlands Road with a predicted decrease of approximately 25% to 30% on the northern section (between Orritor Road and Fairhill Road) and about 20% to 26% on the southern section (between Fairhill Road and A505 Drum Road). The range of flow reduction is similar in both opening and design years.

Similar traffic flow reduction is also experienced on the Morgans Hill Road, it is predicted to decrease by approximately 35%-36% in the opening year. By the design year, the decrease is approximately 33%-35%.

Scenario	AM	IP	PM	AADT
Base	1100	720	1150	11550
DM	1160	760	1220	12170
Red_SHL	750	510	850	8210
PurpleA_SHL	710	490	830	7900
PurpleB_SHL	560	350	680	6010
Green_SHL	710	480	830	7850

Scenario	AM	IP	PM	AADT
Base	330	210	310	3370
DM	340	220	330	3510
Red_SHL	330	220	320	3390
PurpleA_SHL	330	220	320	3390
PurpleB_SHL	320	220	320	3370
Green_SHL	330	210	320	3370

Scenario	AM	IP	PM	AADT
Base				
DM				
Red_SHL	1130	830	1160	12520
PurpleA_SHL	1080	780	1100	11840
PurpleB_SHL	920	680	910	10120
Green_SHL	1100	780	1100	11880



Scenario	AM	IP	PM	AADT
Base	920	660	900	9930
DM	990	720	970	10760
Red_SHL	530	470	670	6850
PurpleA_SHL	510	440	630	6480
PurpleB_SHL	650	520	740	7700
Green_SHL	510	430	630	6340

Scenario	AM	IP	PM	AADT
Base	900	700	1010	10530
DM	920	760	1070	11190
Red_SHL	580	490	670	7130
PurpleA_SHL	580	500	690	7240
PurpleB_SHL	580	510	660	7270
Green_SHL	580	500	690	7260

Scenario	AM	IP	PM	AADT
Base	160	120	190	1830
DM	170	130	210	2050
Red_SHL	170	130	190	1960
PurpleA_SHL	170	130	210	2000
PurpleB_SHL	170	130	210	2000
Green_SHL	170	130	210	2030

Scenario	AM	IP	PM	AADT
Base	520	350	530	5530
DM	570	390	570	6080
Red_SHL	440	340	420	4910
PurpleA_SHL	450	340	420	4950
PurpleB_SHL	470	350	430	5050
Green_SHL	450	340	420	4960

Scenario	AM	IP	PM	AADT
Base	500	310	470	5020
DM	550	370	530	5700
Red_SHL	410	310	440	4660
PurpleA_SHL	350	270	380	4060
PurpleB_SHL	370	280	390	4180
Green_SHL	350	270	380	4000

Scenario	AM	IP	PM	AADT
Base	960	830	1050	11770
DM	950	820	1010	11540
Red_SHL	620	580	690	7970
PurpleA_SHL	670	600	740	8350
PurpleB_SHL	690	620	770	8640
Green_SHL	670	600	740	8380

Scenario	AM	IP	PM	AADT
Base				
DM				
Red_SHL	1520	1220	1460	17330
PurpleA_SHL	1330	1130	1290	15660
PurpleB_SHL	1270	1060	1200	14730
Green_SHL	1310	1100	1270	15300

Scenario	AM	IP	PM	AADT
Base	1230	1060	1370	15120
DM	1260	1130	1420	15850
Red_SHL	910	840	1110	11910
PurpleA_SHL	970	860	1140	12220
PurpleB_SHL	1000	890	1180	12730
Green_SHL	970	860	1140	12260

Scenario	AM	IP	PM	AADT
Base	1110	1040	1180	14090
DM	1150	1080	1220	14630
Red_SHL	630	510	630	7270
PurpleA_SHL	690	580	720	8210
PurpleB_SHL	720	610	750	8660
Green_SHL	700	590	730	8360

Scenario	AM	IP	PM	AADT
Base	750	550	850	8520
DM	770	570	880	8850
Red_SHL	820	610	980	9540
PurpleA_SHL	810	610	980	9500
PurpleB_SHL	810	610	970	9490
Green_SHL	810	610	980	9490

Scenario	AM	IP	PM	AADT
Base	1040	850	770	11310
DM	1080	900	850	12050
Red_SHL	510	360	310	4890
PurpleA_SHL	600	420	390	5800
PurpleB_SHL	610	450	430	6210
Green_SHL	600	440	400	6020

Scenario	AM	IP	PM	AADT
Base	600	330	530	5560
DM	650	360	530	5880
Red_SHL	720	340	780	6680
PurpleA_SHL	730	360	810	6930
PurpleB_SHL	750	370	830	7110
Green_SHL	740	360	810	6940

Scenario	AM	IP	PM	AADT
Base				
DM				
Red_SHL	1510	1220	1470	17370
PurpleA_SHL	1330	1120	1290	15620
PurpleB_SHL	1270	1060	1200	14690
Green_SHL	1310	1100	1270	15300

Scenario	AM	IP	PM	AADT
Base	1000	780	850	10920
DM	1020	810	890	11320
Red_SHL	1070	880	990	12270
PurpleA_SHL	1050	870	970	12050
PurpleB_SHL	1050	870	940	11950
Green_SHL	1050	870	960	12000

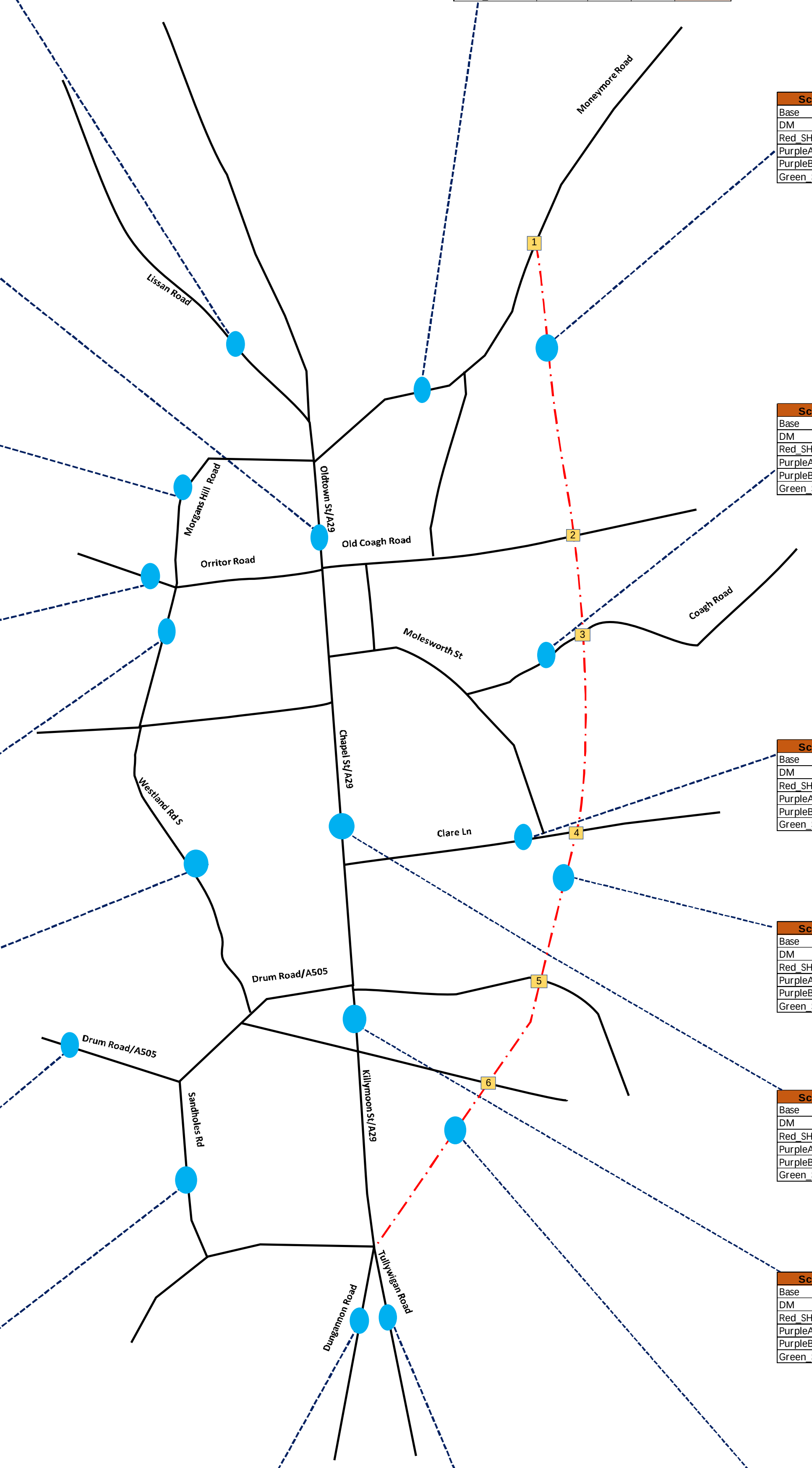
Scenario	AM	IP	PM	AADT
Base	490	420	600	6180
DM	530	440	600	6420
Red_SHL	660	550	740	8000
PurpleA_SHL	600	540	660	7540
PurpleB_SHL	600	530	660	7480
Green_SHL	610	540	670	7610

AG At Grade
GS Grade Separated

Scenario	1	2	3	4	5	6
Base	AG	AG	AG	AG	AG	AG
DM	AG	AG	AG	AG	AG	AG
Red_WOSHL	AG	GS	GS	AG	AG	AG
PurpleA_WOSHL	AG	GS	GS	AG	GS	AG
PurpleB_WOSHL	AG	GS	GS	AG	GS	AG
Green_WOSHL	AG	GS	GS	AG	GS	GS
Red_SHL	AG	GS	GS	AG	AG	AG
PurpleA_SHL	AG	GS	GS	AG	GS	AG
PurpleB_SHL	AG	GS	GS	AG	GS	AG
Green_SHL	AG	GS	GS	AG	GS	GS

			Grade

Figure 7-11 – Flow Comparison for DS Schemes - 2025



Scenario	AM	IP	PM	AADT
Base	1100	720	1150	11550
DM	1270	880	1360	13810
Red_SHL	910	690	1030	10500
PurpleA_SHL	900	680	1030	10420
PurpleB_SHL	720	490	840	7960
Green_SHL	920	680	1030	10450

Scenario	AM	IP	PM	AADT
Base	330	210	310	3370
DM	400	260	400	4150
Red_SHL	380	260	370	3990
PurpleA_SHL	380	260	380	4000
PurpleB_SHL	380	250	370	3940
Green_SHL	380	260	380	4000

Scenario	AM	IP	PM	AADT
Base				
DM				
Red_SHL	1320	1020	1360	15020
PurpleA_SHL	1260	970	1320	14380
PurpleB_SHL	1080	800	1070	11880
Green_SHL	1280	970	1330	14460

Scenario	AM	IP	PM	AADT
Base	920	660	900	9930
DM	1120	860	1130	12620
Red_SHL	590	530	720	7560
PurpleA_SHL	600	540	730	7720
PurpleB_SHL	740	680	820	9360
Green_SHL	590	540	720	7700

Scenario	AM	IP	PM	AADT
Base	900	700	1010	10530
DM	1000	880	1190	12690
Red_SHL	660	600	760	8430
PurpleA_SHL	670	610	770	8510
PurpleB_SHL	650	580	760	8250
Green_SHL	660	600	770	8470

Scenario	AM	IP	PM	AADT
Base	160	120	190	1830
DM	210	180	260	2670
Red_SHL	220	160	250	2540
PurpleA_SHL	200	160	260	2470
PurpleB_SHL	200	160	250	2430
Green_SHL	200	160	260	2490

Scenario	AM	IP	PM	AADT
Base	520	350	530	5530
DM	650	470	640	7010
Red_SHL	520	390	490	5670
PurpleA_SHL	520	390	500	5700
PurpleB_SHL	530	390	510	5810
Green_SHL	520	390	500	5710

Scenario	AM	IP	PM	AADT
Base	500	310	470	5020
DM	680	500	680	7460
Red_SHL	460	360	530	5400
PurpleA_SHL	400	330	460	4820
PurpleB_SHL	400	340	450	4870
Green_SHL	390	320	440	4740

Scenario	AM	IP	PM	AADT
Base	960	830	1050	11770
DM	990	920	1120	12690
Red_SHL	660	650	760	8820
PurpleA_SHL	700	660	780	9060
PurpleB_SHL	740	690	820	9480
Green_SHL	700	660	780	9060

Scenario	AM	IP	PM	AADT
Base				
DM				
Red_SHL	1690	1460	1730	20360
PurpleA_SHL	1590	1350	1510	18640
PurpleB_SHL	1490	1260	1430	17470
Green_SHL	1570	1340	1500	18480

Scenario	AM	IP	PM	AADT
Base	1230	1060	1370	15120
DM	1370	1260	1570	17610
Red_SHL	1000	940	1210	13180
PurpleA_SHL	1030	950	1230	13360
PurpleB_SHL	1060	1000	1260	13930
Green_SHL	1030	950	1230	13370

Scenario	AM	IP	PM	AADT
Base	1110	1040	1180	14090
DM	1210	1120	1290	15300
Red_SHL	680	560	710	8060
PurpleA_SHL	700	620	780	8730
PurpleB_SHL	750	660	820	9300
Green_SHL	700	620	780	8780

Scenario	AM	IP	PM	AADT
Base	750	550	850	8520
DM	840	630	990	9750
Red_SHL	880	690	1080	10590
PurpleA_SHL	880	690	1090	10620
PurpleB_SHL	880	690	1070	10560
Green_SHL	880	690	1090	10620

Scenario	AM	IP	PM	AADT
Base	1040	850	770	11310
DM	1150	980	950	13080
Red_SHL	530	380	310	5090
PurpleA_SHL	590	410	390	5680
PurpleB_SHL	600	460	410	6200
Green_SHL	590	420	390	5780

Scenario	AM	IP	PM	AADT
Base	600	330	530	5560
DM	710	420	560	6630
Red_SHL	770	430	850	7680
PurpleA_SHL	790	410	860	7640
PurpleB_SHL	820	420	900	7840
Green_SHL	790	410	870	7610

Scenario	AM	IP	PM	AADT
Base				
DM				
Red_SHL	1690	1460	1740	20390
PurpleA_SHL	1580	1350	1510	18590
PurpleB_SHL	1490	1260	1420	17420
Green_SHL	1570	1340	1500	18480

Scenario	AM	IP	PM	AADT
Base	1000	780	850	10920
DM	1120	910	1020	12690
Red_SHL	1190	1020	1130	14040
PurpleA_SHL	1170	1010	1110	13820
PurpleB_SHL	1160	1000	1100	13730
Green_SHL	1170	1010	1100	13790

Scenario	AM	IP	PM	AADT
Base	490	420	600	6180
DM	530	440	610	6440
Red_SHL	640	600	770	8390
PurpleA_SHL	600	570	660	7720
PurpleB_SHL	570	560	660	7590
Green_SHL	600	570	670	7830

AG At Grade
GS Grade Separated

Scenario		1	2	3	4	5	6
Base		AG	AG	AG	AG	AG	AG
DM		AG	AG	AG	AG	AG	AG
Red_WOSHL		AG	GS	GS	AG	AG	AG
PurpleA_WOSHL		AG	GS	GS	AG	GS	AG
PurpleB_WOSHL		AG	GS	GS	AG	GS	AG
Green_WOSHL		AG	GS	GS	AG	GS	GS
Red_SHL		AG	GS	GS	AG	AG	AG
PurpleA_SHL		AG	GS	GS	AG	GS	AG
PurpleB_SHL		AG	GS	GS	AG	GS	AG
Green_SHL		AG	GS	GS	AG	GS	GS

			Grade

Figure 7-12 – Flow Comparison for DS Schemes - 2040

7.2.5.2. Network Wide Impacts

Table 7-13 summarises the changes across the simulation network between the 2019 base year and the future Do-Minimum scenario for each forecast year.

Increases in both total travel time and total travel distance are caused by the increase in travel demand across the network. Whilst the increase in total travel distance is proportionate with the increase in demand, the PCU hours travelled are increasing disproportionately when compared to the PCU kilometres travelled. This indicates an increasing delay across the network without any interventions in place.

Table 7-13 – Growth in Demand, PCU KM and PCU Hours 2019 to 2040, DM case

Time Period	Total matrix demand growth (total PCUs/hr)		Simulation Travel Time (total PCU-hrs)		Simulation Travel Distance (total PCU-kms)	
	2019-2025	2019-2040	2019-2025	2019-2040	2019-2025	2019-2040
AM	5%	13%	9%	18%	6%	13%
IP	6%	15%	10%	21%	7%	16%
PM	6%	14%	10%	23%	7%	15%

Table 7-14 shows the network-wide performance in terms of PCU hours and PCU kilometres for DM and the DS scenarios for 2025. The table also presents the comparison of travel time and travel distance changes per vehicle relative to the DM scenario.

There are net reductions in travel time and slight increase in PCU kilometres travelled predicted with all the proposed options. The reduction in total travel time is comprised of the travel time savings gained by traffic on the proposed bypass route as well as the reduction in the junction delays on the existing town centre routes. The slight increase in PCU kilometres is caused by some of the trips travelling longer to access the scheme to take advantage of the shorter journey times.

Although there is a general reduction in travel time across the Do-Something scenarios, compared against each scenario, DS3 (Purple B Route Option) represents the lowest travel time savings compared with the Do-Minimum. This is due to the tie-in with the A29 Moneymore Road being located slightly further away from Cookstown compared to other route alignments. Hence, the trips from and to the northern part of Cookstown, travel an increased distance to access the Purple B scheme, making the scheme less attractive for traffic.

Table 7-14 – Change in PCU KM and PCU hours between DM and DS– 2025

	Do Minimum	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
AM Peak					
PCU hours	1,016	862	866	870	866
Vehicle Kilometres	40,420	41,160	41,283	40,891	41,223
Change in Vehicle Hours		-15.2%	-14.8%	-14.4%	-14.8%
Change in Vehicle Kilometres		1.8%	2.1%	1.2%	2.0%
Average Inter Peak					
PCU hours	801	679	684	689	685

	Do Minimum	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Vehicle Kilometres	32,339	32,706	32,924	32,630	32,839
Change in Vehicle Hours		-14.6%	-14.0%	-14.5%	-15.4%
Change in Vehicle Kilometres		1.8%	0.9%	1.5%	0.9%
PM Peak					
PCU hours	1,097	943	948	952	948
Vehicle Kilometres	42,865	43,760	43,869	43,350	43,769
Change in Vehicle Hours		-14.0%	-13.6%	-13.2%	-13.6%
Change in Vehicle Kilometres		2.1%	2.3%	1.1%	2.1%

Table 7-15 presents the network-wide performance in terms of PCU hours and PCU kilometres between DM and various DS scenarios for 2040 it also summarises the changes in travel time and travel distance per vehicle for the Do-Something options relative to the DM.

Similar to 2025 network statistics, the above table also indicates that, there are net reductions in travel time and slight increase in vehicle kilometres, as a result of the proposed schemes. When compared with all other DS scenarios, DS3 (Purple B Route Option) continue to represent the lowest change with respect to the 2040 Do-Minimum scenario.

Table 7-15 – Change in PCU KM and PCU hours between DM and DS– 2040

	Do Minimum	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
AM Peak					
PCU hours	1,116	973	976	979	975
Vehicle Kilometres	43,661	45,505	45,832	45,329	45,761
Change in Vehicle Hours		-12.8%	-12.5%	-12.3%	-12.6%
Change in Vehicle Kilometres		4.2%	5.0%	3.8%	4.8%
Average Inter Peak					
PCU hours	896	780	785	791	785
Vehicle Kilometres	35,478	37,074	37,352	36,923	37,270
Change in Vehicle Hours		-12.9%	-12.4%	-11.7%	-12.4%
Change in Vehicle Kilometres		4.5%	5.3%	4.1%	5.1%
PM Peak					
PCU hours	1,246	1,088	1,090	1,093	1,090
Vehicle Kilometres	46,904	49,271	49,476	48,864	49,382
Change in Vehicle Hours		-12.7%	-12.5%	-12.3%	-12.5%
Change in Vehicle Kilometres		5.0%	5.5%	4.2%	5.3%

7.2.5.3. Journey Time Summary

Evidence presented above shows that efficiency of the Do-Something networks has increased showing decreased journey times through the town centre and an overall increase in average speed across the entire network. Table 7-16 and Table 7-17 summarise the changes in average speed across network within the simulation area for 2025 and 2040 respectively.

Table 7-16 – Change in Average Speed (DS-DM) – 2025

	Do Minimum	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
AM Peak					
Simulation Average Speed (km/h)	40	48	48	47	48
Difference		**8**	**8**	**7**	**8**
Average Inter Peak					
Simulation Average Speed (km/h)	40	48	48	47	48
Difference		**8**	**8**	**7**	**8**
PM Peak					
Simulation Average Speed (km/h)	39	46	46	46	46
Difference		**7**	**7**	**7**	**7**

Table 7-17 – Change in Average Speed (DS-DM) – 2040

	Do Minimum	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
AM Peak					
Simulation Average Speed (km/h)	39	47	47	46	47
Difference		**8**	**8**	**7**	**8**
Average Inter Peak					
Simulation Average Speed (km/h)	40	48	48	47	48
Difference		**8**	**8**	**7**	**8**
PM Peak					
Simulation Average Speed (km/h)	37	45	45	45	45
Difference		**8**	**8**	**7**	**8**

When considering the average speed across the network, a higher average speed represents a more efficient network. It is clear from the above tables that, the average speeds in the simulation area increases across all the proposed DS scenarios (from DS1 to DS4). The increase in speeds is notable in all three time periods and in both opening year and design year.

DS3 (Purple B Route Option) represents the smallest increase in average speed with respect to the Do-Minimum. However, DS3 still represents a proportionally similar improvement when compared to the other Do-Something scenarios.

7.2.6. OVERALL SUMMARY

The Do-Minimum scenarios show that without significant intervention the issue of congestion and traffic within the town centre becomes progressively more severe as demand increases in the future forecast years. As the traffic volume increases it adds strain on the operation of the signalised junctions within Cookstown which could lead to an increase in delays and journey times.

All the Do-Something scenarios show a significant improvement in network-wide performance when compared to the Do-Minimum scenarios. One of the key impacts is the rerouting of traffic away from the town centre resulting in less congestion and an improved town centre environment.

The efficiency of the Do-Something networks increases with a decrease in journey times through the town centre and an overall increase in average speed across the entire network.

When comparing the bypass schemes, the analysis suggests that Red, Purple A and Green Route Options provide the greatest improvement to congestion.

7.3. ECONOMIC PERFORMANCE OF OPTIONS

7.3.1. METHODOLGY

The economic appraisal of a highway scheme assesses the net benefits to users and the wider community as a result of the scheme, set against the capital construction and operational costs, incurred over a 'whole life' period.

The economic assessment of the A29 Cookstown Bypass comprises the direct economic impacts on road users, government and other related economic impacts in accordance with the Green Book - Appraisal and Evaluation in Central Government ("the Green Book").

The economic assessment process estimates the following components:

- Scheme cost – defined as the total amount of money spent in constructing and maintaining the scheme. It includes preparation costs (planning and designing), land acquisition cost, construction costs, supervision and maintenance costs.
- Scheme benefits – a full cost benefit analysis was required to assess the proposed scheme in 'value for money' terms. The appraisal comprised three components;

Transport Economic Efficiency (TEE) benefits to road users, including time savings and vehicle operating costs
Accident savings and associated economic benefits
Monetised benefits / disbenefits from changes to greenhouse gas emissions, air quality and noise impacts

The benefits from these three categories were combined and compared to costs to produce a Benefit Cost Ratio (BCR) which allows comparison of the value for money of each option.

7.3.2. TUBA ASSESSMENT

The calculation of transport economic efficiency impacts on road users (excluding accident benefits) was undertaken using the Department for Transport's (DfT) TUBA V.1.9.13 (Transport Users Benefit Appraisal) program. This was used to assess the benefits arising from changes in journey times and vehicle operating costs which are calculated separately for Business Users and Consumer Users.

TUBA takes, as its principal input, zone to zone matrices of trip numbers, travel times and distances travelled to calculate the net road user benefits over a 60-year appraisal period.

For the appraisal of road user benefits, standard values of time, operating cost and other related economic parameters for traffic appraisal are applied, using the standard 'economic parameter data' based on TAG data book (May-2019.V1.12).

The journey time and vehicle operating costs represent the economic benefits that accrue to road travellers as a result of the scheme. They include savings in journey time and changes in vehicle operating costs, to Business Users and Consumer Users. The vehicle operating costs are both distance and speed related, and include fuel costs and non-fuel costs, e.g. tyres, maintenance, depreciation, etc.

The benefits are calculated for all users of the network and include those who travel on the new road and those travelling on all existing roads. For example, while users of the Scheme could experience time savings, users of the existing road network may also experience benefits as average speeds for journeys increase as a result of traffic relief.

The Transport Economic Efficiency (TEE) benefits of the scheme calculated from TUBA are presented in Table 7-18. Note that monetary values are shown as £000s consistent with the TUBA output.

Table 7-18 - Transport User Benefits from TUBA Assessment (£000s) - Core Scenarios

Benefit Description	Red Route Option (£000s)	Purple A Route Option (£000s)	Purple B Route Option (£000s)	Green Route Option (£000s)
Consumer Benefits Commuting	32,561	31,439	30,249	31,494
Consumer Benefits Other	37,666	35,470	33,402	35,564
Business User Benefits	47,980	46,304	45,798	46,527
TOTAL BENEFITS	**118,207**	**113,213**	**109,449**	**113,585**

Across all the options, the scheme is shown to provide benefits exceeding £100million over the 60-year appraisal period. Business Users are shown to gain the greatest benefit from the scheme, due to their relatively high values of time, however commuters and other consumer users are also shown to gain benefits from the scheme.

The Red route provides the greatest benefit (£118m), whilst the Purple B route provides the least benefit (£109m). Purple A and Green routes show a very similar level of user benefit (£113m).

The Red route attracts the highest traffic volumes to the bypass and consequently provides maximum relief to town centre, whereas Purple B route is the least attractive among the proposed alignments. The traffic attraction and the congestion relief provided by Purple A and Green routes are very similar and reflected in the total transport user benefits presented above.

7.3.3. COBALT ACCIDENT ASSESSMENT

An assessment of accident benefits was undertaken using The COBALT (COst and Benefit to Accidents – Light Touch) computer program, version 2013.02 - the DfT cost benefit analysis program that assesses benefits from accident savings. The program forecasts number of Personal Injury

Accidents (PIA) and casualties by severity and forecasts the changes as monetised accident costs for inclusion in the Analysis of Monetised Costs and Benefits (AMCB) table.

Six years of accident data was obtained for the Cookstown area between 17th April 2013 and 27th March 2019 and accident rates were calculated. The default accident rates were used across the network for links where actual observed accidents were not available.

COBALT calculates a severity split using standard factors which estimate the number of accidents classified by injury severity (fatal, serious or slight). COBALT then applies the appropriate costs per accident to establish the economic cost of accidents over the appraisal period. The COBALT economic parameter file based on TAG data book (May-2019.V1.12) was used to calculate accident impacts in line with TAG guidance.

Guidance in the COBA manual states that the accident appraisal area should extend far enough from the improvement (or scheme) to include all links on which there is a substantial difference in the assigned traffic flows between ‘Do-Minimum’ and ‘Do-Something’ networks. In line with TAG guidance, a change of ± 10% in AADT flows (relative difference DM and DS Flows) from the 2040 model was used to define the COBALT appraisal area. The appraisal area was kept consistent for all the DS schemes.

The COBALT analysis indicates that, all the scheme options will have a positive impact on accident rates with varying levels of benefit, as presented in Table 7-19 and Table 7-20.

Table 7-19 - Accident and Casualty Savings over 60 years

Scheme	Accidents	Casualties with Scheme			Accident Saved by Scheme	Casualties Saved by Scheme		
		Fatal	Serious	Slight		Fatal	Serious	Slight
DM	2,998	26	396	3,547	-	-	-	-
Red Route Option	2,618	26	357	3,108	380	0	39	438
Purple A Route Option	2,626	26	358	3,119	372	0	38	428
Purple B Route Option	2,694	26	366	3,197	304	0	30	350
Green Route Option	2,627	26	358	3,120	371	0	38	427

Table 7-20 - Present Value of Accident Savings (£000)

Scheme	Accident costs (£000)	Savings in Accident Costs (£000)
DM	124,788	-
Red Route Option	111,699	13,088
Purple A Route Option	112,090	12,698
Purple B Route Option	114,666	10,122
Green Route Option	112,063	12,724

All the proposed scheme options provide considerable accident benefits. The Red route attracts the greatest traffic away from the congested town centre routes to a high standard bypass alignment, and therefore reduces a higher number of accidents and provides maximum benefits. The Purple B route attracts less traffic when compared to other scenarios and therefore provides a slightly lower accident benefit. The accident benefits provided by Purple A and Green routes are similar.

7.3.4. MONETISED ENVIRONMENTAL BENEFITS

7.3.4.1. Greenhouse Gases

TAG Unit A3 - Environment Impact Appraisal states that it is important to consider the impact of a proposed transport scheme on greenhouse gas (GHG) emissions, whether they are increased or decreased. As such, consideration of greenhouse gas emissions has been undertaken following guidance in TAG UNIT A3.

7.3.4.2. Local Air Quality

The air quality appraisal has also been undertaken in accordance with TAG Unit A3. This guidance defines a step-by-step approach for appraising local air quality based on quantification of the change in concentration of traffic-related pollutants NO_2 and PM_{10}. This has been undertaken for properties within 200m of the affected road network as defined within the Design Manual for Road and Bridges (DMRB) Volume 11, Section 3, Part 1: Air Quality Guidance and interim advice notes.

7.3.4.3. Noise Assessment

Chapter 2: Noise impacts of TAG Unit A3 outlines a step-by-step process by which noise implications of road schemes can be appraised. This guidance refers to the assessment guidance contained within the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 7, Noise and Vibration. This guidance has been followed for the appraisal and quantification of the noise impacts.

7.3.4.4. Monetised Environmental Impacts

The GHG, air quality and noise assessments were undertaken following the methodologies set out above with the resulting benefits / disbenefits presented in Table 7-21, in 2010 values and prices.

Table 7-21 – Present Value of GHG, Air quality and Noise assessments (£000)

Scheme	Quantified Benefits GHG (£000)	Quantified Benefits Air Quality (£000)	Quantified Benefits Noise (£000)	Total Environment Benefits (£000)
Red Route Option	5,890	5,617	6,375	17,882
Purple A Route Option	5,536	5,611	6,551	17,698
Purple B Route Option	6,582	5,228	6,357	18,167
Green Route Option	5,020	5,678	7,243	17,941

All schemes are shown to provide positive benefits in terms of GHG, air quality and noise impacts. The difference in total environment benefits generated by the schemes range between £17.7 million for the Purple A option, to £18.2 million for the Purple B option.

The Purple B scheme delivers the lowest air quality and noise benefits as it provides the least traffic relief to the existing town centre route. Due to its alignment (further away from the urban area), Purple

B attracts less traffic hence the overall vehicles travel kilometres travelled is less, resulting in a higher GHG benefit when compared with other options.

7.3.5. INVESTMENT COSTS

For the economic appraisal a whole life Present Value Cost (PVC) of the scheme is required. This includes Capital cost (or investment cost) and Operation and Maintenance (O&M) costs. All costs are adjusted to market prices and discounted using standard treasury discount rates to a PVC according to when they occur in the future. The main components of the capital or investment costs for the scheme are:

- Preparation and supervision costs
- Land and property costs, including compensation
- Construction costs, including main works, ancillary works, statutory undertakings, site supervision and testing

The expenditure profiles are based upon cost estimates for each financial year prepared in 2019 Q3 prices and then inflated to outturn costs using projected construction-related inflation. In line with TAG Unit A1.2 (Scheme Costs), it is standard practice to include a risk allowance and optimism bias on top of the scheme estimated costs. The investment costs for the schemes are presented in Table 7-22. These are presented in 2019 Q3 price base and in 2010 price base and values, in line with TAG guidance.

Table 7-22 – Capital Cost Estimate (£000)

Scheme	Investment Cost 2019 Q3 price base (£000)	Investment Cost Discounted to Present Value 2010 (£000)
Red Route Option	55,970	30,457
Purple A Route Option	54,214	29,369
Purple B Route Option	54,162	29,334
Green Route Option	59,920	32,512

The Purple B Route Option has the lowest overall capital or investment cost when compared to the other routes. This is primarily due to its location furthest from Cookstown, lower land costs and reduced construction on the A29 Moneymore Road. Although construction cost wise, Red is the least expensive option with the shortest overall length and the lowest structural costs when compared to other options, its position on zoned land closer to Cookstown increases the overall capital cost of this option.

In addition to investment costs, it is necessary for the economic assessment to take account of the cost of maintaining the new section of the scheme over the 60-year assessment period. The operation and maintenance (O&M) cost for the bypass scheme has been estimated based on unit prices, adjusted to market prices and discounted to 2010 using standard treasury discount rates.

The O&M costs for different scenarios are presented in Table 7-23.

Table 7-23 – Operation and Maintenance Cost Estimate (£000)

Scheme	Present Value of Costs (PVC)
Red Route Option	1,100
Purple A Route Option	1,203
Purple B Route Option	1,296
Green Route Option	1,181

Red route (DS-1) has the shortest alignment and this is reflected in it having the lowest O&M cost. With the longest alignment, Purple B route (DS-3) has the highest O&M cost estimate

7.3.6. ECONOMIC ASSESSMENT SUMMARY

A full cost benefit analysis was carried out to assess the proposed scheme options in 'value for money' terms. The appraisal included an assessment of economic benefits to road users (TEE benefits); an assessment of accident savings; and the monetised benefits from changes to greenhouse gas emissions, air quality and noise.

The benefits from these three categories were combined to give a Present Value of Benefits (PVB) for each option. These were compared to costs (PVC) of each option to produce a Net Present Value (NPV) and a Benefit to Cost Ratio (BCR) for each assessed option. This informed the Value for Money assessment which was undertaken with reference to the Value for Money Framework published by the DfT.

The results of the economic assessment are presented using the following standard TAG tables,

- Transport Economic Efficiency (TEE)
- Public Accounts (PA)
- Analysis of Monetised Costs and Benefits (AMCB)

7.3.6.1. Transport Economic Efficiency (TEE) Table

The TEE table lists out the user and provider economic benefits for each mode (Road, Bus Rail etc.,) separately. It does not report the benefits arising from the reduction in accidents with the scheme, nor environmental benefits.

Table 7-24 presents only the Road user benefits, since impacts on Bus, Rail and Other modes were considered to be marginal and therefore have not been quantified as part of the current assessment.

The TEE table also includes user charges, benefits / disbenefits during construction and maintenance periods. The assessment of the road user dis-benefits associated with delays during construction of the scheme together with the benefits/disbenefits resulting from delays during periods of maintenance was not carried out for this Stage 2 assessment.

Table 7-24 – Transport Economic Efficiency (TEE) Table (2010 prices in £000)

Area of Assessment		Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Non-Business - Commuting	Travel time	32,338	31,462	30,145	31,445
	Vehicle Operating Costs	223	-23	104	49
	User charges	-	-	-	-
	During Construction & Maintenance	-	-	-	-
	Net Non-Business - Commuting	**32,561**	**31,439**	**30,249**	**31,494**
Non-Business - Other	Travel time	37,456	35,706	33,375	35,659
	Vehicle Operating Costs	210	-236	27	-95
	User charges	-	-	-	-
	During Construction & Maintenance	-	-	-	-
	Net Non-Business - Others	**37,666**	**35,470**	**33,402**	**35,564**
Business User Benefits	Travel time	41,028	40,220	38,716	40,261
	Vehicle Operating Costs	6,952	6,084	7,082	6,266
	User charges	-	-	-	-
	During Construction & Maintenance	-	-	-	-
	Net Business	**47,980**	**46,304**	**45,798**	**46,527**
TOTAL TEE BENEFITS (2010 prices in £000**)**		**118,207**	**113,213**	**109,449**	**113,585**

The above table shows the present value of the total TEE benefits range from £109m for Purple B route (DS-3) to £119m for Red route (DS-1). This table shows that there are significant travel time savings and general savings related to VOC as a result of all the proposed schemes.

The slight VOC disbenefit experienced under Purple A (DS-2) and Green (DS-4) route options are due to some of the town centre trips diverting away from the existing A29 and travelling longer to access the proposed scheme to take advantage of the shorter journey times however overall these trips will continue to benefit from the proposed scheme.

7.3.6.2. PUBLIC ACCOUNTS (PA) TABLE

The 'Public Accounts' (PA) relate to the costs faced by Government (either local or central) to implement the scheme. This includes investment costs, operating costs, revenue, developer and other contributions, if any, grant/subsidy payments, if any; and indirect tax revenues to the government e.g. through fuel duty that results from the scheme.

In the PA table the costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers. All entries are discounted present values in 2010 prices and values.

Table 7-25 – Public Accounts (PA) Table (2010 prices in £000)

Cost Category		Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Local Government Funding	Revenue	-	-	-	-
	Operating Costs	-	-	-	-
	Investment Costs	-	-	-	-
	Developer Contributions	-	-	-	-
	Grant/Subsidy Payments	-	-	-	-
	NET IMPACT	**0**	**0**	**0**	**0**
Central Government Funding	Revenue	0	0	0	0
	Operating Costs	1,100	1,203	1,296	1,181
	Investment Costs	30,457	29,369	29,334	32,512
	Developer Contributions	0	0	0	0
	Grant/Subsidy Payments	0	0	0	0
	NET IMPACT	**31,557**	**30,572**	**30,630**	**33,693**
Central Government - Indirect Tax Revenues		**3,321**	**2,837**	**3,176**	**2,939**
Totals (£000)	**Broad Transport Budget**	**31,557**	**30,572**	**30,630**	**33,693**
	Wider Public Finances	**3,321**	**2,837**	**3,176**	**2,939**

This table shows the discounted value of the operating costs ranges between £1.0M to £1.3M and investment cost of the schemes ranges between £29.3M to £32.5M giving a net impact in the range of £30.6M to £33.7M. Based on the overall capital spend Purple A is the least expensive at approximately £30.6M and Green route is the most expensive at approximately £33.7M.

Indirect tax revenues range between £2.8M to £3.5M. The positive indirect tax revenues indicate a reduction in government's tax revenue (through fuel duty) as a result of the scheme. It therefore follows that the Red route, which generates the highest VOC savings, results in the greatest reduction in indirect tax revenues. Purple A route is shown to have the lowest impact on the indirect tax revenues – this is consistent with this option generating the lowest VOC savings.

7.3.6.3. ANALYSIS OF MONETISED COSTS AND BENEFITS (AMCB) TABLE

The overall 'Analysis of Monetised Costs and Benefits' (AMCB) includes benefits due to savings in accidents (number of accidents and its severity), greenhouse gas emissions, air quality and noise levels as a result of the scheme. These would be reported as negative, if they were to increase.

The Net Present Value (NPV) of the scheme is the difference between Present Value of Benefits (PVB) and Present Value of Cost (PVC). All the schemes provide a positive Net Present Value (NPV), which indicates a positive return on investment. The total benefits are compared with the total costs from the public accounts identified above, to determine the Benefit to Cost Ratio (BCR) of the individual schemes and the Value for Money (VfM) of the schemes.

Table 7-26 – Analysis of Monetised Costs and Benefits (AMCB) Table (2010 prices in £000)

Benefit and Cost Category	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Local Air Quality	5,617	5,611	5,228	5,678
Greenhouse Gases	5,890	5,536	6,582	5,020
Noise	6,375	6,551	6,357	7,243
Accidents	13,088	12,698	10,122	12,724
Economic Efficiency: Consumer Users (Commuting)	32,561	31,439	30,249	31,494
Economic Efficiency: Consumer Users (Other)	37,666	35,470	33,402	35,564
Economic Efficiency: Business Users and Providers	47,980	46,304	45,798	46,527
Wider Public Finances (Indirect Taxation Revenues)	-3,321	-2,837	-3,176	-2,939
Present Value of Benefits (PVB) (£000)	**145,857**	**140,771**	**134,561**	**141,312**
Broad Transport Budget	31,557	30,572	30,630	33,693
Present Value of Costs (PVC) (£000)	**31,557**	**30,572**	**30,630**	**33,693**
Net Present Value (NPV) (£000)	**114,300**	**110,199**	**103,931**	**107,618**
BCR	**4.62**	**4.60**	**4.39**	**4.19**

The AMCB table presented in Table 7-26 shows the Red Route option generates the highest NPV followed by Purple A and Green with Purple B generating the lowest NPV.

The overall balance between benefits and costs is positive across all the scheme options. The calculated BCR ranges between 4.19 and 4.62. The Red route generates the highest BCR followed by Purple A and Purple B. Green route generates the lowest BCR.

With reference to the DfT value for money categorisation, all assessed scheme options represent 'Very High' value for money with a BCR value greater than or equal to 4.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. CONCLUSIONS

With the economic benefits of the scheme assessed and confirmed, a Preferred Route can be selected from the four route options considered. The selection process should be based on the performance of the options against the identified objectives whilst taking consideration of the engineering constraints and assessments. This section summarises the performance of the options against the identified High-Level objectives for the scheme, to be read in conjunction with the Assessment Summary Tables (ASTs) included in Appendix C of this report.

8.1.1. ASSESSMENT AGAINST HIGH LEVEL SCHEME OBJECTIVES - ECONOMY OBJECTIVE

8.1.1.1. Journey Times

The traffic and economic analysis indicates that all route options offer journey time savings. Strategic based traffic favour the Purple B Route Option, with a mix of both local and strategic orientated traffic utilise the Purple A and Green Route Options. The Red Route Option attracts more local traffic than strategic traffic.

Both the Purple A and Green Route Options provide the most beneficial journey time savings.

8.1.1.2. BCRs / NPVs

The Analysis of Monetised Costs and Benefits (AMCB) demonstrates that all route options provide significant cost savings. The AMCB include savings in Air Quality, Greenhouse Gases, Noise and Accident reductions. The Red Route Option has the highest Net Present Value (£114m) and the Purple B Route Option provides the lowest present Net Present Value (£104m).

Table 8-1 – Summary of Economic Value (2010 prices in £000)

Benefit and Cost Category	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Net Present Value (£000)	114,300	110,199	103,931	107,618
Benefit Cost Ratio (BCR)	4.62	4.60	4.39	4.19
Rank	1	2	3	4

Based on the above results, all Route Options would represent ‘Very High’ value for money. It is therefore concluded that the Red Route Option would deliver the highest overall economic returns of investment.

Overall Economy Ranking

- 1st preference: Red Route Option
- 2nd preference: Purple A Route Option
- 3rd preference: Purple B Route Option
- 4th preference: Green Route Option

8.1.2. ASSESSMENT AGAINST HIGH LEVEL SCHEME OBJECTIVES - ENVIRONMENT OBJECTIVE

8.1.2.1. Air Quality

The preferred route option is identified as the Green Route Option based on an overall consideration of human health, ecologically sensitive receptors and the potential for both beneficial and adverse effects relating to particulates and emissions associated with the proposed scheme in construction and operation. Ranking for the preferred route option has been identified as follows:

- 1st preference: Green Route Option
- 2nd preference: Purple A Route Option
- 3rd preference: Purple B Route Option
- 4th preference: Red Route Option

8.1.2.2. Cultural Heritage

The preferred route option is identified as the Red Route Option due to having fewer direct impacts on known cultural heritage assets than the other three route options. Mitigation measures would seek to reduce these effects on the cultural heritage resource. Ranking for the preferred route option has been identified as follows:

- 1st preference: Red Route Option
- 2nd preference: Purple A Route Option
- 3rd preference: Green Route Option
- 4th preference: Purple B Route Option

8.1.2.3. Landscape and Visual

There are no significant differentiators for landscape or visual effects between all route options, and as a result there is no clear preferred route option.

Landscape

The Red Route Option is marginally preferred in terms of potential residual landscape effects due to its closer proximity and association with the existing urban edge of Cookstown. Ranking for the preferred route option has been identified as follows:

- 1st preference: Red Route Option
- Equal 2nd preference: Purple A Route Option
- Equal 2nd preference: Purple B Route Option
- 4th preference: Green Route Option

Visual

The Purple B Route Option is marginally preferred in terms of residual visual effects due to the lower number of visual receptors potentially affected. Ranking for the preferred route option has been identified as follows:

- 1st preference: Purple B Route Option
- 2nd preference: Purple A Route Option
- 3rd preference: Green Route Option
- 4th preference: Red Route Option

8.1.2.4. Biodiversity

The preferred route option is identified as the Red Route Option based on the residual impacts on the various biodiversity receptors associated with the proposed scheme. Effects are considered to be comparable across all route options. The principal notable difference between the four route options is the different sizes of the development footprints and associated variations on habitat loss, habitat fragmentation and locally occurring species.

Ranking for the preferred route option has been identified as follows:

- 1st preference: Red Route Option
- 2nd preference: Purple A Route Option
- 3rd preference: Purple B Route Option
- 4th preference: Green Route Option

8.1.2.5. Geology and Soils

The preferred route option is identified as the Red Route Option based on consideration of the potential loss of agricultural soils (Ha) and also consideration of potential for contaminative historical land uses becoming mobilised by construction of the scheme, with the resulting potential for risk to human health and the environment.

Ranking for the preferred route option has been identified as follows:

- 1st preference: Red Route Option (19.36Ha lost)
- 2nd preference: Purple B Route Option (24.55Ha lost)
- 3rd preference: Purple A Route Option (24.78Ha lost)
- 4th preference: Green Route Option (26.2Ha lost)

8.1.2.6. Material Assets and Waste

The preferred route option is identified as the Green Route Option based on consideration of the consumption of materials assets and disposal and recovery of waste for each route option during construction and for the first year of operation.

Ranking for the preferred route option has been identified as follows:

- Equal 1st preference: Green Route Option
- Equal 1st preference: Red Route Option
- Equal 4th preference: Purple A Route Option
- Equal 4th preference: Purple B Route Option

8.1.2.7. Noise and Vibration

All four of the route options are predicted to result in significant operational noise effects both beneficial (noise reductions) in alleviated areas and adverse (noise increases) in areas closest to the route options. Comparing both operational and construction noise effects, the Green Route Option option is the most preferred and the Red Route Option option is the least preferred.

Ranking for the preferred route option has been identified as follows:

- 1st preference: Green Route Option
- 2nd preference: Purple B Route Option
- 3rd preference: Purple A Route Option
- 4th preference: Red Route Option

8.1.2.8. Population and Health

Land use and accessibility

The preferred route options are identified as the Purple A and Purple B based on the potential for significant effects (from land take and severance) on private property and housing, community land, development land and businesses, agricultural land holdings and WCH. Notably, the Red Route Option is the only route which is likely to require the acquisition of an existing property. The Green Route Option will affect a larger proportion of Grade 2 ALC agricultural land than the other route options. There is no differentiator between route options for impacts on community land and walkers, cyclists and horse riders at this stage.

Ranked preference for land use and accessibility is as follows:

- Equal 1st preference: Purple A Route Option
- Equal 1st preference: Purple B Route Option
- Equal 3rd preference: Red Route Option
- Equal 3rd preference: Green Route Option

Human health

There is little difference between the effects on health outcomes for each of the route options, with the main impacts generally common across all of the route options. Using information from other environmental topic assessments which are relevant to human health in this Stage 2 reporting, the ranked preference for health is as follows:

- 1st preference: Green Route Option
- Equal 2nd preference: Purple A Route Option
- Equal 2nd preference: Purple B Route Option
- 4th preference: Red Route Option

8.1.2.9. Climate

Greenhouse Gas

Purple B Route Option is identified as the preferable option based on assessment of the GHG emissions that will occur during the construction phase (2023-2025) and operational phase (2025-2084) for each route option,

Ranking for the preferred route option has been identified as follows:

- 1st preference: Purple B Route Option
- 2nd preference: Red Route Option
- 3rd preference: Purple A Route Option
- 4th preference: Green Route Option

Climate Resilience

There is no differentiation of the effects of climate change for any of route options at this stage.

Ranking for the preferred route option has been identified as follows:

- Equal 1st preference: Red Route Option
- Equal 1st preference: Purple A Route Option
- Equal 1st preference: Purple B Route Option
- Equal 1st preference: Green Route Option

8.1.2.10. Road Drainage and the Water Environment

There is little difference identified between the residual impacts for each of the route options, with the main impacts on the water environment generally common across all of the route options. The only exception between the route options is the total cut lengths, which are more significant for the Green Route Option than all other route options.

Ranking for the preferred route option has been identified as follows:

- Equal 1st preference: Red Route Option
- Equal 1st preference: Purple A Route Option
- Equal 1st preference: Purple B Route Option
- 4th preference: Green Route Option

8.1.2.11. IN-COMBINATION AND CUMULATIVE EFFECTS

Intra-Project Effects

There are potential residual intra-project effects between the environmental topics for all route options.

Inter-Project Effects

Potential post-mitigation or residual inter-project cumulative effects have been identified for all route options due to potential effects on air quality, landscape, ecology, geology and soils, materials, noise, population and human health, and hydrology and water quality receptors.

There are no potential cultural heritage or climate related inter-project cumulative effects identified due to the nature of the receptors or the nature of the assessment.

8.1.2.12. Overall Environment Ranking

The assessments carried out for each of the environmental disciplines has informed overall ranked preferences for each route option by discipline as summarised in Table 8-2 below.

- Overall, the adverse/beneficial significance of effects weightings do not differentiate for or against any particular route.

The overall ranked scoring for Purple A/ Purple B and Red Route Options are similar. Based on a lowest ranked preference scoring the overall preferred route for environmental disciplines is as follows:

- Equal 1st preference: Purple A Route Option
- Equal 1st preference: Purple B Route Option
- 3rd preference: Red Route Option
- 4th preference: Green Route Option

Table 8-2 - Environmental Assessment Summary Table

Topic Rank and Summary of Effect	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Air Quality* – Ranked Preference	4	2	3	1
Air Quality* – Adverse/Beneficial	NA	NA	NA	NA
Cultural Heritage – Ranked Preference	1	2	4	3
Cultural Heritage – Adverse/Beneficial	xx	xx	xx	xx
Landscape and Visual – Ranked Preference	Landscape 1 Visual 4	Landscape 2 Visual 1	Landscape 2 Visual 1	Landscape 4 Visual 3
Landscape and Visual – Adverse/Beneficial	Landscape xx ▪ In the lower order of Moderate Adverse ▪ Marginally Most Preferred Visual xx ▪ Moderate Adverse ▪ Marginally Least Preferred	Landscape xx ▪ Moderate Adverse Visual xx ▪ Moderate Adverse ▪ Marginally Most Preferred	Landscape xx ▪ Moderate Adverse Visual xx ▪ Moderate Adverse ▪ Marginally Most Preferred	Landscape xx ▪ In the higher order of Moderate Adverse ▪ Marginally Least Preferred Visual xx ▪ Moderate Adverse
Biodiversity – Ranked Preference	1	2	3	4
Biodiversity - Adverse/Beneficial	x	x	x	x

Topic Rank and Summary of Effect	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Geology and Soils – Ranked Preference	1	3	2	4
Geology and Soils - Adverse/Beneficial	xxx	xxx	xxx	xxx
Material Assets and Waste – Ranked Preference	1	3	3	1
Material Assets and Waste - Adverse/Beneficial	x	x	x	x
Noise**– Ranked Preference	4	3	2	1
Noise**- Adverse/Beneficial	NA	NA	NA	NA
Population and Health (Land Use and Accessibility) – Ranked Preference	3	1	1	3
Population and Health (Land Use and Accessibility) - Adverse/Beneficial	xxx	xxx	xxx	xxx
Population and Health (Health) – Ranked Preference	4	2	2	1
Population and Health (Health) *,** - Adverse/Beneficial	NA	NA	NA	NA
Greenhouse Gas*** – Ranked Preference	2	3	1	4

Topic Rank and Summary of Effect	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Greenhouse Gas*** - Adverse/Beneficial	✔ ✔	✔ ✔	✔ ✔	✔ ✔
Climate Resilience – Ranked Preference	1	1	1	1
Climate Resilience - Adverse/Beneficial	0	0	0	0
Road Drainage and the Water Environment – Ranked Preference	1	1	1	4
Road Drainage and the Water Environment – Adverse/Beneficial	xxx	xxx	xxx	xxx
OVERALL RANKED PREFERENCE – ENVIRONMENT	**28**	**26**	**26**	**34**
OVERALL – ADVERSE BENEFICIAL	**17 x** **2 ✔**	**17 x** **2 ✔**	**17 x** **2 ✔**	**17 x** **2 ✔**

Table Key:
✔ Slight Beneficial ✔ ✔ Moderate Beneficial ✔ ✔ ✔ Significant Beneficial 0 Neutral
× Slight Adverse ×× Moderate Adverse ××× Significant Adverse
Ranking Scale: 1 denotes the most preferred route option down to 4 for the least preferred.
* The human health component of the operational stage air quality assessment has identified both beneficial and adverse effects at different spatial clusters of receptors for each route option. In order to classify these to assist route options comparison, the net overall effects for each option have been evaluated based on the effects table (see Table 6-11) contained in the air quality section.
** The noise assessment has identified both beneficial and adverse effects at different spatial clusters of receptors for each route option. In order to classify these to assist route options comparison, the net overall effects for each option have been evaluated based on the effects tables given in the noise section.
*** Note that the emissions reduction that is anticipated to occur during the operational phase is anticipated to offset the construction phase emissions and then further reduce emissions relative to the baseline.

8.1.3. ASSESSMENT AGAINST HIGH LEVEL SCHEME OBJECTIVES - SOCIAL OBJECTIVE

8.1.3.1. Accidents

All Route Options provide accident benefits. There is negligible difference in accident benefits between the Red, Purple A and Green Route Options. The Purple B Route Option provides the lowest accident benefits.

The Red Route Option would have the highest accident benefits of £13.1m, followed by Purple A and Green Route Option both with £12.7m and the Purple B Route Option with £10.1m.

8.1.3.2. Safety

Road Safety has focussed on locations where collision rates are normally higher, looking at junctions and areas where poor visibility caused by substandard stopping sight distances / visibility issues are present.

The Green Route Option is preferred as there are no side roads with direct access onto the mainline and no departures from standards relating to visibility.

Purple A and Purple B Route Options are less preferable to Green Route Option as each has one side road with direct access onto the mainline and 2no. combination departures from standard relating to stopping sight distance on the mainline.

The Red Route Option is the least preferred route as it has two side roads with direct access onto the mainline and 2no. combination departures from standard relating to stopping site distance on the mainline. The departures from standard relating to stopping sight distance in the proximity of the Castle Road left in / left out junction combined with the departure from standard for road users exiting the side road looking left is likely to be considered as a road safety issue.

8.1.3.3. Accessibility

All Route Options provide overbridges at Old Coagh and Coagh therefore maintaining the same level of accessibility as currently exists.

The Red Route provides a Left In / Left Out junction at Castle Road and Killymoon Rd, respectively. The Purple A and Purple B Route Options provide Left In / Left Out junctions at its interface with Castle Road. These junction arrangments only permit access to Killymooon Road or Castle Road, respectively, by road users travelling in a southbound direction. Similarly, this junction arrangement only permits roads users joining the bypass from Killymooon Road or Castle Road to travel in a southbound direction.

The Purple A and Purple B Route Options provide an underbridge at Killymoon Road, therefore maintaining the current level of accessibility.

The Green Route Option provides an underbridge at both Castle Road and Killymoon Road, therefore maintaining the current level of accessibility. It must be highlighted that with the introduction of an underbridge at Castle Road, quite significant excavation of the existing drumlin is required, resulting in embankments of approximately 23m deep.

8.1.3.4. Severance

Mixing of strategic and local traffic would be significantly reduced for all route options, with a significant proportion of strategic traffic (which includes HGVs) bypassing the town centre, reducing the flow of traffic through Cookstown. The relief of some of the traffic on the urban road network may improve access to community facilities, with a reduction in vehicular/pedestrian conflict due to the easing of congestion. This would make the town more accessible, improving amenity and reducing community severance caused by traffic congestion for Cookstown residents.

8.1.3.5. Overall Social Ranking

1. Purple A Route Option
2. Green Route Option
3. Purple B Route Option
4. Red Route Option

8.1.4. ASSESSMENT AGAINST HIGH LEVEL SCHEME OBJECTIVES – PUBLIC ACCOUNTS OBJECTIVE

The information outlined in describes how the various route options would impact on the government, including costs incurred by central or local government bodies.

Table 8-3 – Summary of Public Accounts Affordability

	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Broad Transport Budget (2010)	£31.557m (3rd)	£30.572m (1st)	£30.630m (2nd)	£33.693m (4th)
Total Scheme Cost (Q3 2019)	£44.3m (3rd)	£42.8m (1st)	£42.8m (1st)	£47.7m (4th)
Proposed Route Option Affordability Ranking	3rd	1st	2nd	4th

Based on the above assessment, the Purple A and Purple B Route Options would be deemed to be the most deliverable routes when considering scheme cost and availability of government funding.

8.1.5. OVERALL RANKING OF ROUTE OPTIONS

Table 8-4 – Overall Ranking of Route Options

	Red Route Option	Purple A Route Option	Purple B Route Option	Green Route Option
Economy	1st	2nd	3rd	4th
Environment	3rd	1st	1st	4th
Social	4th	1st	3rd	2nd
Public Accounts	3rd	1st	2nd	4th
Overal Ranking	**3rd**	**1st**	**2nd**	**4th**

8.2. RECOMMENDATIONS

It is recommended that the Purple A Route Option along with Sandholes Link Road is taken forward as the Preferred Option. This combination is preferable in terms of environment, social and public accounts, second on economy and therefore should progress to Stage 3 of the Scheme Assessment Process.

At Stage 3 the following should be given further consideration;

- Road Safety: a review of the junction strategy at Castle Road.
- Climate Change: assess and mitigate the impact of the scheme on the environment.
- Active Travel: assess how the scheme interacts with other modes of transport.
- Alignment optimisation:
  - A review of the alignment to reduce severance and improve the usability of residual land separated by the route.
  - Review the cut slope signature using a targeted Geotechnical Investigation;
  - Maximise the cut fill balance to reduce carbon and environmental impacts.
- Consultation: further consultation should be undertaken with,
  - All relevant Statutory bodies,
  - Affected landowners and other relevant parties to mitigate impacts of the scheme,
  - Statutory Undertakers to develop utility diversions where necessary.

Appendix A

DRAWINGS

Public

Drawing Reference	Drawing Title
718314-WSP-B-D-0000-0038	Stage 2 – All Route Options Scheme Overview and Existing Road Network
718314-WSP-B-D-0100-0002	Stage 2 – Red Route C2 Inquiry NIE Utilities
718314-WSP-B-D-0100-0003	Stage 2 – Purple A Route C2 Inquiry NIE Utilities
718314-WSP-B-D-0100-0004	Stage 2 – Purple B Route C2 Inquiry NIE Utilities
718314-WSP-B-D-0100-0005	Stage 2 – Sandholes Link Road C2 Inquiry NIE Utilities
718314-WSP-B-D-0100-0006	Stage 2 – Red Route C2 Inquiry NIW Utilities
718314-WSP-B-D-0100-0007	Stage 2 – Purple A Route C2 Inquiry NIW Utilities
718314-WSP-B-D-0100-0008	Stage 2 – Purple B Route C2 Inquiry NIE Utilities
718314-WSP-B-D-0100-0009	Stage 2 – Sandholes Link Road C2 Inquiry NIE Utilities
718314-WSP-B-D-0100-0010	Stage 2 – Red Route C2 Inquiry Existing Communications
718314-WSP-B-D-0100-0011	Stage 2 – Purple A Route C2 Inquiry Existing Communications
718314-WSP-B-D-0100-0012	Stage 2 – Purple B Route C2 Inquiry Existing Communications
718314-WSP-B-D-0100-0013	Stage 2 – Sandholes Link Road C2 Inquiry Existing Communications
718314-WSP-B-D-0100-0014	Stage 2 – Red Route C2 Inquiry Existing Misc Utilities
718314-WSP-B-D-0100-0015	Stage 2 – Purple A Route C2 Inquiry Existing Misc Utilities
718314-WSP-B-D-0100-0016	Stage 2 – Purple B Route C2 Inquiry Existing Misc Utilities
718314-WSP-B-D-0100-0017	Stage 2 – Sandholes Link Road C2 Inquiry Existing Misc Utilities
718314-WSP-B-D-0100-0018	Stage 2 – Green Route C2 Inquiry NIE Utilities
718314-WSP-B-D-0100-0019	Stage 2 – Green Route C2 Inquiry NIW Utilities
718314-WSP-B-D-0100-0020	Stage 2 – Green Route C2 Inquiry Misc Utilities
718314-WSP-B-D-0100-0021	Stage 2 – Green Route C2 Inquiry NIE Existing Communications
718314-WSP-B-D-0500-0014	Stage 2 – Red Route Option Watercourses and Floodplains
718314-WSP-B-D-0500-0015	Stage 2 – Purple A Route Option Watercourses and Floodplains
718314-WSP-B-D-0500-0016	Stage 2 – Purple B Route Option Watercourses and Floodplains
718314-WSP-B-D-0500-0017	Stage 2 – Sandholes Link Road Watercourses and Floodplains
718314-WSP-B-D-0500-0018	Stage 2 – Red Route Preliminary Drainage Design Sheet 1
718314-WSP-B-D-0500-0019	Stage 2 – Red Route Preliminary Drainage Design Sheet 2
718314-WSP-B-D-0500-0020	Stage 2 – Red Route Preliminary Drainage Design Sheet 3
718314-WSP-B-D-0500-0021	Stage 2 – Purple A Route Preliminary Drainage Design Sheet 1
718314-WSP-B-D-0500-0022	Stage 2 – Purple A Route Preliminary Drainage Design Sheet 2
718314-WSP-B-D-0500-0023	Stage 2 – Purple A Route Preliminary Drainage Design Sheet 3
718314-WSP-B-D-0500-0024	Stage 2 – Purple B Route Preliminary Drainage Design Sheet 1
718314-WSP-B-D-0500-0025	Stage 2 – Purple B Route Preliminary Drainage Design Sheet 2
718314-WSP-B-D-0500-0026	Stage 2 – Purple B Route Preliminary Drainage Design Sheet 3
718314-WSP-B-D-0500-0027	Stage 2 – Sandholes Link Road Preliminary Drainage Design
718314-WSP-B-D-0500-0028	Stage 2 – Green Route Preliminary Drainage Design Sheet 1

Drawing Reference	Drawing Title
718314-WSP-B-D-0500-0029	Stage 2 – Green Route Preliminary Drainage Design Sheet 2
718314-WSP-B-D-0500-0030	Stage 2 – Green Route Preliminary Drainage Design Sheet 3
718314-WSP-B-D-0500-0031	Stage 2 – Green Route Option Watercourses and Floodplains
718314-WSP-B-D-0600-0001	Stage 2 – All Route Options Geotechnical Constraints Plan
718314-WSP-B-D-0600-0006	Drift Geology
718314-WSP-B-D-0600-0007	Solid Geology
718314-WSP-B-D-0800-0097	Typical Carriageway Cross-sections Sheet 1
718314-WSP-B-D-0800-0098	Typical Carriageway Cross-sections Sheet 2
718314-WSP-B-D-0800-0099-	Stage 2 – Red Route Mainline Plan and Profile Sheet 1
718314-WSP-B-D-0800-0100	Stage 2 – Red Route Mainline Plan and Profile Sheet 2
718314-WSP-B-D-0800-0101	Stage 2 – Red Route Mainline Plan and Profile Sheet 3
718314-WSP-B-D-0800-0102	Stage 2 – Red Route Mainline Plan and Profile Sheet 4
718314-WSP-B-D-0800-0103	Stage 2 – Red Route Mainline Plan and Profile Sheet 5
718314-WSP-B-D-0800-0104	Stage 2 – Red Route Castle Road Left In-Left Out Plan and Profile
718314-WSP-B-D-0800-0105	Stage 2 – Red Route Killymoon Left In-Left Out Plan and Profile
718314-WSP-B-D-0800-0106	Stage 2 – Red Route B73 Coagh Road Underbridge Plan and Profile
718314-WSP-B-D-0800-0107	Stage 2 – Red Route Old Coagh Road Underbridge Plan and Profile
718314-WSP-B-D-0800-0108	Stage 2 – Red Route A29 Moneymore Road Dualling Plan and Profile
718314-WSP-B-D-0800-0109	Stage 2 – Purple A Route Mainline Plan and Profile Sheet 1
718314-WSP-B-D-0800-0110	Stage 2 – Purple A Route Mainline Plan and Profile Sheet 2
718314-WSP-B-D-0800-0111	Stage 2 – Purple A Route Mainline Plan and Profile Sheet 3
718314-WSP-B-D-0800-0112	Stage 2 – Purple A Route Mainline Plan and Profile Sheet 4
718314-WSP-B-D-0800-0113	Stage 2 – Purple A Route Mainline Plan and Profile Sheet 5
718314-WSP-B-D-0800-0114	Stage 2 – Purple A Route Mainline Plan and Profile Sheet 6
718314-WSP-B-D-0800-0115	Stage 2 – Purple A Route Castle Road Left In-Left Out Plan and Profile
718314-WSP-B-D-0800-0116	Stage 2 – Purple A Route Killymoon Road Overbridge Plan and Profile
718314-WSP-B-D-0800-0117	Stage 2 – Purple A Route B73 Coagh Road Underbridge Plan and Profile
718314-WSP-B-D-0800-0118	Stage 2 – Purple A Route Old Coagh Road Underbridge Plan and Profile
718314-WSP-B-D-0800-0119	Stage 2 – Purple A Route A29 Moneymore Road Dualling Plan and Profile
718314-WSP-B-D-0800-0120	Stage 2 – Purple B Route Mainline Plan and Profile Sheet 1
718314-WSP-B-D-0800-0121	Stage 2 – Purple B Route Mainline Plan and Profile Sheet 2
718314-WSP-B-D-0800-0122	Stage 2 – Purple B Route Mainline Plan and Profile Sheet 3
718314-WSP-B-D-0800-0123	Stage 2 – Purple B Route Mainline Plan and Profile Sheet 4

Drawing Reference	Drawing Title
718314-WSP-B-D-0800-0124	Stage 2 – Purple B Route Mainline Plan and Profile Sheet 5
718314-WSP-B-D-0800-0125	Stage 2 – Purple B Route Mainline Plan and Profile Sheet 6
718314-WSP-B-D-0800-0126	Stage 2 – Purple B Route Mainline Plan and Profile Sheet 7
718314-WSP-B-D-0800-0127	Stage 2 – Purple B Route Castle Road Left-In-Left Out Plan and Profile
718314-WSP-B-D-0800-0128	Stage 2 – Purple B Route Killymoon Road Overbridge Plan and Profile
718314-WSP-B-D-0800-0129	Stage 2 – Purple B Route B73 Coagh Road Underbridge Plan and Profile
718314-WSP-B-D-0800-0130	Stage 2 – Purple B Route Old Coagh Road Underbridge Plan and Profile
718314-WSP-B-D-0800-0131	Stage 2 – Sandholes Link Road Plan and Profile
718314-WSP-B-D-0800-0132	Stage 2 – Red Route Proposed Molesworth Road Plan and Profile
718314-WSP-B-D-0800-0164	Stage 2 – SAR1 Assessment Corridors
718314-WSP-B-D-0800-0165	Stage 2 – All Routes Existing Structures
718314-WSP-B-D-0800-0191	Stage 2 – Green Route Mainline Plan and Profile Sheet 1
718314-WSP-B-D-0800-0192	Stage 2 – Green Route Mainline Plan and Profile Sheet 2
718314-WSP-B-D-0800-0193	Stage 2 – Green Route Mainline Plan and Profile Sheet 3
718314-WSP-B-D-0800-0194	Stage 2 – Green Route Mainline Plan and Profile Sheet 4
718314-WSP-B-D-0800-0195	Stage 2 – Green Route Mainline Plan and Profile Sheet 5
718314-WSP-B-D-0800-0196	Stage 2 – Green Route Mainline Plan and Profile Sheet 6
718314-WSP-B-D-0800-0197	Stage 2 – Green Route Castle Road Overbridge Plan and Profile
718314-WSP-B-D-0800-0198	Stage 2 – Green Route Killymoon Road Overbridge Plan and Profile
718314-WSP-B-D-0800-0199	Stage 2 – Green Route B3 Coagh Road Underbridge Plan and Profile
718314-WSP-B-D-0800-0200	Stage 2 – Green Route Old Coagh Road Underbridge Plan and Profile
718314-WSP-B-D-0800-0201	Stage 2 – Green Route A29 Moneymore Road Dualling Plan and Profile
718314-WSP-B-D-0800-0216	Stage 2 – Purple B Route A29 Moneymore Road Plan and Profile
718314-WSP-B-D-3000-0128	Stage 2 – All Routes Landscape Analysis
718314-WSP-B-D-3000-0129	Stage 2 – All Routes Visual Receptor
718314-WSP-B-D-3000-0130	Stage 2 – All Routes Key Viewpoint Photographs Sheet 1
718314-WSP-B-D-3000-0131	Stage 2 – All Routes Key Viewpoint Photographs Sheet 2
718314-WSP-B-D-3000-0132	Stage 2 – All Routes Key Viewpoint Photographs Sheet 3
718314-WSP-B-D-3000-0133	Stage 2 – All Routes Key Viewpoint Photographs Sheet 4
718314-WSP-B-D-3000-0134	Stage 2 – All Routes Key Viewpoint Photographs Sheet 5
718314-WSP-B-D-3000-0135	Stage 2 – All Routes Key Viewpoint Photographs Sheet 6
718314-WSP-B-D-3000-0136	Stage 2 – All Routes Landscape Character Photographs Sheet 1
718314-WSP-B-D-3000-0137	Stage 2 – All Routes Landscape Character Photographs Sheet 2

Drawing Reference	Drawing Title
718314-WSP-B-D-3000-0138	Stage 2 – All Routes Population and Health Sensitive Receptors
718314-WSP-B-D-3000-0162	Stage 2 – All Routes International Designated Sites
718314-WSP-B-D-3000-0163	Stage 2 – All Routes National Designated Sites
718314-WSP-B-D-3000-0164	Stage 2 – All Routes Non-Statutory Designated Sites
718314-WSP-B-D-3000-0165	Stage 2 – All Routes Ecological Features of Interest
718314-WSP-B-D-3000-0166	Stage 2 – All Routes Cultural Heritage Overview
718314-WSP-B-D-3000-0167	Stage 2 – All Routes Hydrology Overview
718314-WSP-B-D-3000-0168	Stage 2 – All Routes Hydrogeology
718314-WSP-B-D-3000-0169	Stage 2 – All Routes Detailed Hydrology and Hydrogeology
718314-WSP-B-D-3000-0170	Stage 2 – All Routes Water Framework Directive Surface Watercourse and Groundwater Overview
718314-WSP-B-D-3000-0176	Stage 2 – All Routes Cultural Heritage Sheet 5
718314-WSP-B-D-3000-0177	Stage 2 – All Routes Cultural Heritage Sheet 4
718314-WSP-B-D-3000-0178	Stage 2 – All Routes Cultural Heritage Sheet 3
718314-WSP-B-D-3000-0179	Stage 2 – All Routes Cultural Heritage Sheet 1
718314-WSP-B-D-3000-0180	Stage 2 – All Routes Cultural Heritage Sheet 2
718314-WSP-B-D-3000-0181	Stage 2 – All Routes Construction Noise Assessment 100m Earthworks Buffers
718314-WSP-B-D-3000-0182	Stage 2 – All Routes Operational Noise Assessment Combined Study Area
718314-WSP-B-D-3000-0194	Stage 2 – All Routes Noise Monitoring Locations Overview
718314-WSP-B-D-3000-0195	Stage 2 – All Routes Noise Monitoring Locations Sheet 1
718314-WSP-B-D-3000-0196	Stage 2 – All Routes Noise Monitoring Locations Sheet 2
718314-WSP-B-D-3000-0197	Stage 2 – All Routes Noise Monitoring Locations Sheet 3
718314-WSP-B-D-3000-0198	Stage 2 – All Routes Noise Monitoring Locations Sheet 4
718314-WSP-B-D-3000-0199	Stage 2 – Red and Sandholes Route Options Construction Stage Assessment – Construction Dust Assessment Study Area – Red & SHL
718314-WSP-B-D-3000-0200	Stage 2 – Purple A and Sandholes Route Options Construction Stage Assessment – Construction Dust Assessment Study Area – Purple A & SHL
718314-WSP-B-D-3000-0201	Stage 2 – Purple B and Sandholes Route Options Construction Stage Assessment – Construction Dust Assessment Study Area – Purple B & SHL
718314-WSP-B-D-3000-0202	Stage 2 – Green and Sandholes Route Options Construction Stage Assessment – Construction Dust Assessment Study Area – Green & SHL
718314-WSP-B-D-3000-0203	Stage 2 – Red and Sandholes Route Options Construction Stage Assessment – Operational Stage Assessment Affected Road Network – Red & SHL

Drawing Reference	Drawing Title
718314-WSP-B-D-3000-0204	Stage 2 – Purple A and Sandholes Route Options Construction Stage Assessment – Operational Stage Assessment Affected Road Network – Purple A & SHL
718314-WSP-B-D-3000-0205	Stage 2 – Purple B and Sandholes Route Options Construction Stage Assessment – Operational Stage Assessment Affected Road Network – Purple B & SHL
718314-WSP-B-D-3000-0206	Stage 2 – Green and Sandholes Route Options Construction Stage Assessment – Operational Stage Assessment Affected Road Network – Green & SHL
718314-WSP-B-D-3000-0207	Stage 2 – All Route Options Operational Stage Assessment Study Area
718314-WSP-B-D-3000-0208	Stage 2 – All Route Options Air Quality Monitoring Locations in Operational Study Area
718314-WSP-B-D-3000-0209	Stage 2 – Sandholes Route Options Operational Stage Assessment – Ecological Assessment - Upper Ballinderry ASSI / SAC
718314-WSP-B-D-3000-0210	Stage 2 – All Route Options Compliance Risk Assessment – DEFRA PCM Links in Operational Stage Study Area
718314-WSP-B-D-3000-0211	Stage 2 – All Route Options Location of Developments Considered for Cumulative Effects

Appendix B

SUPPLEMENTARY ENVIRONMENTAL INFORMATION

Public

Public

Appendix C

APPRAISAL SUMMARY TABLE (AST)

Public

wsp.com
Shorefield House
30 Kinnegar Drive
Holywood
County Down
BT18 9JQ