URS

York Street Interchange

Preferred Options Report: Volume 1

Report

22 October 2012

47037827 / S105296

Prepared for:
DRD Roads Service

UNITED
KINGDOM &
IRELAND




REVISION SCHEDULE					
Rev	**Date**	**Details**	**Prepared by**	**Reviewed by**	**Approved by**
0	22 Oct. 2012	First Issue	John McBride Engineer	Michael Megarry Principal Engineer	Kenneth O'Hara Technical Director
			Graham McFarland Senior Engineer		
			Ali Bastekin Technical Director		
			Philip Heyburn Associate		
			Gareth Coughlin Principal Environmental Scientist		
			Russell Bissland Technical Director		

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URS Project Number

URS project number (up to 31 May 2011): S105296
URS project number (from 31 May 2011): 47037827

EXECUTIVE SUMMARY

The city of Belfast is Northern Ireland's major transport hub and the main transport gateway to the rest of the United Kingdom and Europe. It is the focal point for a number of the Key Transport Corridors that collectively form part of the strategic road network managed by Roads Service. The strategic road network, along with the rail network, forms Northern Ireland's overall Regional Strategic Transport Network.

The Key Transport Corridors within Northern Ireland provide connection to other major European cities through the region's gateways. These gateways include the Northern Ireland's airports and sea ports. The Eastern Seaboard Key Transport Corridor runs through Belfast and provides connections to the regional gateways of the International/European Port of Belfast and the George Best Belfast City Airport within the Belfast Metropolitan Urban Area. Within the Belfast Metropolitan Urban Area, the Eastern Seaboard Key Transport Corridor comprises the M1 motorway, the Westlink and the M2 motorway. The importance of the Eastern Seaboard Key Transport Corridor and its component roads is recognised by the European Commission in its designation of the corridor as part of the Priority 9, 13 and 26 axes within the Trans-European Transport Network.

The existing York Street junction is a node on the Eastern Seaboard Key Transport Corridor located to the north of Belfast city centre. At this node, strategic traffic movements on the Eastern Seaboard Key Transport Corridor conflict with traffic movements to and from the M3 motorway and local traffic movements into and out of Belfast city centre. The conflict between strategic and local traffic movements is presently controlled by a complex arrangement of traffic signals that includes four signalised junctions at York Street, York Link, Nelson Street and Great George's Street. The overall signalised "box" created by these four signalised junctions is known as the York Street junction.

The capacity of the existing York Street junction is limited by both the magnitude of competing traffic flows and the various physical constraints at the location. These physical constraints include adjacent residential housing, commercial, retail and industrial properties, elevated rail infrastructure carried on the Dargan Bridge and the capacity of existing roads infrastructure including the Westlink, the M2 motorway and the elevated M3 motorway carried on the Lagan Bridge.

The lack of capacity at the junction causes undue congestion and thereby delays for freight, public transport and private vehicles. It is therefore considered a bottleneck on the strategic road network in accordance with the definition established by Northern Ireland's Regional Transportation Strategy.

Improvements to the strategic road network have been established in Northern Ireland policy through the publication of the Regional Development Strategy and the Regional Transportation Strategy. These strategies are implemented in local policy through the Regional Strategic Transport Network Transport Plan, the Belfast Metropolitan Transport Plan and the Investment Strategy for Northern Ireland. These regional strategies together with the local policy publications were based on the Guidance on the Methodology for Multi-Modal Studies, an objective led approach to seeking solutions to transport-related problems and were prepared in consultation with and informed by stakeholders. As stated in the Regional Strategic Transport Network Transport Plan, these high-level objectives are:

- Environment – to protect the natural and built environment
- Safety – to improve safety
- Economy – to improve sustainable economic activity and get good value for money
- Accessibility – to improve access to facilities for people with disabilities and those without a car and to reduce severance
- Integration – to ensure that all decisions are taken in the context of the Government's integrated transport policy.

Strategic Road Improvements (SRIs) are managed by Roads Service through its SRI Programme. This Programme was expanded in 2006 in response to the identification of an additional £400M by the Northern Ireland Executive in 2005 to facilitate its Investment Strategy for the period 2005 to 2015. The expansion of the SRI Programme followed a period of consultation with the wider community in 2006 further to the publication of a consultation document and a draft Environmental Report. At that time, the York Street Interchange was proposed as an additional SRI scheme termed the Westlink/York Street flyover to alleviate congestion at the existing junction and assessed in both these published documents. Following this process of consultation, the expanded SRI Programme, including this scheme, was adopted and formalised by its inclusion in the published Investment Strategy for Northern Ireland 2008 to 2018.

In 2008, URS was commissioned by Roads Service to assist in the development of the scheme to a point where a Preferred Option could be selected. This commission includes the completion of Scheme Assessments in accordance with the procedures established by the Design Manual for Roads and Bridges. These procedures require the assessment of the engineering, environmental, traffic and economic advantages and disadvantages of the scheme at various stages in the scheme’s development.

In March 2009, URS completed its Stage 1 Scheme Assessment to broadly identify the advantages and disadvantages of the scheme. The findings from the assessment were reported in the Preliminary Options Report of March 2009 that identified that the proposed scheme would provide significant benefits to the region. The report recommended the shortlisting of four of the identified six Preliminary Options and this recommendation was endorsed by the Roads Service Board at its meeting of 26 March 2009.

The project team have subsequently taken forward four of the six Preliminary Options for further assessment in line with the recommendations of the Preliminary Options Report. The engineering designs of the options have been developed in more detail through consultations with various statutory and non-statutory bodies, with a formal public consultation period held in June 2011 to allow members of the public to view and comment upon the proposals.

The developed four options, termed Options A, B, C and D, propose the introduction of grade separation at the existing junction using various alignments.

Option A proposes the partial grade separation of movements between the Westlink and M2, with a grade separated Westlink to M3 movement. Grade separation is provided via alignments in underpasses below the existing Lagan Bridge carrying the M3 and the Dargan Bridge carrying the railway line. York Street would be partially raised to accommodate the underlying links. The M3 to Westlink movement however remains subject to signal control at Nelson Street and York Street. All north facing sliproads at Clifton Street remain open in the proposed layout.

Option B proposes the full grade separation of movements between the Westlink, M2 and M3. Grade separation is provided via alignments in both underpasses below and overbridges above, the Lagan Bridge and Dargan Bridge. York Street would be raised relative to its current position to facilitate the underlying links, with the overbridges spanning over the street. All north facing sliproads at Clifton Street remain open in the proposed layout.

Option C proposes the full grade separation of movements between the Westlink, M2 and M3. Grade separation is provided via underpasses below the Lagan Bridge and Dargan Bridge. York Street would be partially raised to accommodate the underlying links. All north facing sliproads at Clifton Street remain open in the proposed layout.

Option D proposes the partial grade separation of movements between the Westlink, M2 and M3. The movements between the Westlink and M2 in both directions are proposed via road alignments on overbridges above the Lagan Bridge and Dargan Bridge. A grade-separated M3 to Westlink movement would be provided with an overbridge above York Street. The provision of links between the Westlink and M2 allows York Street to remain at its current level, minimising the works required at the junction. However, it is not possible to grade separate the Westlink to M3 movement in this option, with the movement subject to signal control at York Street and Nelson Street. To facilitate the proposed Westlink to York Street slip road, to facilitate the Westlink to M3 movement, it is necessary to close the northbound on-slip from Clifton Street, in the direction of the M2 and M3. The off-slip from Westlink to Clifton Street remains open.

A Design Manual for Roads and Bridges (DMRB) Stage 2 Scheme Assessment has been carried out on the four options for the scheme and this report presents a summary of the assessment as follows:

- **Section 1** of this report presents an introduction and background to the scheme. The scheme's objectives are described along with a review of the scheme's strategic context in relation to the region's transport strategy and policy.
- **Section 2** provides assessment of the existing conditions within the study area including engineering, environmental and traffic conditions and relevant local policies and plans affecting the study area.
- **Section 3** sets out the background to the development of the Options and the consideration of alternative layouts.
- **Section 4** includes consultation with statutory authorities and other interested bodies as well as details of a public consultation held.
- **Section 5** provides an engineering assessment of the various Options considered.
- **Section 6** provides an environmental assessment of the Options identified.
- **Section 7** includes a traffic and economic assessment of the Options identified.
- **Section 8** summarises the key issues and sets out the recommendations, based on the assessed performance of the Options against the scheme objectives.

The economic assessment has found that Option D would not provide economic benefits to the region if selected as the Preferred Option. The assessed economic disbenefits for Option D outweigh its assessed benefits by a ratio of approximately 2:1. It is considered that the proposed closure of the Clifton Street on-slip and the resulting reassignment of traffic onto the Inner Ring contribute to its assessed economic performance. In light of the economic findings, it is recommended that Option D is not selected as the Preferred Option for the scheme.

The assessed economic performance of Options A, B and C is positive, with all the remaining options presenting an overall economic benefit if selected as the Preferred Option for the scheme.

To distinguish the options, the scheme objectives have been reviewed with the findings from the engineering, environmental, traffic and economic assessments. Views on the scheme options expressed in response to the public consultation have been also taken into account. The review has found that the options perform at a broadly similar level, with each option having respective advantages and disadvantages.

Taking into consideration its overall performance across the scheme objectives and the views raised in response to the public consultation, it is recommended that Option C is selected as the Preferred Option by Roads Service.

The option should be further developed in line with the engineering standards set out in the DMRB to a level sufficient for a Stage 3 Scheme Assessment

In developing the option further, the following engineering and operational issues should be given further consideration:

- The potential reintroduction of two-way running on York Street to provide a southbound lane. The use of the southbound lane should reflect Roads Service transport policy for the Belfast City Centre.

- The protection of the underpass, so that it remains operational during a Q_{100} river flood event or a Q_{200} coastal flood event.
- The links and junctions identified to be over-capacity in the 2034 design year by the traffic and economic assessment.
- The proposed drainage system and outfall arrangements, in consultation with NI Water.
- The operational capacity of the interchange, through specialist micro-simulation modelling.
- The engineering solutions to the proposed underpasses and bridges, through consultation with specialist contractors.
- The proposed replacement of the retaining walls on Little George’s Street and Great George’s Street.
- The proposed diversion of existing utilities, through consultation with the various utility providers.
- The temporary traffic management measures required to build the scheme whilst mitigating disruption to road users.

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1 INTRODUCTION

1.1 The Brief

A York Street Interchange is proposed by Roads Service as a long-term Strategic Road Improvement (SRI) scheme to improve links from the A12 Westlink, “the Westlink”, to the M2 Motorway, “the M2”, and M3 Motorway, “the M3” in Belfast. The existing at-grade signalised York Street junction links the Westlink, the M2 and the M3 through a complex arrangement of traffic signals that interface with the surface street network that includes York Street, York Link, Great George’s Street and Nelson Street. Road users currently experience long delays and congestion at peak periods travelling through this signalised gyratory system. The scheme is strategic in nature and is considered necessary in the longer term for the development of the Belfast Metropolitan Area (BMA) beyond 2015.

The general location plan of the existing York Street junction relative to the surrounding strategic road network in the BMA is shown in **Figure 1.1.1**. The general study area is shown in **Figure 1.1.2**.

Scott Wilson was appointed in June 2008 to take forward Design Manual for Roads and Bridges (DMRB) Stage 1 and Stage 2 Scheme Assessments for a proposed scheme to alleviate congestion in the vicinity of the York Street junction.

It should be noted that Scott Wilson were acquired by URS in September 2010 and became part of URS Corporation. For the avoidance of doubt, references to URS forthwith in this report include, inter-alia, references to the former Scott Wilson group of companies.

In undertaking the commission, the following activities were identified by Roads Service:

- analysis of the existing junction
- DMRB Stage 1 Scheme Assessment
- preparation of a DMRB Technical Directive (TD) 37/93 Stage 1 Scheme Assessment Report (the “Preliminary Options Report”)
- DMRB Stage 2 Scheme Assessment
- preparation of a DMRB Technical Directive (TD) 37/93 Stage 2 Scheme Assessment Report (the “Preferred Options Report”).

A copy of the Project Brief received from Roads Service is included in **Appendix A** of this report.

The information to be reviewed included the 2005 “York Street Interchange Preliminary Appraisal Report”, the 2005 “M1/Westlink/M2/M3 York Street Improvements Traffic Management Options Final Report”, historical accident data, traffic conditions and journey time information along the existing network.

The analysis of the existing junction was to include an examination of existing baseline conditions to establish road geometry, traffic flows and environmental conditions.

In April 2008 a programme of traffic surveys were undertaken at the existing junction to quantify strategic trip patterns and daily demand, including Manual Classified Counts (MCCs) and Automatic Traffic Counts (ATCs). In parallel, a pool of conceptual designs for the scheme was developed and ultimately shortlisted to six Preliminary Options that were considered feasible within the constraints of the site. The six Preliminary Options were then subject to a Stage 1 Scheme Assessment, comprising separate engineering, environmental, traffic and economic assessments as required by the DMRB. The findings from the assessment process were reported in the Preliminary Options Report published in March 2009, along with a recommendation to shortlist four of the six Preliminary Options on the basis of their assessed performance.

The recommendations of the Preliminary Options Report were ratified by the Roads Service Board, with Preliminary Options 1, 2, 4 and 6 taken forward for further development and assessment. This report details the subsequent development of the options, now termed Options A, B, C and D and the findings of the Stage 2 Scheme Assessment process.

1.2 Report Structure

This Preferred Options Report has been prepared in accordance with the general requirements for a Stage 2 Scheme Assessment Report set out in DMRB TD 37/93 entitled “Scheme Assessment Reporting” (DMRB 5.1.2) and the Project Brief. The report is structured to cover the primary elements of the DMRB Stage 2 Scheme Assessment reporting from the review of existing conditions to the identification and assessment of potential scheme options.

Section 2 provides assessment of the existing conditions within the study area including engineering, environmental and traffic conditions, and relevant local policies and plans affecting the study area. **Section 3** sets out the background to the development of the Options and the consideration of alternative layouts. **Section 4** provides an engineering assessment of the various Options considered. **Section 5** includes consultation with statutory authorities and other interested bodies as well as details of a risk management workshop held. **Section 6** provides an environmental assessment of the Options identified. **Section 7** includes a traffic and economic assessment of the Options identified. **Section 8** summarises the key issues and sets out the recommendations.

Appendices to the report are included within **Volume 2**, whilst the Assessment Summary Tables referred to in **Section 8** included in the separately published **Volume 3**. Engineering Drawings referenced in **Section 2**, **Section 3** and **Section 5** of this report are also published in **Volume 3** along with the various Figures referenced in **Section 1**, **Section 6** and **Section 7** of this report.

1.3 Scheme Objectives

1.3.1 *High Level Objectives*

The objectives for the scheme at a high-level reflect the Government’s five main objectives for transport outlined in its 1998 White Paper entitled “A New Deal for Transport: Better for Everyone”[1] and detailed in the Regional Strategic Transport Network Transport Plan 2015[2] as:

- Environment - to protect the built and natural environment
- Safety - to improve safety
- Economy - to support sustainable economic activity and get good value for money
- Accessibility - to improve access to facilities for people with disabilities and those without a car and to reduce severance
- Integration - to ensure that all decisions are taken in the context of the Government’s integrated transport policy.

[1] "A New Deal for Transport: Better For Everyone" CM3950, ISBN 0 10 139502 7. July 1998.
[2] “Regional Strategic Transport Network Transport Plan 2015”, Department for Regional Development (DRD). March 2005.

1.3.2 *Scheme Specific Objectives*

The following scheme specific objectives have been identified:

- to remove a bottleneck on the strategic road network
- to deliver an affordable solution to reduce congestion on the strategic road network
- to improve reliability of strategic journey times for the travelling public
- to improve access to the regional gateways from the Eastern Seaboard Key Transport Corridor
- to maintain access to existing properties, community facilities and commercial interests
- to maintain access for pedestrians and cyclists
- to improve separation between strategic and local traffic.

These high-level and specific objectives have been used in the development of the Preferred Options ahead of their assessment.

1.4 Strategic Context

1.4.1 *Northern Ireland Policy*

The Government's White Paper entitled "A New Deal for Transport: Better for Everyone" published in 1998 outlines out its five key objectives for sustainable transport systems as described in **Section 1.3.1**.

In response to this White Paper, the "Moving Forward: The Northern Ireland Transport Policy Statement" published in 1998 outlined a strategy for implementing the Government's objectives in the special context of Northern Ireland. This informed the Regional Strategies for Northern Ireland set out in **Section 1.4.2**.

1.4.2 *Regional Strategies*

1.4.2.1 *The Regional Development Strategy (RDS) 2035 – Building a Better Future*

1.4.2.1.1 *Overview*

The RDS (2035) provides an overarching strategic planning framework to facilitate and guide the public and private sectors. It does not redefine the other Government Departments' strategies but compliments them with a spatial perspective. It revises the original RDS 2025 strategy published in 2001 and amended in 2008 and whilst many of the objectives of the previous strategy are still valid, this document now replaces it.

The RDS influences various government strategies including:

- the Programme for Government (PfG)
- the Investment Strategy for Northern Ireland (ISNI).

The Strategy takes account of key driving forces such as population growth and movement, demographic change, the increasing number of households, transportation needs, climate change and the spatial implications of divisions that still exist in our society. It is a framework which provides the strategic context for where development should happen, however it does not contain operational planning policy which is issued through Planning Policy Statements (PPSs) published by the Department of the Environment (DOE).

The RDS has a statutory basis under the Strategic Planning (Northern Ireland) Order 1999, which requires Government Departments to "have regard to the Regional Development Strategy" in exercising any functions in relation to development.

1.4.2.1.2 ***Key Elements***

The Strategy has four key elements:

- a **Spatial Framework** which divides the region into 5 components based on functions and geography
- **Guidance** at two levels:
  - a) Regional level that is to be applied to all parts of the region
  - b) Specific guidance for each element of the Spatial Framework
- a **Regionally Significant Economic Infrastructure** section which identifies the need to consider strategic infrastructure projects
- **Implementation** which sets out how the strategy will be implemented.

1.4.2.1.3 ***Aims***

The eight aims of the revised RDS are to:

1) Support strong, sustainable growth for the benefit of all parts of Northern Ireland
2) Strengthen Belfast as the regional economic driver and Londonderry as the principal city of the North West
3) Support our towns, villages and rural communities to maximise their potential
4) Promote development which improves the health and wellbeing of communities
5) Improve connectivity to enhance the movement of people, goods, energy and information between places
6) Protect and enhance the environment for its own sake
7) Take actions to reduce our carbon footprint and facilitate adaption to climate change
8) Strengthen links between north and south, east and west, with Europe and the rest of the world.

1.4.2.1.4 ***Spatial Framework***

Implementation of the vision and aims of the RDS requires a Spatial Framework to enable strategic choices to be made in relation to development and infrastructural investment. The key issues which influenced the Spatial Framework within the RDS are the:

- importance of Belfast City, at the heart of a Metropolitan area, as the major driver for regional economic growth; its population has declined but it remains the regional focus for administration, commerce, specialised services and cultural amenities
- significant role which Londonderry has to play as the principal city of an expanding North West region; its recognition as the UK City of Culture 2013, will add impetus to the integrated approach to regeneration being taken forward in the 'One Plan' (One City One Plan One Voice: Regeneration Plan for Derry~Londonderry)
- importance of Main Hubs and Clusters well placed to benefit from and add value to regional economic growth; and that critical mass to attract growth can be created by the identification of clusters.

- need to build on the approach to urban renaissance of developing compact urban form by further integrating key land uses with transportation measures. The focus should be on the use of land within existing urban footprints, particularly within the hubs
- new emphasis on how to reduce dependence on the car and change travel behaviour
- importance in all aspects of forward planning to address the consequences of climate change; this means an even greater focus on where people live and work and how transport and energy needs are planned.

Chapter 3 of the RDS sets out the strategic guidance specific to these areas, focusing on the key principles of the economy, society and the environment. The guidance is also split into Regional Guidance (**RG**) and Spatial Framework Guidance **(SFG**) some of which is specifically applicable to the proposed scheme as described in **Sections 1.4.2.1.5 and 1.4.2.1.6**.

1.4.2.1.5 ***Regional Guidance***

Economy

RG2: Deliver a balanced approach to transport infrastructure – the focus of this guidance is on managing the use of the road and rail space and how it can be used in a better, smarter way. The New Approach to Regional Transportation develops this guidance further (as noted in **Section 1.4.2.3**). In accordance with this guidance, this proposed scheme should aim to:

- improve connectivity
- maximise the potential of the Regional Strategic Transport Network
- use road space and railways more efficiently
- improve social inclusion
- manage the movement of freight
- improve access to our cities and towns
- improve safety by adopting a 'safe systems' approach to road safety.

Society

RG7: Support urban and rural renaissance – in urban areas this guidance focuses on the process of development and redevelopment in urban areas to attract investment and activity, foster revitalisation and improve the mix of uses. In accordance with this guidance, this proposed scheme should aim to:

- reduce noise pollution.

Environment

RG7: Reduce our carbon footprint and facilitate mitigation and adaptation to climate change whilst improving air quality – this guidance focuses on reducing air pollution and greenhouse gas emissions and preparing for the impacts of climate change. These include the effects on species and habitats and on health as a result of warmer temperatures, storms, floods and coastal erosion. In accordance with this guidance, this proposed scheme should aim to:

- reduce greenhouse gas emissions from transport
- reduce noise and air pollution from transport

- use more energy efficient forms of transport
- protect Air Quality Management Areas.

RG11: Conserve, protect and, where possible, enhance our built heritage and our natural environment - in accordance with this guidance, the proposed scheme should provide effective care for the built and natural environment, in terms of improving health and well being, promoting economic development and addressing social problems which result from poor quality environment.

1.4.2.1.6 ***Spacial Framework Guidance***

The spatial framework has the following five components:

- The Metropolitan Area centred on Belfast
- Londonderry - principal city of the North West
- Hubs and Clusters of Hubs
- The Rural Area
- Gateways and corridors.

The Metropolitan Area centred on Belfast

The Belfast Metropolitan Urban Area (BMUA) at the centre of the regional transport network and the major gateway for national and international trade. The BMUA has a major role in the European network of City Regions with vital links to Dublin, Britain and continental Europe. Belfast's airports and sea port serve the Region as gateway links to the world.

SFG1: Promote urban economic development at key locations throughout the BMUA and ensure sufficient land is available for jobs - significant investment will be required to sustain and grow the BMUA. Employment opportunities should be planned in a way that recognises the roles that the component parts play; builds on planned regeneration initiatives and maximises the use of existing and planned infrastructure provision, including public transport.

SFG4: Manage the movement of people and goods within the BMUA - recognises that transport has a key role to play in developing competitive cities and regions. An efficient transport infrastructure is not only important for a successful economy but it can also help promote social inclusion by providing an affordable alternative to the private car.

SFG5: Protect and enhance the quality of the setting of the BMUA and its environmental assets - the BMUA has a significant natural setting surrounded by hills. It is important to recognise the significance of the existing environmental assets and protected areas of high scenic value.

Gateways and Corridors

Gateways are strategically important transport interchanges which are important for economic development, freight distribution activities and additional employment generation. The quality of connection from the air and sea ports to the internal transport network is crucial for economic competitiveness and the convenience of the travelling public.

Belfast is the major Regional City Gateway with the principal sea port of Northern Ireland and a city airport. In 2009 the sea port handled approximately 1.3million passengers and 12 million tonnes of goods whilst the city airport handled around 2.6 million passengers.

Economic Corridors have been identified based on the Regional Strategic Transport Network (RSTN) and have a fundamental role to play in regional growth. They can help strengthen economic competitiveness, increase the attractiveness of Belfast and Londonderry, provide access to the air and sea ports and are essential for providing access to the gateways.

SFG15: Strengthen the Gateways for Regional Competitiveness - Gateways should be able to deal with goods and passenger traffic efficiently and be considered as an asset by potential investors and local firms. Many of the gateways are intrinsically linked to important nature conservation sites or the aquatic environment and their development must be appropriately managed to take account of this.

- Provide high quality connections to and from the air and sea ports.
- Enhance gateways and their environmental Image.

Chapter 4: Regionally Significant Economic Corridors

Chapter 4 of the RDS states that spatial planning and related infrastructure development is essential to enable a working economy. Being part of an island, air and sea ports and land gateways are of fundamental importance to the region. Gateways should be able to cope with the volume and variety of traffic passing through them. They should also aim to accommodate businesses that benefit from proximity to the point of entry/departure.

Gateways are where first impressions are formed and should provide a high quality experience for the traveller.

- Transport linkages to and from the air and sea ports should be of the highest quality.
- Improving key transport corridors enhances accessibility to regional services and reduces peripherality. This means high quality road and, where available, rail links.
- The transportation networks help to deliver balanced economic growth.

As one of Northern Ireland's economic drivers, an efficient transport system in Belfast is essential to allow people and goods to move quickly around the city and to commute to and from it. High quality public transport for Belfast is therefore also necessary for regional prosperity.

1.4.2.2 *The Regional Transportation Strategy 2002-2012*

The RDS published in 2001 described how the Regional Transportation Strategy (RTS) is an integral part of it and set the vision for it "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". This vision is still appropriate for the New Approach to Regional Transportation (discussed further below). The RTS will guide investment decisions up to 2015. Following this the Strategic Document, *'Ensuring a Sustainable Transport Future - A New Approach to Regional Transportation'* will be used for decision making.

An integral feature of the RDS (2001) was the production of the Regional Transportation Strategy for Northern Ireland 2002 to 2012. This identified strategic transportation investment priorities and considered potential funding sources and affordability of planned initiatives over this ten year period. The overall development of this strategy was based on the Guidance on the Methodology for Multi-Modal Studies (GOMMMS), an objective led approach to seeking solutions to transport-related problems. The Government's five key objectives of environment, safety, economy, accessibility and integration were adopted and were central to the development of the RTS. Following extensive consultation on transportation issues facing the region an understanding was formed of the current constraints of the transportation system and requirements for future growth in line with the RDS. By comparing perceived problems to potential solutions a comprehensive list of potential transportation initiatives was drawn up.

The RTS was then implemented through three Transport Plans: the Regional Strategic Transport Network Transport Plan; the Belfast Metropolitan Transport Plan; and the Sub-Regional Transport Plan.

1.4.2.3 *Ensuring a Sustainable Transport Future – A New Approach to Regional Transportation*

The current Regional Transportation Strategy 2002-2012 was successful in securing high levels of public funding to improve transportation infrastructure. However, the speed and direction of change in society prompted the need for review. The increase in population and vehicles has placed significant pressures on transportation networks coupled with fiscal constraints and the need to reduce environmental impacts.

Ensuring a Sustainable Transport Future: A New Approach to Regional Transportation was published by the Department For Regional Development in March 2012. The New Approach builds on what has been achieved. It emphasises the need to concentrate on moving people rather than vehicles, creating space on the networks for people and also for freight and on maintaining what is in place and using it in a smarter way.

The New Approach is different from the current strategy in that it is not constructed on schemes and projects. Rather it sets the High Level Aims and Strategic Objectives for transportation in Northern Ireland that form the basis for future decision-making on DRD's transportation funding priorities.

The New Approach compliments the revised RDS 2035 and does not include details of schemes or projects. The document focus' on three high level aims for transportation along with twelve supporting Strategic Objectives, covering the economy, society and the environment. The High Level Aims and Strategic Objectives are:

A. Support the Growth of the Economy:

  1: Improve connectivity within the region

  2: Use road space and railways more efficiently

  3: Better maintained transport infrastructure

  4: Improve access in our towns and cities

  5: Improve access in rural areas

  6: Improve connections to key tourism sites.

B. Enhance the quality of life for all:

  7: Improve Safety

  8: Enhance Social Inclusion

  9: Develop transport programmes focused on the user.

C. Reduce the Environmental Impact of Transport:

  10: Reduce Greenhouse gas emissions from transport

11: Protect biodiversity

12: Reduce water, noise and air pollution.

The new approach starts with the assumption that the decision to travel has been made. It seeks to provide the infrastructure and services that will ensure that travel and transport are as sustainable as possible.

This Strategic Document considers a number of key trends in transportation, such as:

- the number of vehicles has increased and is over 1million
- up to 2007, the volume of freight was increasing
- by 2031 the population is forecast to be over 2 million.

The York Street Interchange scheme clearly compliments the Strategic Objectives of this Strategy, in particular, improving connectivity within the region, improved access in our towns and cities and improved connections to key tourism sites.

1.4.3 ***Transport Plans***

1.4.3.1 *Overview*

As noted above, a number of Transport Plans have been developed to implement the RTS and will continue until 2015.

1.4.3.2 *The Regional Strategic Transport Network Transport Plan*

The Regional Strategic Transport Network Transport Plan (RSTNTP) 2015 was prepared within the framework established by the RDS and the associated RTS. The RSTNTP aimed to develop a RSTN based on the five Key Transport Corridors identified in the RDS.

The RSTN included the complete rail network and the strategic road network. The strategic road network is comprised of the combined network formed by the Key Transport Corridors, Link Corridors and Trunk Roads as shown in **Figure 1.4.1**.

The RSTNTP includes a programme for the implementation of Strategic Road Improvements (SRIs) to remove bottlenecks on the key network where lack of capacity is causing serious congestion, and to improve the environment by providing bypasses of towns situated on the RSTN, thus relieving the effects of heavy through traffic.

Roads Service manages the delivery of the identified SRIs through a series of programmes defined in the Roads Service Policy and Procedure Guide RSPPG_E030 "Major Road Improvement Schemes: Inception to Construction".

- Construction Programme - contains those schemes which have completed the statutory procedures (where applicable) and for which funding has been confirmed.
- Preparation Pool – this is a list of high priority major road improvement schemes that are being taken through the statutory procedures, including acquisition of land, in advance of funding being confirmed. Subsequent progression into the Construction Programme is dependent on the level of funding available at that time
- The Forward Planning Schedule – this is a list of major road improvement schemes, which together with those in the Preparation Pool, could be started within the next 10 years or so, subject to satisfactory economic and other appraisals, availability of funding, and satisfactory progression through the statutory procedures.

1.4.3.3 *The Belfast Metropolitan Transport Plan*

The Belfast Metropolitan Transport Plan 2015 (BMTP) is a local transport plan specifically for the BMA developed to deliver the RTS. The BMTP was integrated with the draft Belfast Metropolitan Area Plan 2005 (BMAP) and acted as a Technical Supplement within this document in relation to transportation.

The overall development of the BMTP was based on GOMMMS, ensuring that a comprehensive range of solutions had been considered covering all modes of transport. It also ensured integration between transport and land use. The BMTP development was especially influenced by the guidance provided by the RDS and RTS and enabling the generic multi-modal study process to be focused on the particular needs and special context of the BMA. An extensive consultation exercise was also undertaken, ensuring that the views of a wide range of stakeholders were taken into account in the development of the Plan. The consultation process built upon the extensive consultation exercise undertaken to support the RDS and RTS.

The BMTP identified a road hierarchy within the BMA comprising the Strategic Highway Network linked to the wider RSTN in the RSTNTP and a Non-Strategic Highway Network. The Strategic Highway Network identified by the BMTP includes the Westlink, M2 and M3 and a series of improvements are identified on the M1/Westlink and M2 routes to remove identified bottlenecks. With regard to the planned improvements to the M1/Westlink, the BMTP cautioned that:

"the improvements to the M1/Westlink will require further consideration to be given to improving the capacity and operation of the signalised junctions at York Street/Westlink and Nelson Street/York Link/Great George's Street."

1.4.3.4 *The Investment Strategy for Northern Ireland*

The Programme for Government (PfG) 2011-2015 document published in March 2012 sets out the Northern Ireland Executive's strategic priorities and key plans for investment in Northern Ireland for 2011-2015. This PfG has been used to determine the draft Investment Strategy for Northern Ireland for 2011 to 2021 (ISNI). This draft document *"highlights the progress made to date and sets out the next phase of investment in key projects and programmes".*

A major commitment of the PfG is to *"progress the upgrade of key road projects and improve the overall road network to ensure that by March 2015 journey times on key transport corridors reduce by 2.5% - against the 2003 baseline (DRD)"*

The draft ISNI aims to create a high quality transport network and recognises that Investment in the Roads Network will reduce journey times, improve safety, and provide enhanced access to our urban centres and inter-regional Gateways. The draft ISNI notes that development work will continue on a range of major projects including the Westlink/York Street Junction.

Moving forward the draft ISNI highlights further upgrades on routes on the strategic roads will improve journey times, enhance safety and improve access to the ports and gateways thereby contributing to an improving economy.

1.5 Network Constraints

Within the RTS the importance of a strategy to remove bottlenecks is recognised. In particular this focuses upon strategic road improvements to upgrade the Key Transport Corridors and the other routes on the RSTN. The RTS also defines the bottlenecks as structural deficiencies where lack of capacity causes undue congestion and thereby delay for freight, public transport and cars.

1.6 Proposed Scheme Context

1.6.1 *Expanding the Strategic Road Improvement Programme 2015 – Consultation Document*

The previous ISNI published in December 2005, identified an additional £400M for the Roads Service's SRI Programme that was in place at the time of publication. In response to this expanded programme of investment, Roads Service developed a list of additional SRIs as part of an Expanded SRI Programme.

The proposed Expanded SRI Programme, like the RSTNTP, was based on the guidance set out in the RDS and the RTS. The selection was based on the Government's five key objectives for transport of environment, safety, economy, accessibility and integration. It built upon the extensive work undertaken for the RSTNTP and among other objectives aimed to address bottlenecks on the strategic road network, giving priority to the Key Transport Corridors, Link Corridors and then the Trunk Roads.

The Expanded SRI Programme was balanced across Northern Ireland and included major improvements necessary to deal with bottlenecks and safety concerns. As part of these improvements a grade separated junction was identified at York Street. This was set out within Annex B of the published consultation document[3] as detailed in **Table 1.6.1**.

TABLE 1.6.1: EXTRACT FROM ANNEX B OF EXPANDING THE STRATEGIC ROAD IMPROVEMENT PROGRAMME 2015 CONSULTATION DOCUMENT

Proposed additional SRI schemes to be added to programme subject to consultation		
Scheme	**Description**	**Cost (£ M)**
Eastern Seaboard Corridor		
Westlink/York St flyover	Provide grade separated junction at the last remaining part of Westlink which has a traffic signalled junction	£ 50M

The consultation process for the Expanding the Strategic Road Improvement Programme 2015 – Consultation Document commenced on 31 July 2006 and continued until 29 September 2006. The document was consulted upon widely and during this period there were no adverse reactions to the programme of works proposed at York Street.

Based on the above, the Expanded SRI programme builds on the RDS and RTS and therefore is considered to have the same strategic policy status.

[3] "Expanding the Strategic Road Improvement Programme Consultation Document", Roads Service, DRD. July 2006.

1.6.2 *Expanding the Strategic Road Improvement Programme 2015 – Draft Environmental Report*

To compliment the Expanded SRI programme a draft Environmental Report[4] for the Strategic Environmental Assessment was proposed. The consultation process for the draft Environmental Report also commenced on 31 July 2006 and continued until 29 September 2006.

The draft Environmental Report noted that the Expanded SRI Programme was one aspect of the ISNI which was multi-modal in nature. The ISNI proposed investment in rail network renewal and new buses to improve travel times and accessibility by all modes across Northern Ireland.

The expanded SRI programme was based on the RDS, the RTS and the RSTNTP. Improved strategic road links have the potential to provide beneficial impacts across the Government's five key criteria.

The document was adopted by the Department and included Summary Tables indicating the Environmental Assessment Impacts of the schemes. The assessment for the Westlink/York Street Flyover is reproduced in **Table 1.6.2**:

[4] "Expanding the Strategic Road Improvement Programme 2015 Draft Environmental Report", DRD. July 2006.

TABLE 1.6.2: ENVIRONMENTAL ASSESSMENT SUMMARY TABLES FOR WESTLINK/YORK STREET FLYOVER

Eastern Seaboard Corridor – Westlink/York Street Flyover

Theme	Appraisal Criteria	Effects	Summary of Effects	Comments
Environment	Biodiversity	0	In general, proposed works are within an urban environment and will have no impact on biodiversity.	
	Countryside	0	Proposed works are within an urban environment and will have no impact on the countryside.	
	Climate Change & Air Pollution	✓	Proposed works will relieve congestion in an urban area. This is expected to result in improved air quality in this vicinity. Air quality will be the subject of assessment as part of the detailed scheme appraisal process. It should be noted that the additional capacity provided by proposals may also lead to induced traffic which may erode benefits to climate change.	
	Management of the Water Environment	0	In general, proposed road scheme is within an urban environment and does not include a significant increase in impermeable surfaces and will have no noticeable impact on the water environment.	
	Mineral Resources (Mineral Conservation)	X	The construction of proposed new highway schemes will increase the use of mineral reserves.	Use recycled materials where practicable.
	Waste Disposal	X	The construction of proposed new highway schemes will result in waste material.	Recycle waste material where practicable.
	Energy Efficient Transport Modes	X	Proposed works will not formally promote efficient transport modes and have the potential for encouraging further car use.	
	Built and Archaeological Heritage	0	Proposed works do not impact on designated sites of national and international importance.	
	Urban Environmental Quality	✓	Proposed works will improve the access arrangements to the Strategic Highway Network and reduce congestion and may be associated with local urban regeneration.	

TABLE 1.6.2: ENVIRONMENTAL ASSESSMENT SUMMARY TABLES FOR WESTLINK/YORK STREET FLYOVER

Eastern Seaboard Corridor – Westlink/York Street Flyover

Theme	Appraisal Criteria	Effects	Summary of Effects	Comments
Quality of Life	Current Needs	✓	Proposed new highway schemes will provide for the needs of the current generation.	
	Unemployment/Poverty	✓	The construction of proposed new highway schemes will provide substantial employment opportunities. The proposals would contribute to the removal of bottlenecks within settlements and would therefore permit more reliable journey times for business and freight movement.	
	Education	-	Proposed new highway schemes will have no impact on education.	
	Crime	-	Proposed new highway schemes will have no impact on crime.	
	Housing Conditions	-	Proposed new highway schemes will have no impact on housing conditions.	
	Public Health	✓	Proposed works will remove a congested signalised arrangement connecting three strategic routes and replace this with a grade separated solution. This should have a positive impact on road casualties.	

Key to Effects

✓	Positive
X	Negative
o	Neutral relationship
-	No relationship
?	Relationship uncertain

The draft Environmental Report highlighted the positive and negative aspects of the scheme including the improved access arrangements to the strategic road network with reduced congestion and possible urban regeneration, but noted that the scheme would not formally promote efficient transport modes and had the potential for encouraging further car use.

The Expanded SRI Programme, which focuses on road improvements, is one aspect of the ISNI. In addition, the ISNI also proposes investment in rail and new buses to improve travel times and accessibility by all modes across Northern Ireland.

The scheme should also deliver benefits to public transport bus services that are currently delayed when passing through the series of signalised junctions to contribute towards the ISNI objectives for improved travel times by all modes of transport.

Following closure of the consultation period, the scheme was included in the Investment Delivery Plan (IDP) for Roads document, as described in **Section 1.6.3**.

1.6.3 *Investment Delivery Plan for Roads*

The IDP for Roads indicates that Roads Service, in developing a SRI Programme, has ensured that the contribution to the Northern Ireland Executive's three cross-cutting strategic objectives of ISNI (economic, societal and environmental) has been maximised.

The SRI Programme is managed under the four categories set out in RSPPG_E030, namely the Construction Programme, the Preparation Pool, the 10 Year Forward Planning Schedule and the Long Term Forward Planning Schedule. Details on these categories have been provided previously in **Section 1.4.3**.

The IDP for Roads indicates that:

"The Strategic Road Improvement Programme is based on the guidance set out in the Regional Development Strategy and the Regional Transportation Strategy and builds on the work of the Regional Strategic Transport Network - Transport Plan. The Programme aims to develop the strategic road network, targeting bottlenecks, in order to make all areas of the Province readily accessible to the Regional Gateways and the Belfast Metropolitan Area; and thus endeavouring to help the region realise its economic potential and make it as attractive as possible to future investors."

Roads Service has set in place a strategy to ensure the delivery of unprecedented levels of capital roads investment envisaged through ISNI.

Annex 1 in the IDP for Roads shows the programme of SRIs that are proposed over the 10 years of the ISNI period to 2017/18. This includes a summary of major investment in roads and confirms that the grade-separated junction for the York Street/M2/M3 intersection on the Westlink is included in the IDP as extracted into **Table 1.6.3** below:

TABLE 1.6.3: EXTRACT FROM ANNEX 1 OF THE IDP FOR ROADS

Profile Title and Description	Capital Value (£M) Current Prices	Anticipated Procurement Route[1]	Indicate Next Gateway Stage[2]	Anticipated Date of Advertisement to Market	Estimated Completion Date / Delivery Date	Location
Westlink / York Street Flyover *Grade separated junction for the York St/M2/M3 intersection on the Westlink*		D&B	Gateway 1	2013/14 to 2017/18		Belfast

Notes
[1] Procurement route stated is most likely option from (a) PFI/PPP; (b) Design and Build; (c) Conventional Procurement
[2] Gate 0: Strategic Assessment Gate 1: Business Justification Gate 2: Procurement Strategy Gate 3: Investment Decision Gate 4: Readiness for Service Gate 5: Benefits Evaluation

The scheme was identified at this time as the “Westlink/York Street flyover” included in the proposed 10 Year Forward Planning Schedule in the Expanded SRI Programme. This proposed Expanded SRI Programme, like the RSTNTP, was based on the guidance set out in the RDS and the RTS and the inclusion of the scheme was based on the Government’s five key criteria stated previously. Roads Service published a Consultation Document for the proposed Expanded SRI Programme in July 2006, along with a draft Environmental Report to provide an assessment of the potential environmental impacts of the proposals contained in the Expanded SRI Programme. Roads Service also undertook a screening analysis under Section 75 of the Northern Ireland Act 1998 for the Expanded SRI Programme and concluded that a further full Equality Impact Assessment was not required as the proposed programme did not affect the full Equality Impact Assessment carried out and published in June 2005 for the RSTNTP. A copy of the screening analysis form is included in **Appendix B**.

The consultation period closed in September 2006 and following this period of consultation, the Expanded SRI Programme was integrated into the Northern Ireland Executive’s published Programme for Government 2008 to 2011 under the IDP for Roads document published as part of ISNI.

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2 EXISTING CONDITIONS

2.1 Engineering

2.1.1 *Road Network*

2.1.1.1 *Overview*

This section provides a broad engineering assessment of the existing roads on the strategic road network (Westlink, M2 and M3) and local city centre streets not included in the strategic road network (York Street, Great George's Street, York Link, Nelson Street, Little York Street, Shipbuoy Street, Dock Street, Corporation Street, Trafalgar Street, Whitla Street, Garmoyle Street, North Queen Street and Clifton Street).

The existing road network is illustrated in **Figure 2.1.1**.

The assessment considers the following areas:

- route descriptions for the Westlink, M2, and M3
- horizontal alignment and junction standards on the Westlink, M2 and M3
- vertical alignment standards on the Westlink, M2 and M3
- route descriptions for local city centre streets
- horizontal alignment standards on local city centre streets
- vertical alignment standards on local city centre streets
- route length summary.

The assessment of the Westlink will be curtailed to the extent of the study area at Clifton Street grade separated junction. The assessment of the M2 will be curtailed to the extent of the study area at Junction 1A (Duncrue Street) to the north and the Lagan Bridge to the south. Commentary is provided on the adjacent sections on the Westlink and M2 outside the study area that have undergone significant improvements carried out as part of the Roads Service DBFO Package 1 Contract. The assessment of the M3 will be curtailed to the extent of the study area at the Lagan Bridge.

The Design Speed used in assessing the layout and standard of the existing junction is based upon the speed limit applied to the section of the main carriageways (Westlink, M2 and M3) under analysis and the requirements, in particular, of TD 9/93 entitled "Highway Link Design" (DMRB 6.1.1). The Design Standard TD 22/06 entitled "Layout of Grade Separated Junctions" (DMRB 6.2.3) is also referenced in the following text.

An initial assessment of the alignment of the main carriageways on the strategic road network (Westlink, M2 and M3) has been made based upon the speed limit applied to the section of the main carriageways under analysis and the requirements, in particular, of TD 9/93.

It should be noted that the Westlink, M2 and M3 motorways are operated and maintained by Highway Management (City) Limited under the terms of its DBFO Contract with the Department for Regional Development. Under the terms of the DBFO Contract, the concessionaire will not be liable for reductions in lane availability due to temporary traffic management for the proposed interchange scheme.

2.1.1.2 *Westlink Route Description*

The Westlink was built between 1979 and 1983, commencing at Junction 1 of the M1 motorway (Broadway) in south Belfast and terminating at the York Street junction to the north of the city centre. The route provides strategic links from the M1 to the M2, the M3 and the Shore Road in both north-bound and south-bound directions. It is part of the strategic road network, located on the Eastern Seaboard Key Transport Corridor, as identified in the RSTNTP and the majority of its length is designated as a “special road”. A “special road” is a road which, under the terms of The Roads (Northern Ireland) Order 1997 has legal restrictions on its use by specific categories of road vehicles and on the placement of services by the various utility companies.

The Westlink also forms part of the Euro Route E01 defined by the United Nations Economic Commission for Europe (UNECE) and forms part of the Priority 9, 13 and 26 axes on the Trans-European Transport Network (TEN-T).

As part of the Roads Service DBFO Package 1 Contract, the Westlink has been subject to major improvements over some of its length. Completed in early 2009 the Westlink has been upgraded to a Dual 3 Lane Urban All-Purpose (D3UAP) section, as defined in DMRB TD 27/05 entitled “Cross Sections and Headrooms” (DMRB 6.1.2), from its start at a grade separated junction at Broadway to the existing grade separated junction at Divis Street. It should be noted that the finished lane widths do not meet the minimum requirements for a D3UAP section as set out in TD 27/05. A lane gain/lane drop arrangement reduces the route to a Dual 2 Lane Urban All-Purpose (D2UAP) section beyond the existing Divis Street junction and represents the extent of the recent improvements. At this point a narrow concrete safety barrier provides the central median with narrow hardstrips in each direction. To the north of Divis Street this D2UAP provision is maintained under the existing Peter’s Hill overbridge, with direct taper merges and diverges on both carriageways to the Clifton Street grade separated junction. Again, the cross-section provided does not meet the minimum requirements for a D2UAP section set out in TD 27/05.

Immediately north of the Clifton Street junction, a lane gain to the nearside from Clifton Street provides three lanes heading north-bound out of the depressed section and onto the existing North Queen Street underbridge along with a narrow hard shoulder. These north-bound lane widths are substandard, with lane widths of 2.85m (lane 1), 2.75m (lane 2) and 3.0m (lane 3) on the North Queen Street Bridge. The carriageway runs north on an embankment beyond the North Queen Street underbridge. Upon its final approach to the York Street junction, a direct taper from the offside of the north-bound carriageway provides separation for M3-bound traffic.

In June 2009, improvements were carried out to the intersection of the Westlink with York Street at the York Street junction. The works were designed by URS under this commission and completed in September 2009 by John McQuillan (Contracts) Ltd under an existing Roads Service term contract. The works comprised widening of the existing Westlink approach to York Street on the south side, into the Northside Park and Ride overflow car park, to provide six lanes on approach to the junction. The additional lane provided is a dedicated left-turn lane for traffic intending to travel to York Street from Westlink. Three lanes are maintained for onward travel from the Westlink to the M2, with an additional two lanes on the offside separated by a traffic island and designed for the M3 and city centre onward destinations. The junction is traffic signal controlled, with a staggered pedestrian crossing provided across the Westlink following completion of the widening works.

The south-bound carriageway from the intersection of the Westlink with York Street at the York Street junction comprises three lanes, merging to two lanes south of the junction. The carriageway runs south on embankment with two lanes provided on North Queen Street underbridge. This provision is maintained as the carriageway enters into a depressed section south-bound to the Clifton Street junction, where a taper diverge provides a connection to Clifton Street, with the city centre as an onward destination. Two lanes are provided south-bound from the Clifton Street junction towards the Peter's Hill overbridge, with taper merges and diverges to the previously identified lane gain arrangement on the south-bound carriageway at Divis Street.

2.1.1.3 *Westlink Horizontal Alignment and Junction Standards*

The Westlink is restricted to a speed limit of 50mph. In accordance with TD 9/93, this equates to a Design Speed of 85A kph and the existing alignment has been assessed to this standard.

As stated previously, a considerable section of the Westlink has undergone significant improvements under the M1/Westlink Improvements SRI. Although outside the study area considered, it is important to include the horizontal alignment delivered through these improvements within the overall assessment of the horizontal alignment of the route.

Following completion of the improvements on the Westlink the route has an alignment comprising a series of relatively short straights connected by a number of tight horizontal radii. The minimum horizontal curvature provided to link these straights is 150m, a total of Three Steps below the Desirable Minimum standard. It should be noted that this sub-standard radius occurs outside the study area, at the Mulhouse Road/Roden Street junction. Within the study area, north of Clifton Street junction, the Westlink is subject to a substandard right-hand curve with a horizontal radius of approximately 350m. A curve radius of 350m is Two Steps below the Desirable Minimum standard. This curve reverses immediately east of North Queen Street underbridge, with the north-bound carriageway subject to a reverse left-hand curve of approximately 350m. The curve transitions to a straight immediately upon approach to the existing York Street junction. The south-bound carriageway forks from the north-bound carriageway and appears to maintain a curve with a radius of approximately 350m, transitioning to a straight alignment in advance of its intersection with the existing York Street junction.

Grade separated junctions have been provided at all conflict points, with the exception of the Mulhouse Road/Roden Street junction where an at-grade left-in, left-out arrangement is provided. Weaving lengths between all successive merges and diverges are below the Absolute Minimum standard of 240m for the 85A kph Design Speed. Furthermore, the positioning of successive merges on the south-bound carriageway at Grosvenor Road junction and Mulhouse Road/Roden Street junction is approximately 295m, less than the required 319m (3.75 x Design Speed) as set out in TD 22/06.

Table 2.1.1 summarises the horizontal alignment and the weaving lengths provided on the Westlink:

TABLE 2.1.1: HORIZONTAL ALIGNMENT AND WEAVING LENGTH PROVISION ON WESTLINK (POST IMPROVEMENTS)

Section Start	Section End	Minimum Horizontal Radius	Minimum Weaving Length	Distance Between Successive Merges	Distance Between Successive Diverges
Broadway Underpass	Mulhouse Road/Roden Street junction	320m	470m	N/A	N/A
Mulhouse Road/Roden Street junction	Grosvenor Road junction	150m	150m	295m	N/A
Grosvenor Road junction	Divis Street junction	1800m	N/A	N/A	690m
Divis Street junction	Clifton Street junction	350m	300m	N/A	N/A
Clifton Street junction	York Street junction	350m	N/A	N/A	N/A

2.1.1.4 *Westlink Vertical Alignment Standards*

As stated previously, the Design Speed for the Westlink is 85A kph. It is noted that on the section of the Westlink outside the designated study area, a minimum K value of 13 has been provided on sag curves and this corresponds to One Step below the Absolute Minimum K value set out in TD 9/93. In a similar manner, a minimum K value of 17 has been provided on crest curves and this corresponds to Two Steps below the Desirable Minimum K value of 55. An instantaneous gradient of approximately 6% is provided on the carriageway at the transition between sag and crest curves between the Divis Street junction and the Clifton Street junction. Within the study area, crest curves have been provided on the depressed section of the route that appear to coincide with a One Step reduction in the Desirable Minimum K value, with a maximum gradient of approximately 5% at the transitions between sag and crest curves. The carriageway approaches the York Street junction at a relatively flat gradient of approximately 2%.

2.1.1.5 *M2 Route Description*

The M2 was also constructed between 1979 and 1983, with the foreshore section between Junction 1A (Duncrue Street) and the Lagan Bridge completed most recently. The M2 forms part of the strategic road network.

The foreshore section of the M2 included within the study area was constructed essentially as advance works in anticipation of the onward connection to the proposed structure, the Lagan Bridge, across the River Lagan. To avoid differential settlement of the 8m embankment the earthworks were pre-consolidated using a number of techniques.

The M2 foreshore section is located on the Eastern Seaboard Key Transport Corridor, as identified in the RSTNTP and is part of the T7 Trunk Road. The route north of the study area has also been subject to major improvements under the Roads Service DBFO Package 1 Contract which involved major widening and other improvements. The M2 also forms part of the Euro Route E01 defined by UNECE and is part of the Priority 9, 13 and 26 axes on the TEN-T.

The foreshore section of the M2 immediately north of Junction 1A characterises a dual 5 lane urban motorway, with the north-bound and south-bound carriageways described further below.

The south-bound carriageway of the M2 within the study area commences with a lane drop at Junction 1A (Duncrue Street) designated for city centre and docks traffic, which reduces the number of lanes to four on the south-bound carriageway. Of the four south-bound lanes, lanes three and four are designated for onward travel to the M3 whilst lanes one and two are designated for onward travel to the city centre and the Westlink. A hard shoulder is provided on the nearside, with a hardstrip provided on the offside. A wide central median is provided with a safety barrier provided. The existing steel safety barrier system is scheduled to be replaced by the DBFO Co. in summer 2012 with a concrete step barrier system. The south-bound carriageway continues from Junction 1A on embankment to its crossing of Dock Street at the Dock Street underbridge. Immediately south of the Dock Street underbridge, lanes 1 and 2 south-bound diverge from the carriageway down a steep gradient into a lane gain arrangement with Nelson Street at street level. The remaining two south-bound lanes continue on embankment to the Lagan Bridge, where they become the start of the M3 south-bound carriageway. A narrow hard shoulder is provided to the nearside with a narrow hardstrip provided to the offside.

The north-bound carriageway commences on the Lagan Bridge, immediately north of Junction 1A on the M3. This structure is bounded to the west by the Dargan Bridge, which runs in parallel. The carriageway comprises two lanes with a narrow hard shoulder to the nearside and a narrow hardstrip to the offside. The Dargan Bridge continues to run parallel to the carriageway, to the lane gain arrangement from the York Street junction, where an additional three lanes join the north-bound carriageway in an alignment passing under the Dargan Bridge. This five-lane carriageway continues north on embankment to its crossing of Dock Street at the Dock Street underbridge. Immediately north of the Dock Street underbridge, the railway line carried on the Dargan Bridge provides a boundary to the west. The five lanes continue north beyond the study area.

Of the five north-bound lanes, lanes four and five are designated for onward travel to the M5 Motorway, lanes two and three are designated for onward travel on the M2 and lane one is designated for onward travel to the Shore Road at the next exit at Junction 1 (Fortwilliam).

2.1.1.6 *M2 Horizontal Alignment and Junction Standards*

The M2 is subject to the national speed limit over the majority of its length and therefore a Design Speed of 120A kph can be used for assessment of the existing horizontal alignment from the northern boundary of the study area to the merge and diverge arrangements at Junction 1A. As with the assessment of the Westlink, the M2 has undergone significant improvements as part of Roads Service DBFO Package 1 Contract. Although outside the study area considered, it is important to include the horizontal alignment delivered through these improvements within the overall assessment of the horizontal alignment of carriageway.

The improvements to the M2 comprise on-line widening of the south-bound carriageway and accordingly no significant improvements have been made to the existing horizontal alignment. The existing horizontal alignment over the existing “hill section” is sub-standard with curves below the Desirable Minimum value. The existing horizontal alignment at Greencastle Interchange is also sub-standard, with the horizontal geometry on the main links approximately Three Steps below the Desirable Minimum value. South of Greencastle Interchange, the carriageway has an almost straight alignment on the foreshore section. The existing Dock Street underbridge carries the M2 over the Dock Street junction. Junctions are positioned such that the minimum weaving lengths and required spacing between successive diverges exceed the required standard.

Table 2.1.2 summarises the horizontal alignment and the weaving lengths provided on the M2:

TABLE 2.1.2: HORIZONTAL ALIGNMENT AND WEAVING LENGTH PROVISION ON M2 MOTORWAY (POST IMPROVEMENTS)

Section Start	Section End	Minimum Horizontal Radius	Minimum Weaving Length	Distance Between Successive Merges	Distance Between Successive Diverges
Sandyknowes junction	Greencastle Interchange	550m	4400m	N/A	N/A
Greencastle Interchange	Fortwilliam junction	430m	1155m	N/A	N/A
Fortwilliam junction	Duncrue Street junction	Straight	1190m	N/A	N/A
Duncrue Street junction	York Street junction	570m	N/A	N/A	595m

2.1.1.7 *M2 Vertical Alignment Standards*

The identified Design Speed for the M2 is 120A kph. It is noted that on the foreshore section of the M2, the vertical alignment is relatively flat with a typical 0.5% instantaneous gradient, increasing to an instantaneous 3% gradient on approach to the Dock Street underbridge. Over the structure the alignment transitions to a crest curve with a K value of approximately 20, five-steps below the Desirable Minimum, with an instantaneous gradient of approximately 5% as it transitions into a sag curve on the embankment north of the Lagan Bridge, where it becomes the M3. The gradient on the off-slip from the M2 to Nelson Street is approximately 8%.

2.1.1.8 *M3 Route Description*

The M3 was constructed in the 1990s as part of the Lagan Bridge and Dargan Bridge works, with completion of Phase 2 of the works in 1998. The route is part of the strategic road network, located on the T1 Trunk Road network and provides a strategic link between Belfast and Bangor.

The section of the M3 within the study area comprises a Dual 4 Lane Urban Motorway (D4UM), as defined in TD 27/05 at its south-east extent. Narrow hard shoulders and hardstrips are provided on the nearside and offside of both carriageways respectively. The majority of this section is elevated above street level on the Lagan Bridge and bounded to the west by the Dargan Bridge, with the track elevated to a similar level. On the north-bound carriageway, lanes one and two form a lane drop arrangement at Junction 1A. These two lanes continue north on a ramp structure where widening is provided to increase the lanes available to four. The four lanes continue in an alignment under the Dargan Bridge to the intersection at street level with Nelson Street, where an additional left-turn filter lane is provided. This junction is signal controlled. The two remaining north-bound lanes on the mainline continue on the structure to form the start of the M2 immediately north of Junction 1A. On the south-bound carriageway, the M3 commences immediately south of Junction 1A on the M2, with two lanes continuing south to a lane gain arrangement at Junction 1A. At this point, two lanes travelling south from a street level signal controlled junction with Nelson Street join the elevated carriageway in structure, with four lanes continuing south beyond the extents of the study area.

2.1.1.9 *M3 Horizontal Alignment and Junction Standards*

The M3 is restricted with a 50mph speed limit within the study area and therefore a Design Speed of 85A kph can be used for assessment of the existing horizontal alignment.

From the eastern boundary of the study area, the M3 comprises a right-hand curve of approximately 320m radius as the carriageway is carried on the existing Lagan Bridge. A 320m curve radius is 2-steps below Desirable Minimum for the identified Design Speed.

Within the study area, there are no successive merges and diverges on the M3 to allow an assessment of weaving lengths. However, if the assessment of the M3 is extended to the east to include the existing Middlepath Street junction, a weaving length of approximately 350m exists on the north-bound carriageway between the lane gain at Middlepath Street and the lane drop to the existing York Street junction. This is in excess of the 240m Absolute Minimum weaving length required for this 85A kph Urban Road. In a similar manner on the south-bound carriageway between the lane gain at York Street junction and the lane drop at Middlepath Street, a weaving length of approximately 290m is provided, again in excess of the 240m Absolute Minimum.

Table 2.1.3 summarises the horizontal alignment and the weaving lengths provided on the M3:

TABLE 2.1.3: HORIZONTAL ALIGNMENT AND WEAVING LENGTH PROVISION ON M3 MOTORWAY

Section Start	Section End	Minimum Horizontal Radius	Minimum Weaving Length	Distance Between Successive Merges	Distance Between Successive Diverges
Middlepath junction	York Street junction	320m	290m	N/A	N/A

2.1.1.10 *M3 Vertical Alignment Standards*

The identified Design Speed for the M3 is 85A kph owing to the imposed speed limit of 50mph. The vertical alignment on the M3 in a south-bound direction from the M2 starts with a sag curve with a K value of approximately 13, on the embankment north of the Lagan Bridge. The sag curve connects into a 4% gradient on the Lagan Bridge which connects into a further series of crest and sag curves which meet or exceed standard K values.

2.1.1.11 *York Street Route Description*

York Street runs in a generally south to north direction to form the western side of the signalised gyratory system. At its start at the intersection with Great Patrick Street five one-way lanes are provided to its intersection with Great George's Street at a signal controlled-junction. A left-turn filter lane provides access to a Roads Service public car-park facility and onward travel to the Westlink. North-east of this junction, six one-way lanes are maintained with access provided on the nearside to an existing Roads Service public car park. Lanes one and two continue to the intersection with Westlink and York Link, with onward travel through a signal controlled junction whilst lanes three, four and five are designated for onward travel to the M2 in a fork away from lanes one and two. To the offside, lane 6 provides a link to York Link at a priority junction. A dedicated access for buses is provided from lane 6 to an existing bus-stop at the corner of York Street and York Link. North of the York Street and York Link intersection, two one-way lanes provide onward north-bound travel and a single lane separated by a traffic island provides connection to the north-bound carriageway of the M2 via the M2 on-slip.

2.1.1.12 *Great George's Street Route Description*

Great George's Street runs in a generally south to north direction through the existing York Street junction and forms the southern side of the signalised gyratory system. A single carriageway, it commences at the intersection between Nelson Street and the off-slip from the M3 and comprises seven one-way lanes. Lane seven is a dedicated access to Little York Street. Six one-way lanes are maintained through to the intersection with York Street at a signal controlled junction. At this junction, lane one is designated for onward travel to North Queen Street, lanes two, three and four are designated for onward access to the Westlink and lanes five and six are designated for onward travel onto York Street, with the M2 and M3 as ahead destinations. The route then reduces to a single carriageway west of this junction, providing one-way access to existing housing developments. The route terminates at a priority junction with North Queen Street.

2.1.1.13 *York Link Route Description*

York Link runs in a generally west to east direction through the existing York Street junction and forms the northern side of the signalised gyratory system. A single carriageway, it commences at the intersection between the Westlink and York Street and comprises two one-way lanes initially. A third lane opens to provide three lanes under both the Lagan Bridge and Dargan Bridge and the route terminates at its intersection with Nelson Street at a signal-controlled junction. Lanes one and two at this point are designated for onward travel to the M3 via an on-slip ramp structure and lane three is designated for onward travel onto Nelson Street, with city centre as an ahead destination.

2.1.1.14 *Nelson Street Route Description*

Nelson Street comprises two one-way single carriageways travelling generally north and south away from its intersection with Dock Street. The north-bound Nelson Street carriageway comprises a single carriageway leading away from a signal controlled junction at Dock Street to Duncrue Street. Two lanes are provided in the north-bound direction with a dedicated bus-lane provided in a south-bound direction.

The south-bound Nelson Street runs in a generally north to south direction and forms the eastern side of the York Street signalised gyratory system. A single carriageway, initially two lanes are provided for onward travel to the city centre and M3 and a single lane diverges across a large traffic island to join the two lanes on the off-slip from the M2 in a lane gain arrangement. This traffic island continues to provide separation through to its intersection with York Link at a signal-controlled junction. South of this junction, the route travels under the Lagan Bridge and Dargan Bridge and intersects with Great George Street and the off-slip from the M3 at a signal controlled junction. Five lanes are provided, with two lanes remaining separated by a traffic island. These two lanes provide south-bound onward travel through the junction where the carriageway opens to provide a total of five lanes at its intersection with Great Patrick Street. The remaining three lanes at the junction provide onward access onto Great George Street.

2.1.1.15 *Little York Street Route Description*

Little York Street, also called Nile Street on existing BCC street signs, is a short length of narrow single carriageway that provides access to the existing Park-and-Ride facility

(Northside) and Shipbuoy Street located in the centre of the York Street junction's signalised gyratory system. It has no through connection to York Link.

2.1.1.16 *Shipbuoy Street Route Description*

Shipbuoy Street is a short length of narrow single carriageway that is accessed from Little York Street. It serves as access for lands in the centre of the York Street junction and includes a large turning area as no through connection to Nelson Street is provided.

2.1.1.17 *Dock Street Route Description*

This route comprises a short length of single carriageway with two lanes in each direction separated by a traffic island running between two structures. The route passes under the Dargan Bridge and the M2 and terminates on each side at a signal-controlled junction.

2.1.1.18 *Corporation Street Route Description*

This route runs in a generally north to south direction from its intersection with Dock Street at a signal controlled junction to its intersection with Dunbar Link at another signal controlled junction. A single carriageway, it comprises two south-bound lanes with two lanes in the opposite north-bound direction reverting to a single lane north-bound for buses only at the entrance to Clarendon Dock. It should be noted that road traffic with the exception of buses can only travel north along this route to Clarendon Dock. The route passes under the Lagan Bridge with a signal controlled junction provided at the intersection with Corporation Square. The route also provides access in the north-bound direction to a small Roads Service public car park located underneath the M3 off-slip. The Roads Service Eastern Division's Belfast North Section Office, the Newtownabbey and Carrickfergus Section Office and the Department of the Environment's Road Transport Licensing Division are located to the west of Corporation Street in a shared depot.

2.1.1.19 *Trafalgar Street Route Description*

This short length of narrow single carriageway is accessed from Corporation Street and provides access to the rear of properties on Corporation Street, including the Roads Service Corporation Street Depot.

2.1.1.20 *North Queen Street Route Description*

The section of this route considered within the study area comprises a short length of single carriageway passing under the Westlink, running in a generally north to south direction. A wide carriageway is provided with a single lane running in each direction separated by hatched road markings.

2.1.1.21 *Clifton Street Route Description*

Within the study area, Clifton Street comprises a single carriageway running in a generally east to west direction. The route intersects the Westlink at the existing Clifton Street grade separated junction, with on-slips and off-slips providing access to and from the Westlink. These junctions are controlled by traffic signals. Typically two lanes are provided in each direction, with a ghost island used to facilitate right turns into Stanhope Street.

2.1.1.22 *Whitla Street Route Description*

Whitla Street comprises a single carriageway of approximately 130m length, providing connection in a one-way west to east direction between Nelson Street/Duncrue Street and Garmoyle Street. A total of three lanes are provided on the link, with direct accesses on opposite sides of the carriageway into the Whitla Street fire station and the Dufferin Road gate to the Port of Belfast. A priority junction provides connection for northbound traffic on Nelson Street to return south along the route. The carriageway is approximately 18.5m wide, with hatched road markings used to restrict the width to the available running lanes.

2.1.1.23 *Garmoyle Street Route Description*

Garmoyle Street comprises a single carriageway running in a one-way north to south direction between Whitla Street and Dock Street. The route intersects Dock Street at an existing signalised junction. Three lanes are provided initially on the link, opening to four lanes at the entrance to the Dufferin Road gate to the Port of Belfast. Of the four lanes provided, lanes 1 and 2 are designated for onward travel to the city centre, with lanes 3 and 4 designated for right turning traffic onto Dock Street. A traffic island is used to separate the movements at the Dock Street junction, with a filter lane provided on the nearside to facilitate left-turns onto Dock Street in the direction of the Port of Belfast.

2.1.1.24 *Local Roads – Horizontal Alignment Standards*

With the exception of the Westlink, M2 and M3, all other existing carriageways in the study area comprise single carriageways with horizontal alignments in keeping with their urban location and nature. The fixed speed limit on these restricted roads is 30mph, with 60B kph the appropriate Design Speed. The majority of these carriageways comprise horizontal curve radii that are less than the Desirable Minimum of 255m which is typical of carriageways in an urban environment. Junction arrangements are typical of those commonly found in urban locations primarily at-grade priority and signal controlled junctions.

2.1.1.25 *Local Roads – Vertical Standards*

With the exception of the Westlink, M2 and M3, all other existing carriageways in the study area comprise single carriageways with vertical alignments in keeping with the relatively flat topography of the study area in the vicinity of the York Street junction.

2.1.1.26 *Route Summary*

Table 2.1.4 summarises the type and approximate length for each road and street considered in this existing route assessment:

TABLE 2.1.4: APPROXIMATE ROAD/STREET LENGTHS AND CLASSIFICATION

Road/Street Name	Classification	Approximate Length (m)
Westlink	A12	570
M2	M2	560
M3	M3	660
York Street	A2	830
Great George's Street	A2	430
York Link	A2	150
Nelson Street	A2	840
Little York Street	U617/U618	80

TABLE 2.1.4: APPROXIMATE ROAD/STREET LENGTHS AND CLASSIFICATION		
Road/Street Name	**Classification**	**Approximate Length (m)**
Nile Street	U617	80
Shipbuoy Street	U617	80
Dock Street	A2	300
Corporation Street	A2	690
Trafalgar Street	U617	90
North Queen Street	B126	740
Clifton Street	A6	340

2.1.2 ***Structures***

2.1.2.1 *Overview*

A number of structures exist within the extents of the scheme. These structures are identified on **Figure 2.1.2**. Brief summaries of the identified structures are included below.

2.1.2.2 *Lagan Bridge*

The Lagan Bridge was constructed between 1991 and 1994 as part of the Cross-Harbour Links contract. The main bridge comprises a viaduct structure with associated ramp structures which cross over numerous city streets and the River Lagan, supporting the M3 motorway. The bridge deck for the structure generally comprises of post-tensioned precast concrete box segments and is supported in turn on reinforced concrete piers. The piers are supported on piled foundations, typically bored CFA piles to a depth of approximately 30m below existing ground level (c. -28mAOD). It is noted that Roads Service's Director of Engineering Memorandum DEM 5/99 of 1999 enacted a moratorium of the future construction of post-tensioned grouted duct concrete bridges such as this bridge and the Dargan Bridge. The moratorium remains in effect at this time.

2.1.2.3 *Dargan Bridge*

The Dargan Bridge operated by Translink was constructed as part of the same works contract as the Lagan Bridge and comprises a viaduct structure which crosses over both city streets and the River Lagan. The bridge supports a single track railway line with passing points, opening to twin tracks on the main river span. The bridge is of similar construction to the Lagan Bridge, with the deck comprising of a series of post-tensioned precast concrete box segments supported on reinforced concrete piers and piled foundations.

2.1.2.4 *Dock Street Bridge*

Dock Street Bridge is a continuous four span precast composite concrete simply supported structure carrying twin 7.3m wide carriageways (the M2). The structure has varying spans, with a south span of 10.4m, a north span of 12.6m, and two internal spans of 16.5m. The structure has zero skew.

The bridge was constructed between 1981 and 1982, with the northbound (western) carriageway subsequently widened in 1991. The bridge deck comprises precast prestressed

M4 concrete beams supporting a cast in-situ concrete slab. At the internal supports, the deck is supported on in-situ concrete crosshead beams which are, in turn, supported on individual reinforced concrete columns. These columns are supported on piled foundations. At each end of each internal support, the last two columns are connected by reinforced concrete infill walls to enhance the resistance of the columns to vehicle impacts. The end supports comprise reinforced concrete abutments, which are piled. The crosshead beams and end diaphragms are post tensioned transversely. The structural connection between the original deck and the widened section is between the deck slabs only. There is no transverse post tensioning of the deck between the end diaphragms.

2.1.2.5 *North Queen Street Bridge*

North Queen Street Bridge is a single span precast composite concrete simply supported structure carrying twin 7.3m wide carriageways (the Westlink) with a 2.550m wide central reservation and 2.5 metre wide footways on each side. The bridge is skewed at an angle of 23º and has a skew span of 22.2m between bearing centres. The bridge deck comprises 24 No. precast prestressed M6 concrete beams supporting a cast in-situ concrete slab. The deck is supported on in-situ concrete abutments by 24 No. bearing pads. The abutments are carried on reinforced concrete spread footings. Record drawings for the structure are dated circa 1980 and it is thought that the bridge was constructed in the early 1980s.

It is noted that North Queen Street Bridge is situated on the site of the former McGurk's bar, which was destroyed in a terrorist bombing attack in 1971. A number of memorials to the victims have been erected over the years at the bridge structure. In 2001, a stone memorial was erected on the footway adjacent to the south east wingwall of the bridge. In December 2011, an additional memorial was erected on the south east wing wall by relatives of the victims which comprises a false façade depicting the original bar's appearance, fixed to the south east wingwall of the bridge.

2.1.2.6 *Dock Street Rail Bridge*

The Translink operated railway bridge at Dock Street was constructed as part of the Cross-Harbour bridge contract along with the Lagan and Dargan Bridges. It is a two span structure with varying skew and cross-section along its length. The structure comprises two longitudinal steel box girders with intermediate transverse cross-girders. Precast deck planks formed permanent formwork to the cast in-situ deck, which supports the rail ballast. The steel box girders are supported in the centre by two reinforced concrete piers, but insufficient record information exists to determine the nature of the foundation structure. However, it can be reasonably assumed that piled foundations have been used in a manner akin to the adjacent Dock Street road bridge.

2.1.2.7 *Whitla Street Subway*

Whitla Street subway was originally constructed in the 1980s as part of the M2 motorway. The structure comprises a reinforced concrete box section, supported on raked piled foundations. The original structure was widened in 1991 on the western side in accompaniment to the construction of the Dargan Bridge.

2.1.2.8 *Clifton Street Bridge*

Clifton Street Bridge was constructed in 1979 as part of the original Westlink construction. It comprises a single 21.5m span over the Westlink carriageway. The bridge deck comprises 25 No. precast M5 beams at 1.02m centres, supporting a cast in-situ concrete slab. The deck is supported on in-situ concrete abutments by 25 No. bearing pads, with the abutments carried on reinforced concrete spread footings.

2.1.2.9 *Westlink Retaining Walls*

The outer retaining walls on the Westlink depressed section at Clifton Street are of reinforced concrete construction and are of an inverted T type. Record drawings suggest that the walls have spread footings and bear directly onto placed fill. The retained height varies from approximately 2m to 5m over the length of the walls, with a typical stem width of 500mm.

2.1.2.10 *Little George's Street Retaining Walls*

The retaining walls at Little George's Street are located at the land boundary to the rear of existing domestic properties. The walls are of an inverted T type, with a reinforced concrete stem of approximately 450mm in width. The wall comprises a series of panels with a stepped top outline, with a brick outer skin provided on exposed faces. The retained height varies from approximately 1m to 2m over the length of the wall. The wall has spread footings and bears directly onto underlying strata. The retaining wall extends to a position near the new gantry base installed as part of the 2009 York Link improvement works, where a brick boundary wall commences and continues to York Street before turning northwards and continuing along the back of the footway on York Street to Henry Street.

2.1.2.11 *Great George's Street Retaining Walls*

The retaining walls at Great George's Street are of an inverted T type, with a reinforced concrete stem of approximately 450mm in width. The wall comprises a series of panels with a smooth top outline, with brick facings provided on exposed faces. The retained height varies from approximately 1m to 2m over the length of the wall. The wall bears directly onto underlying strata.

2.1.3 *Climate, Topography and Ground Conditions*

2.1.3.1 *Climate*

Information quoted within this chapter is reproduced from the Met Office's climate summary for Northern Ireland, based on its records from the years 1971 to 2000[5].

In general, Northern Ireland is cloudier than the rest of the United Kingdom, because of the hilly nature of the terrain and the proximity to the Atlantic Ocean. Even so, the coastal strip of County Down has an annual average total of over 1,400 hours of sunshine. The dullest parts of Northern Ireland are the more mountainous areas of the north and west, with annual average totals of less than 1,100 hours. Mean daily sunshine figures reach a maximum in May or June, and are at their lowest in December. The key factor is, the variation in day length through the year, but wind and cloud are major controlling factors as well. Annual mean sunshine duration for the area would typically be between 1,250 and 1,300 hours.

Rainfall in Northern Ireland varies widely, with the highest average annual totals being recorded in the Sperrin, Antrim and Mourne Mountains, where the annual precipitation is approximately 1,600mm. Proximity to the Atlantic Ocean and the prevailing south-westerly low pressure systems are the cause of the comparatively high rainfall figures experienced in the west of the Province of up to 1,950mm of rainfall per annum, compared with just less than 800mm of rainfall per annum to the south of Lough Neagh and the east of the Province.

Seasonal rainfall variation in Northern Ireland is not large, but the wettest months are between October and January. This is partly a reflection of the relatively low frequency of thunderstorms in the Province and the high frequency of winter Atlantic depressions.

[5] "Northern Ireland: Climate", http://www.metoffice.gov.uk/climate/uk/ni/, last accessed January 2012.

The occurrence of snow is closely linked to temperature and altitude being comparatively rare near sea level but much more frequent over the hills. The average number of days when snow falls varies between 10 near the east coast to over 35 in the mountains of Sperrin, Antrim and Mourne. The number of days on which snow lies varies from less than 5 days around the coast to over 30 days in the mountains. On rare occasions the snow has lain in excess of 30 days or indeed caused travel disruption for up to 5 days.

Throughout Northern Ireland, mean annual temperature varies little at low altitudes, averaging between 8.5°C to 9.5°C with the higher mean values occurring nearer to the coasts. As would be expected, the lowest mean annual temperatures are recorded with increasing height, therefore Slieve Donard (Northern Ireland's highest mountain) would have an average annual temperature of about 4.5°C. Due to the influences of the surrounding sea, Northern Ireland's winter temperatures are relatively mild, therefore inland areas generally experience colder temperatures than the coast, with the opposite being the case in the summer months. On average the area can expect a mean annual temperature of 8.5°C to 9.5°C.

Inland, generally January or February are the coldest months of the year with mean daily, minimum temperatures being between 0.5°C in upland areas and about 2.0°C on the coast. July is the warmest month, with the mean daily maximum temperatures being between 17.0°C in upland areas to almost 20.0°C.

In general, wind speed increases with height, with the strongest winds being observed over the summits of hills and mountains. The coastal fringes of County Antrim and Down have about 15 gales per year, while the number of days decreases inland to five days or fewer. These are associated with the passage of deep depressions across or close to the British Isles and most frequently occurring in the winter months. In comparison with the rest of the British Isles, the frequency of gales experienced in Northern Ireland is relatively low, due to the shielding effect that the rest of Ireland and some parts of Scotland has on decreasing wind speed.

2.1.3.2 *Topography*

The topography of the land traversed has an influence on the horizontal and vertical alignment of the routes considered. The natural topography within the study area is relatively flat, given its proximity to sea level, with typical levels at York Street junction being approximately 2.0m Above Ordnance Datum (AOD). The M2 is elevated to a level of approximately 10.0m AOD, approximately 8.0m above the surrounding streets from Dock Street underbridge and increases to tie-in with the Lagan Bridge and Dargan Bridge, which are elevated to approximately 12.0m AOD.

Within the study area, the M3 is supported on the Lagan Bridge. The Westlink is located at the west of the study area in a depressed section at Clifton Street, approximately 7m below the surrounding streets. The carriageway rises out of this cutting and approaches the existing York Street junction on an embankment falling from approximately 9.0m AOD at North Queen Street underbridge to meet the typical street level of 2.0m AOD at the York Street junction.

2.1.3.3 *Ground Conditions*

The solid and drift geology for the area is considered in more detail within **Section 6.11**, in particular **Figure 2.1.3**. The map indicates that the site is underlain by drift deposits comprising quaternary alluvium and glacial deposits from the Pleistocene Period to the present. The estuarine alluvium thickness is shown to be between 10-15m thick, particularly along the eastern boundary of the study area.

The bedrock geological map indicates that the site consists of Sherwood Sandstone Group (formerly the 'Bunter Sandstone') of the Triassic Period. The bedrock formation consists of sandstone, siltstones and mudstone alternations. This has been intruded by several Basalt dykes whose trend is NW-SE.

From the Travers Morgan and Partners report of February 1967 entitled “Report on Belfast Urban Motorway”, a review of the Belfast Sheet of the Geological Survey of Northern Ireland (GSNI) along with an additional site investigation led to the development of geological sections along the proposed route, which was similar to the present location of the Westlink, M2 and M3 routes. A copy of the geological section prepared for this area and included as Figure 7 of the report is reproduced in this report as **Figure 2.1.4**.

Previous borehole records were obtained from fourteen separate ground investigations from across the study area and the following soil and rock lithologies were identified in the following stratigraphic order:

- Engineered Fill
- Made Ground
- Raised Beach Deposits,
- Estuarine Alluvium Deposits
- Peat
- Alluvial Deposits
- Glacial Deposits
- Bedrock.

These boreholes suggest ground water level variation between depths of 0.5m to 2.5m below ground level (bgl). It is also anticipated that groundwater level of the study area is subject to tidal influence. **Table 2.1.5** summarises in-situ test results in stratigraphic order.

TABLE 2.1.5: SUMMARY OF HISTORIC IN SITU TESTS

Strata	Description	SPT 'N' Values	Depth to Top (m)	Thickness (m)
Engineered Fill	Quarry Fill within the M2 M3 road embankment	Not Recorded	From Ground Level	0.0-5.50
Made Ground	highly variable materials from historical filling	Not Recorded	From Ground Level	0.3 – 1.0
Raised Beach Deposits	sands, occasionally sand and gravels	Not Recorded	0-2.5	0.0 -
Estuarine Alluvium (Belfast Sleech)	very soft to soft sandy silts	0 to 9	0.3 – 1.4	8.3 – 11.3
Peat	Friable sub-amorphous with decayed roots	2 to 6	9.5 – 12.5	< 1.6
Alluvial Deposits	Sandy gravels and gravelly sand	7 to 25	10.1 – 12.2	0.4 – 3.7
Glacial Deposits with cobbles and boulders	firm clay, stiff clay, stiff clay occasionally with thin laminations	23 to >50	10.8 – 15.4	7.6 – 37.3
	glacial sand and gravel bands	14 to 23	Variable within clay	1-5-
Sherwood Sandstone	Red sandstones, mudstone, siltstones and conglomerates	>50	Up to 51m (getting deeper to south east of site)	Not Proven
Basalt	Moderately weak brown	Not Recorded	4.20	Not Proven

Potential locations where contaminated land may be encountered are shown on **Figure 6.11.1** based on a desktop assessment of former uses.

Further information on the existing ground conditions is available in the Preliminary Sources Study Report prepared by URS for Roads Service.

2.1.4 *Hydrology and Drainage*

2.1.4.1 *Overview*

2.1.4.1.1 *Proximity to Existing Watercourses*

The low lying nature of the area and its close proximity to a tidal section of the River Lagan and Belfast Lough has significantly influenced the development of drainage infrastructure within the study area over the years. Information relating to the existing drainage network in the area has been received from Department of Agriculture and Rural Development (DARD) Rivers Agency and NI Water.

Based on the data received, with the exception of the River Lagan and the Mile Water River culvert, there are no other known open or culverted drains or rivers either designated or otherwise within the site extents. The Mile Water culvert flows from west to east and is located within the northern section of the site extents. The Farset River flows west to east approximately 200m south of the site extents. Both the Farset River and the Mile Water River culverts outfall at locations which are downstream of the Lagan Weir structure to the Belfast Lough.

2.1.4.1.2 ***Flood Risk from Rivers and Sea***

The River Lagan which sits outside of the immediate York Street Interchange site is the significant waterway within the wider Belfast area and for some 5.6km upstream of the Lagan Bridge and the York Street Interchange site area is subject to tidal influence. Existing ground levels within the site area are relatively flat with only minor undulations through the site and beyond in the direction of the river. With the lowest level in the area being of the order of 1.6 mAOD and the level of the flood protection structures adjacent to the River Lagan providing protection up to a level of 2.7 – 3.0 mAOD then high tidal and flood events when the peak river water levels rise above the level of the flood protection level will result in an inundation of the docklands area, and beyond, into the proposed site area and southwards into Belfast City Centre. Consequently the River Lagan and its characteristics play a significant part in influencing the flood risk pertaining to the scheme study area.

The site area along with the greater Belfast City Centre area is currently being investigated and modelled in detail by Rivers Agency to gain a more comprehensive understanding of flood inundation flow patterns and extents and their likely frequency. The currently published output from this analysis are the Rivers Agency Strategic Flood Map (NI) Rivers and Sea[6] maps which identify those areas which may potentially experience flooding as a result of their proximity to rivers or the sea. Ongoing consultations with Rivers Agency and review of the Strategic Flood Maps suggest that the study area falls within the zone which is at risk of potential flooding if the existing flood defences were breached or overtopped. **Figures 2.1.5, 2.1.6 and 2.1.7** illustrate the existing information published by Rivers Agency with respect to the study area.

Apart from the River Lagan and Belfast Lough, the majority of the York Street Interchange site area is lacking in the provision of existing storm culverts or open waterways. The guidance from Rivers Agency and NI Water in connection with the potential flood risk from sources within the site extents (other than the River Lagan and Belfast Lough) indicates that the flood risk is only very minor and local in nature.

2.1.4.1.3 ***Overview of Existing Sewerage***

Utilising the information received from the NI Water, Rivers Agency and Roads Service record drawings for recent schemes it has been ascertained that the drainage regime within the site area consists of a series of networks of road gullies and collector pipes. These networks collect runoff from the existing carriageways and adjacent areas and the storm water generated outfalls by gravity to the existing combined storm and foul water sewers which are in general owned and maintained by NI Water. The exceptions to this are a section of elevated M3 highway between the M3 Lagan Bridge and Nelson Street which drains to Belfast Lough via NI Water combined sewer overflow culverts and an area of the existing M2 motorway which drains to the Mile Water River culvert at the northern end of the site.

Buildings in the site area also discharge both storm water and foul sewage to this network of combined sewers.

[6] "Strategic Flood Map (NI) – Rivers and Sea", www.dardni.gov.uk/riversagency/index/strategic-flood-maps.html, last accessed February 2012.

NI Water has provided existing sewerage infrastructure records for the York Street area but it is noted that road drainage pipes are generally not shown on these records as they are installed and maintained by Roads Service and are generally of smaller diameter. As-built drawings for the Lagan and Dargan Bridges, constructed in the early to mid 1990s and the Westlink, constructed in the early 1980s have also been sourced. Information obtained from each of these various sources has been combined as shown on **Drawing S105296-D-SK-EX-001**. A schematic version of this drawing has been prepared to illustrate the main facilities including the main sewers and is included as **Drawing S105296-D-SK-EX-002**.

The NI Water Belfast Sewers Project was completed on 19 May 2010 and runs under Corporation Street and Garmoyle Street in a south to north direction. This scheme procured the installation of a large diameter tunnel at significant depth, i.e. greater than 20m below existing road level, to improve existing drainage infrastructure during severe rainfall events in the greater Belfast area. Information on the line and level of this tunnel has been sought and has been provided by NI Water. This information has also been included in **Drawings S105296-D-SK-EX-001 and S105296-D-SK-EX-002**.

The study area generally drains in an easterly direction from the western extents of the study area (i.e. Westlink towards the Belfast docks area) via road drainage infrastructure and NI Water combined sewerage. The existing network of NI Water pipes discharges into a large 2400mm diameter combined sewer, known as the Low Level Sewer, which gravitates in a northerly direction along Corporation Street. The completed Belfast Sewers Project storm tunnel follows roughly along the same line as this existing (Low Level) sewer but has been installed at considerably lower depth. These large scale sewers flow in a northerly direction out of the study area to Duncrue Street Wastewater Treatment Works, a facility which is owned, maintained and operated by NI Water. From a review of the existing records it appears that there is currently no pumped road drainage within the scheme study area.

2.1.4.1.4 ***Flood Risk from Combined Storm and Foul Water Sewerage***

Aside from the potential for flooding within the site which exists due to the close proximity of the River Lagan and Belfast Lough and the low lying nature of the site there is also a minor flood risk associated with the storm, foul and combined sewerage networks within, and in the surrounding areas adjacent to, the site. NI Water has been consulted in connection with this possible flood risk. NI Water has provided output data from their hydraulic storm and foul sewerage modelling that demonstrates that there are areas present within York Street and Dock Street which could be subject to minor localised flooding under a 1 in 5 year return period design storm event. However NI Water has indicated that to their knowledge there are no recorded historical flooding incidents in the area of the proposed interchange location.

2.1.4.2 *Road Drainage – West-bound Westlink and Great George's Street*

Close to the Westlink overbridge above North Queen Street, there is a high point in the existing vertical alignment of the Westlink. The drainage at this point breaks and the west-bound carriageway between North Queen Street and York Street is drained through gullies and collector pipes which flow east to the York Street/Great George's Street junction where these outfall to a 600mm diameter combined sewer. This combined sewer flows in an easterly direction within Great George's Street, picking up road drainage gullies before eventually connecting into the main Low Level Sewer in Corporation Street.

There are connections into the main 600mm diameter sewer in Great George's Street at Little York Street and Nelson Street.

2.1.4.3 *Road Drainage – East-bound Westlink, York Street and Dock Street Drainage*

Within York Street there are two primary combined sewers which flow in a northerly direction. One of the sewers is indicated to be of 375mm diameter and is located in the centre of the York Street carriageway. This 375mm sewer gravitates into an adjacent sewer in York Street, which varies in size from 375mm diameter to 750mm diameter. This connection occurs in the vicinity of the Cityside Retail Park. The road gullies in York Street appear to discharge directly into these sewers.

At the York Street/Dock Street junction the 750mm diameter sewer changes direction and continues in an easterly direction. It runs beneath the M2 and Dargan Bridge in the north footpath of Dock Street and connects into a larger 1050mm diameter sewer which in turn connects into the main Low Level Sewer in Corporation Street.

2.1.4.4 *Road Drainage - York Link Drainage*

York Link is drained as three separate catchments through a succession of gullies and combined sewers. The west section is drained via a 225mm diameter combined sewer which connects to the 600mm diameter sewer in York Street at the Henry Street junction.

The central section of York Link is drained by a 225mm diameter combined sewer which flows in an easterly direction and discharges into a 225mm diameter combined sewer in Nelson Street which flows to and connects into the Low Level Sewer in Corporation Street.

The east section of York Link is the on-slip ramp which rises towards the existing elevated highway. Runoff is collected by gullies and a collector pipe in the east verge which discharges to the same 225mm diameter combined sewer in Nelson Street as the central section, which ultimately discharges to the Low Level Sewer in Corporation Street.

2.1.4.5 *M2 and M3 Motorway Drainage and Nelson Street*

On the section of the M2/M3 that is within the study area i.e. from the bridge over Dock Street to the Lagan Bridge, highway runoff is again collected using gullies and discharged to collector pipes.

From a high point in the vertical road alignment at the Dock Street bridge, the west side of the M2, south of the high point, is drained down the off-slip to the Westlink and connects into the 600mm diameter combined sewer in York Street. The east side of the M2, south of the road high point, is drained to a road low point. From the low point, downstream pipe-work follows a path down the embankment and is shown to connect into a storm sewer in the east footway of Nelson Street.

The M2 off-slip onto Nelson Street and a central section of Nelson Street also drain to this storm sewer in the east footway of Nelson Street. From this manhole a 600mm diameter sewer traverses the Roads Service Depot car park and connects to the Low Level Sewer in Corporation Street.

At the north end of Nelson Street runoff is collected by gullies which discharge into the 1050mm diameter combined sewer in Dock Street. At the south end of Nelson Street, including part of the M3 off-slip, runoff is collected by gullies and connected into the 600mm diameter combined sewer in Great George's Street. Both the 600mm and 1050mm diameter combined sewers connect at separate locations into the Low Level Sewer in Corporation Street.

The remaining existing drainage within the study area is that of the Lagan and Dargan Bridges which were constructed in the early to mid 1990s. Both the railway line and highway are elevated structures spanning between piers which are supported on pile caps and piles. The as-built drawings received for the project show that the highway sheds runoff to gullies which discharge to a single carrier drain within the hollow concrete deck. The carrier drain connects to down-pipes which have been cast in to certain concrete piers. These down-pipes then connect into carrier pipes at ground level which then outfall to adjacent NI Water sewers.

As-built drawings with respect to the ground level drainage and some details of elevated highway drainage have been sourced, however specific drainage drawings for the elevated highway and the railway line have not been obtained. An assumption has been made that a typical as-built drawing of drainage detail applies throughout the elevated highway.

From a high point in the vertical road alignment at approximately where the M3 crosses over Nelson Street, the M3 elevated highway and part of the M3 off-slip (to Great George's Street), south of the high point slopes towards the M3 Lagan Bridge. Storm-water which is generated from this elevated section of highway is collected and discharged to ground level road drainage such as 150mm to 450mm diameter carrier pipes which discharge into the NI Water combined sewer overflow culvert(s). These culvert(s) then discharge to Belfast Lough at the south side of the M3 Lagan Bridge.

2.1.4.6 *M2 Motorway from Dock Street to Mile Water Footbridge*

From the high point in the vertical road alignment at the Dock Street overbridge the M2, north of the high point, slopes towards a low point near where the Mile Water River culvert crosses beneath the M2. From the Mile Water footbridge the M2 falls in a southerly direction towards the same culvert. At this low point runoff which is collected from this M2 catchment area is discharged to the culvert which ultimately discharges to Pollock Dock.

2.1.4.7 *Belfast Sewers Project*

The main storm tunnel for the Belfast Sewers Project is a 4.05m internal diameter tunnelled pipeline which is located approximately 25m below existing ground level. Within the study area this tunnel is located under Corporation Street and Garmoyle Street and takes the form of a gravity sewer which falls in a northerly direction towards Duncrue Street Wastewater Treatment Works. A smaller 2.44m diameter tunnel is located in Donegall Quay which changes direction to flow in a westerly direction along Corporation Square where it connects into the main 4.05m diameter tunnel at the junction with Corporation Street. At this location there is a new 12.5m internal diameter shaft i.e. Shaft 10 as shown on **Drawing S105296-D-SK-EX-001** previously.

There are several existing combined sewer overflow culverts which are located in Frederick Street, Great Patrick Street and Gamble Street which currently outfall to the River Lagan. The flow of foul water sewage within these culverts was intercepted and diverted as part of the Belfast Sewers Project to Shaft 10 via a 1500mm diameter sewer installed just east of and parallel to Corporation Street. Downstream of this diversion the combined sewer overflow culverts still receive storm-water discharges via drainage connections from adjacent car parking areas and elevated road and rail structures.

2.1.5 ***Public Utilities***

Given the long history associated with development right up to the present day, it was anticipated that there would be an extensive network of underground utility service cables, ducts and pipes to be accommodated within the designated site area. In order to establish the extent of this network the existing known major utility providers were contacted to establish if they had apparatus within the study area and to request information on the location and type of any identified apparatus. A C2 Preliminary Enquiries letter was sent to the various utility providers in accordance with the Northern Ireland Roads and Utilities Committee (NIRAUC) agreement[7].

As a result of the C2 Preliminary Enquiries it has been established that utility infrastructure owned and maintained by a variety of utility companies e.g. gas, electricity, potable water, storm water, foul sewers, and telecommunications traverse the study area forming potential constraints upon any improvements scheme. The main concentrations of infrastructure are found within the footprints of the existing carriageways and footways in the study area.

The utility infrastructure present within the area serves not only the adjacent residential, commercial and industrial development but also similar developments beyond the study area.

Existing information has been received from the providers who own plant within the study area and these are summarised in **Table 2.1.6**:

[7] "Measures Necessary Where Apparatus is affected by Major Works (Diversionary Measures) 2nd Edition", Northern Ireland Road Authority and Utilities Committee, May 2005.

TABLE 2.1.6: RESPONSES TO C2 PRELIMINARY SERVICE ENQUIRIES

Service Provider	Response
Phoenix Natural Gas	Plant affected
Northern Ireland Electricity (NIE)	Distribution and High Voltage (HV) apparatus affected
Firmus Natural Gas	Unaffected
Police Service of Northern Ireland (PSNI) (Red Light Running Cameras)	Plant affected
Cable & Wireless	Plant affected
Rivers Agency	Plant affected
Ericsson Services	Plant affected
Meteor	Unaffected
NI Water	Plant affected
Eircom UK	Plant affected
British Telecom (BT) NI	Plant affected
Orange Mobiles	Unaffected
Virgin Media	Plant affected
Vodafone	Unaffected
O2	Plant affected
Roads Service: • Street Lighting • Motorway Communications • Traffic Signals	 Plant affected Plant affected Plant affected
PSNI Traffic Branch	Plant affected
National Grid Wireless	Unaffected

2.1.5.1 *Public Utilities*

From the information received, a breakdown of the service provider and the extent of their known infrastructure within each of the routes in the study area were identified and are detailed in **Table 2.1.7**. The approximate locations of the existing services are detailed on the following **Drawings**:

- S105296-S-SK-EX-001 Existing Utilities – Northern Ireland Electricity
- S105296-S-SK-EX-002 Existing Utilities – Northern Ireland Water
- S105296-S-SK-EX-003 Existing Utilities – Phoenix Natural Gas
- S105296-S-SK-EX-004 Existing Utilities – Telecommunications
- S105296-S-SK-EX-005 Existing Utilities – Street Lighting and Traffic Signals Apparatus.

TABLE 2.1.7: APPARATUS IN THE SCHEME STUDY AREA

Route	Utility Provider	Service Utility
York Street	NI Water	2 no. watermains crossing Westlink to Henry Street junction; 1 no. Distribution Trunk of 300mm diameter in west side of road and 1 no. Distribution Main of 150mm diameter in east side of road. From Henry Street junction, 150mm and 300mm diameter Distribution Main and Trunk respectively combine in east side of road and continue as a 300mm diameter Distribution Trunk. 1no. Distribution Trunk of 300mm diameter from Henry Street continues in west side of road.
	NI Water	3 no. combined sewers; 1 no. 375mm diameter sewer in centre of road crossing Westlink increasing to 450mm diameter and 1 no. 375mm diameter sewer in east side of road crossing Westlink increasing to 600mm diameter, 1no. 225mm diameter sewer in east footway.
	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Motorway communications cables.
	Roads Service	Traffic signal cables.
	Cable & Wireless UK	Apparatus/cables within east side of street.
	BT	Apparatus/cables within both sides of street in south side of Westlink. Only in west side, north of Great George's Street.
	NIE	mV (lower to medium voltage), 6.6kV (high voltage) and 11kV (high voltage) underground cables adjacent to and crossing road.
	Phoenix Natural Gas	Low pressure gas mains of 125mm diameter in both sides of street in south side of Westlink. Low pressure gas main of 250mm diameter and a historical main of 200mm diameter in west side of road, north of Westlink.

TABLE 2.1.7: APPARATUS IN THE SCHEME STUDY AREA

Route	Utility Provider	Service Utility
York Link	NI Water	2 no. 225mm diameter combined sewers in south footway.
	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Motorway communications cables.
	Roads Service	Traffic signal cables.
	NIE	mV, 6.6kV and 11kV underground cables adjacent to and crossing road.
Little York Street	NI Water	1 no. combined sewer of 300mm diameter and 1 no. collection sewer of 150mm diameter.
	NI Water	1 no. distribution main of 125mm diameter.
	BT	Apparatus/cables crosses street.
	NIE	mV underground cables adjacent to and crossing road.
Nelson Street	NI Water	1 no. combined sewer of 225mm diameter and 1 no. collection sewer of 150mm diameter.
	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Motorway communications cables.
	Roads Service	Traffic signal cables.
	Cable & Wireless UK	Apparatus/cables within east side of street.
	NIE	6.6kV, 11kV, 33 kV and 110kV underground cables adjacent to and crossing road.
	BT	Apparatus/cables within both sides of street.
	Phoenix Natural Gas	Intermediate pressure (7 Bar) gas main of 250mm diameter within east side of street.
Westlink	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Motorway communications cables.
	Roads Service	Traffic signal cables.
	Phoenix Natural Gas	Low pressure gas main of 250mm crossing Westlink.
M2 (on-slip)	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Motorway communications cables.
	NIE	mV and 6.6kV cables crossing under road.

TABLE 2.1.7: APPARATUS IN THE SCHEME STUDY AREA

Route	Utility Provider	Service Utility
Corporation Street	NI Water	2 no. distribution water mains; 1 no. 225mm diameter increasing to 250mm diameter in west side of road and 1 no. 150mm diameter in east side of road.
	NI Water	1 no. 2400mm trunk combined sewer (known as 'Low Level Sewer') with other sewers connecting to trunk sewer.
	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Traffic signal cables.
	Cable & Wireless UK	Apparatus/cables within west side of street.
	BT	Apparatus/cables within both sides of street.
	NIE	mV, 6.6kV, 11kV and 33kV underground cables adjacent to and crossing road.
	Phoenix Natural Gas	1 no. medium pressure gas main of 250mm in 450mm diameter cast iron sleeve in western side of street and 1 no. historical gas main of 200mm diameter in eastern side of street.
	Eircom UK	Apparatus/cables within east side of street and crossing street.
	Virgin Media	Apparatus/cables within west side of street and crossing street.
Great George's Street	NI Water	1 no. combined sewer of 600mm diameter in middle of road.
	NI Water	1 no. distribution water main of 125mm diameter in south side of road.
	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Traffic signal cables.
	BT	Apparatus/cables within both sides of street.
	Phoenix Natural Gas	1 no. medium pressure gas main of 315mm diameter and 2 no. historical mains of 150mm and 250mm diameter in south side of road.
	NIE	mV, 6.6kV, and 33kV underground cables adjacent to and crossing road.
M3 (Lagan Bridge)	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Motorway communications cables.

TABLE 2.1.7: APPARATUS IN THE SCHEME STUDY AREA

Route	Utility Provider	Service Utility
Dock Street	NI Water	1 no. combined sewer of 750mm diameter increasing to 1050mm diameter in north side of road.
	NI Water	1 no. distribution trunk of 250mm diameter in south footway.
	Roads Service	Street lighting cables and associated lighting columns.
	Roads Service	Traffic signal cables.
	BT	Apparatus/cables in south side of street.
	Cable & Wireless UK	Apparatus/cables in south side of street.
	Virgin Media	Apparatus/cables in north side of street.
	Phoenix Natural Gas	Apparatus/cables crossing the road.
	NIE	mV, 6.6kV and 33kV underground cables crossing road. Redundant 110kV cable in south side of street.
Whitla Street Pedestrian Subway	NI Water	1 no. 300mm diameter distribution trunk.
	NIE	mV, 6.6kV, 33kV and 110kV underground cables within pedestrian underpass.

2.1.6 *Land Ownership*

A summary of the information available from Land and Property Services Northern Ireland (LPSNI) for the area under consideration, correct as of March 2011, is shown in **Figure 2.1.8**.

2.2 Environmental

2.2.1 *Introduction*

The study area is located within North Belfast, close to the docks area and lowest reach of the River Lagan, set within an exclusively urban setting. Belfast City itself lies at the head of Belfast Lough, flanked by the gentle slopes of the Castlereagh and Holywood Hills to the east, and the basalt escarpment of the Antrim Plateau to the north-west, which constrain the development within Belfast, both urban and green field. Significant private and public investment has led to considerable urban renewal, improved infrastructure and significant new urban housing over the past thirty years, with the Waterfront and Laganside areas particularly benefiting from this regeneration and more recently the Titanic Quarter.

Belfast is the capital city of Northern Ireland, and largest hub on the regional transport system. The city occupies a strategic location a number of Key Transport Corridors (KTCs), serving as a regional gateway with important links to other European cities. The railway services for Northern Ireland and cross-border link to Dublin are served from Belfast, via Central and Great Victoria Street stations. The Belfast area has good road communications with other main centres of population within the province, with a number of main routes radiating from the City, including the M1, M2 and M3 motorways.

2.2.2 *Historical*

With reference to the Belfast Area Metropolitan Plan (BMAP) 2015 (Draft Plan), the origins of Belfast can be traced to the early 13th Century, where a small settlement originated at the mouth of the River Lagan. This settlement began to develop as a market place and port during the 17th and 18th Centuries, with development of the manufacturing industry increasing growth of the settlement towards the end of the 19th and beginning of the 20th centuries. Belfast was granted city status by Queen Victoria in 1888. Principal industries around this time were linen, shipbuilding, tobacco and heavy engineering. Belfast prospered and by 1901 was the largest city in Ireland, with one of the largest shipyards in the world.

Whilst the character of the study area is currently dominated by the impacts of a modern transportation network, character is also defined by a strong link to Belfast's industrial past which still bears a significant mark on the urban fabric. The early development of the study area owes itself to the Industrial Revolution when the city expanded northwards as a consequence of the developing docklands. New streets were built in the area at this time, with names such as Pilot, Trafalgar, Nelson and Dock Street, giving a broad indication of the significance of this area in relation to its maritime legacy. The connection to the maritime past remains to this day with buildings such as St Joseph's Church (built in 1881 and at one time sat in the heart of the Sailortown community), Sinclair Seamen's Church (built in 1853) and The Harbour Commissioners Office (built in 1854) reflecting the historic use of the area and the connection to the docklands. All of the aforementioned buildings are architecturally listed; however the most significant of these is The Harbour Commissioners Office situated in Corporation Square where Belfast's shipbuilding industry grew from, and is still the home of the Belfast Harbour Commissioners.

The character of the study area is also defined by one of Belfast's oldest surviving pieces of maritime heritage, Clarendon Dry Dock, which is still in working order. Built on the site of the city's first shipyard, Clarendon Dry Dock No. 1 was completed in 1800, followed in 1826 by Clarendon Dry Dock No. 2 (where the Victoria, a ship used for survey work and maintenance of the navigational lights and fog horns of the port is still serviced and repaired). The dry dock is still operated by the same Victorian engineering design features. At the time of completion in 1826, the port handled 210,000 tonnes of cargo.

Due to the expanding docklands and industrial development, Belfast became the fastest growing urban centre in the United Kingdom, with its population rapidly increasing from 19,000 in 1801 to well over 70,000 in 1841. York Street has been a main thoroughfare of Belfast since the early 19th Century, developing from a residential district into an industrial zone, once home to two industrial enterprises that were the largest of their kind in the world; Mulholland's York Street Mill and Gallagher's Tobacco Factory. The linen mill was founded in the early nineteenth century by Thomas Mulholland and his sons, and the tobacco factory founded in 1867 by Thomas Gallagher, both contributing greatly to the surge of people into this area. At the time, York Street was also a main shopping area and another notable York Street establishment was the foundry of John Rowan and Son.

2.2.3 *Belfast Lough*

The study area is located adjacent to Belfast Harbour, where the transitional waters of the River Lagan flow into Belfast Lough.

Belfast Lough, located approximately 1.5 km northeast of the study area is a semi-closed sea lough, the inner region containing an inter-tidal area comprising a series of mudflats, with the outer area containing mainly rocky shores, with some sandy bays. The mudflats provide a valuable habitat for a range of bird species and the shallow waters on either side of the main shipping channel (which runs through the middle of the lough) sustain a growing shellfish industry.

Whilst there are no designated sites of ecological or nature conservation interest within the immediate study area, the Lough is protected by multiple national and international designations. The shoreline of mudflats, sandy bays and rocky shores are designated as an Area of Special Scientific Interest (ASSI), a Ramsar site, and a Special Protection Area (SPA). The open water portion of the lough is designated separately as a SPA. The ASSI designations consist of two separate sites; Inner Belfast Lough ASSI and Outer Belfast Lough ASSI.

2.2.4 *Belfast Harbour*

Belfast Harbour is Northern Ireland's principal maritime gateway and logistics hub, serving the Northern Ireland economy and increasingly that of the Republic of Ireland. Approximately 60% of Northern Ireland's seaborne trade and 20% of the entire island's is handled at the harbour, handling around 17 million tonnes of cargo per annum and receiving around 5,500 vessels each year.

The Harbour is the principal gateway for Europe and beyond, for imports and exports for Northern Ireland's manufacturing and construction sectors, and entry point for retail and consumer goods for the Northern Ireland market and beyond. It handles over 80% of Northern Ireland's petroleum and oil imports and is Northern Ireland's principal passenger ferry port with 1.3 million ferry passengers, including tourists, using the port's ferry services each year. It handles over 50% of Northern Ireland's ferry & container traffic and is Northern Ireland's leading dry bulk port, for imports of grain and animal feeds, coal, fertilisers and cement, and exports of scrap metal and aggregates.

It is also a major centre of industry and commerce; its Harbour Estate covers an area of 2,000 acres representing 20% of Belfast City area and is also Northern Ireland's logistics and distribution hub and home to major businesses including Microsoft, Harland & Wolff, Capita, CitiGroup and Bombardier.

2.2.5 *George Best Belfast City Airport*

George Best Belfast City Airport is owned by Eiser Infrastructure Fund. It is a regional airport serving a range of destinations, mainly in Great Britain, though it does provide services to mainland Europe. Situated on the south shore of Belfast Lough adjacent to the A2 Sydenham bypass (one of the main arterial routes into the city), the airport has grown significantly in recent years and is a key strategic gateway to the province. The airport currently caters for over 2.5 million passengers per year, representing approximately 40% of the scheduled domestic air traffic to and from Northern Ireland.

It first opened as a commercial airport in 1938 and was launched as the Harbour Airport for commercial traffic in 1983. The new terminal opened in June 2001 and in 2005 there were just over 2.2 million passengers through the terminal.

The primary market is the short haul scheduled services sector, accounting for 54% of the Northern Ireland population and business passengers account for 65% of the market.

2.2.6 *Local Context*

Located at the southern end of one of the main arterial routes (York Street/York Road/Shore Road) in Belfast, the study area is centred on the northern fringe of the City Centre. The area is very much a degraded urban landscape; however has attributes and features reflective of the ever-changing face of Belfast, from the Industrial Revolution through to contemporary 21st Century developments.

At the core of the study area, the main characteristic is its legacy of 20th Century transport planning which has changed the urban fabric, to achieve not only easier traffic movements around the periphery of the City, but to essentially act as one of the primary road transportation hubs for the province, providing a northern gateway to the city. The area is dominated by large scale physical infrastructure features, such as the Lagan and Dargan bridges which have caused a certain degree of severance, disconnecting the city centre from the western docks and ferry terminal (Sailortown). Also part of this transportation legacy, is the A12 Westlink which due to its at-grade intersection with York Street between M2 and M3 motorways, disrupts the continuity of this arterial route. Much of the land in the core of the study area is either Brownfield or currently in use as surface level car parking. Within the confines and immediate surrounds of the existing junction arrangement, there is very little built development. Whilst this land has been developed in the past, very little currently remains, other than a vehicle mechanics on Shipbuoy Street.

Beyond the immediate surrounds of the existing junction arrangement, there is a distinct variation in land use and associated built development. To the west, high density residential housing occupies land north and south of the A12 Westlink. To the south, existing built development is dominated by commercial properties, becoming progressively more built-up away from the junction and closer to the City. The Obel building is located adjacent to the M3 motorway at Donegall Quay, and is currently the tallest residential building in Ireland. It has a mix of residential and office properties within it. To the east, built development is dominated by residential and mixed use office developments, primarily associated with the regeneration area at Clarendon Dock. To the north, built development is primarily dominated by commercial properties ribboning along York Street, most notably Cityside Mall at Yorkgate. The periphery of the study area is also very much reflective of the ever changing face of the Belfast urban fabric, providing not only evidence of previous historical land uses, but also how buildings and sites with strong historical links to Belfast's industrial past (in particular shipbuilding) still contribute significantly to character, cultural heritage, and to continued development through their current and potential future uses.

Acting as a primary road transportation hub, the volume of traffic passing through and beyond the York Street area when compared to the wider provincial road network is very high, so much so that vehicular movements throughout the wider strategic road network have resulted in Air Quality Management Areas (AQMAs) being declared by Belfast City Council. On the western periphery of the study area, the M1-Westlink AQMA has been declared along the M1 Motorway and Westlink Corridor, due to exceedances of the annual mean and hourly mean Nitrogen Dioxide (NO_2) objective value, and the annual mean and 24-hour mean Particulate Matter (PM_{10}) objective value.

The topography of the study area is such that it generally drains in an easterly direction (i.e. from the A12 Westlink towards Belfast Harbour). Based on information received from NI Water, Rivers Agency and Roads Service, the existing drainage regime associated with the York Street study area consists of a network of road gullies and pipes collecting runoff from carriageways and adjacent areas. Primarily, runoff from the existing road network outfalls by gravity to the existing combined storm and foul water sewers (which are generally owned and maintained by NI Water). The exceptions to this are a section of elevated M3 Motorway between the M3 Lagan Bridge and Nelson Street, which drains into Belfast Harbour via a NI Water combined storm water/foul water overflow culvert (though this culvert no longer conveys foul water), and an area of the existing M2 Motorway (north of Dock Street), which drains to the Mile Water culvert and discharges into Pollock Dock.

2.2.7 *Industry*

Belfast currently has a broad base of service industries, which provide the main employment opportunities within the city. The manufacturing industry within the city has declined in significance in recent years, with reduced employment opportunities within this sector. Key employers within Belfast include Bombardier Aerospace, Queens University, and the Belfast Health & Social Care Trust.

As mentioned previously, the study area has a strong industrial heritage, based around traditional industries such as shipbuilding, tobacco and heavy engineering, but while these industries have suffered decline from an increasingly competitive international market, the area has adapted and changed with the times. This is particularly reflected in restoration of the Clarendon Dock area in 1993 into one of Northern Ireland's most prestigious business parks, currently housing offices and apartments and is home to a range of national and international companies. The redevelopment of the Clarendon Dock area is still ongoing and major development proposals (i.e. City Quays) are currently being considered by Planning NI. This is a city centre designated mixed use regeneration project in the heart of Belfast and is an extension to the already fully occupied Clarendon office and residential scheme. The project will benefit from over half a mile of water frontage and extensive open space, and will reconnect the Harbour to the City Centre.

Although the study area has seen significant changes in the type of industry providing the main employment base, it has remained a focal retail centre. Of particular significance is the Cityside Retail Park (formerly Yorkgate) which is a major employer and important retail, service and district centre for the surrounding area. Of particular significance is the link to the industrial past, as the expansive site of the retail park was once home to York Street Mill and Gallagher's Tobacco Factory. Yorkgate Business Park is situated on a thin strip of land between the M2 and York Street, opposite the Cityside Retail Park. Phase I (Galway House) was completed in January 2007 at a cost of £2M, providing retail space on the ground floors and office space above.

2.3 Traffic

Existing conditions in the York Street area are subject to significant congestion during periods of peak traffic demand due to the convergence of traffic from the Westlink, the M2 and M3 and the local surface streets. This demand is controlled by a series of signalised junctions, where signal timings are monitored to improve traffic flow during peak periods. Existing traffic conditions are described in detail within **Section 7.2**.

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3 DESCRIPTION OF SCHEME OPTIONS

3.1 Overview

This section presents a summary of the scheme options developed ahead of their Stage 2 Scheme Assessment in accordance with DMRB TD 37/93 (DMRB 5.1.2). With reference to the Cost Benefit Analysis (COBA) process used in the traffic and economic assessment of the scheme, these options are grouped and described under the preset Do-Nothing, Do-Minimum and Do-Something scenarios.

3.2 Do-Nothing/Do-Minimum Scenarios

No Do-Minimum scenario alternatives have been developed as part of the Stage 2 scheme assessment process. Therefore, the Do-Minimum scenario is considered to equate to the Do-Nothing scenario.

3.3 Do-Something Scenario

3.3.1 *Overview*

Four options shortlisted from the Stage 1 Scheme Assessment process have been further developed and presented as options for the Do-Something scenario. These options introduce grade separation to varying degrees at the existing junction using a variety of overbridge and underbridge structures and underpasses. To introduce a defined break between the form of these options at Stage 1 and Stage 2, the options have been renamed as set out in **Table 3.3.1**:

TABLE 3.3.1: OPTION NAMING CONVENTION AT STAGE 2 SCHEME ASSESSMENT

Stage 1 Option Name	Stage 2 Option Name
Preliminary Option 1	Option A
Preliminary Option 2	Option B
Preliminary Option 4	Option C
Preliminary Option 6	Option D

These options are described in further detail in **Sections 3.3.2 to 3.3.5**.

3.3.2 *Option A*

3.3.2.1 *Description*

Option A presents the first of two depressed concept designs. The layout provides a grade separated junction, but not a full interchange, with Links at either existing ground level or in depressed sections.

A general arrangement for Option A is included as **Drawing S105296-R-SK-A-000**, with profiles of the various links also included as **Drawings S105296-R-SK-A-100 to 101** inclusive and cross-sections at key locations further included on **Drawings S105296-R-SK-A-200 to 205** inclusive.

For the purposes of describing the principal roadworks required, the convention set out in **Table 3.3.2** has been adopted to describe the various links within the proposed layout.

TABLE 3.3.2: OPTION A LINK NAMING CONVENTION

Link	From	To
A	M2	Westlink
B	Westlink	M2
C	Westlink	M3
D	M3	Westlink
E	York Street (South)	York Street (North)
F	York Street	M2
G	Westlink	York Street
H	Corporation Street	Westlink
I	Dock Street	M3
J	M3	York Street

Link A commences with a two-lane lane drop from the M2 motorway at the Whitla Street subway, with the link passing on a proposed overbridge structure over Dock Street. The link is lowered into a depressed corridor underneath Links I, C and the Lagan and Dargan Bridges, with a proposed underpass structure proposed in close proximity (approx 0.5m separation) to the existing Lagan Bridge substructure. To facilitate this alignment, a number of existing properties will require demolition, including the existing Roads Service depot at Corporation Street. At its lowest point, the finished road level on the link is approximately 8m below existing ground level. The link rises upon departure from the pinch point, passing under Link E and rises to tie in with existing levels at North Queen Street Bridge, where widening of the existing carriageway is required. A lane drop is maintained to Clifton Street, with two lanes continuing southbound on Westlink.

It should be noted that the feasibility of the proposed underpass structure underneath the Lagan and Dargan Bridges has been separately examined in the URS report of June 2010 entitled “Evaluation of Underpass Structure (Stage 2)”, report reference S105296/S/02/02.

Link B maintains existing levels over North Queen Street Bridge, with narrow (3m) lane widths provided to avoid the requirement to widen both sides of the North Queen Street Bridge structure. To provide 3m lane widths across all lanes based on measurement of the existing lane widths, the existing kerbline will need to be set back from its existing position by 400mm. This will reduce the nearside verge width from 2.5m to 2.1m. As the carriageway is superelevated, falling to the central reserve, drainage systems are unlikely to be affected by the movement of the kerbline on the nearside. Some temporary protection and relocation of the services known to exist in the nearside verge, specifically motorway communications cables and street lighting cables, will however be required. The existing lane gain from Clifton Street is maintained in the layout. Beyond North Queen Street Bridge, the link lowers into a depressed section under Link E. To provide sufficient headroom, the link is lowered by approximately 3.5m below existing ground level. An underpass structure is proposed, with a single lane diverge to the M3 provided (refer to Link C). As the link approaches the Dargan

Bridge, it rises to match existing levels on the M2 on-slip, with approximately 400mm cover provided to the underlying pile caps. The link then matches the existing alignment on the on-slip to provide a 2-lane lane gain onto the northbound M2 foreshore.

Link C commences as a single lane diverge from Link B under Link E, approximately 3m below existing ground level in a depressed corridor. The link rises to provide 400mm cover to existing underlying pile caps on York Link and headroom to the underlying Link A. A lane gain from Dock Street (Link I) converges with the link, with the two resulting lanes continuing onto the existing on-ramp structure.

Link D commences with an at-grade junction on a realigned Link E, with a two-lane Urban Merge providing a single lane gain onto Link A.

Link E comprises a vertical and horizontal realignment of York Street to provide headroom over Link A, C and in particular, Link B. The vertical realignment of the link starts on approach to its existing junction with Great George's Street, with the link raised by approximately 800mm at the junction, supported by a proposed retaining wall. The link continues to rise to a maximum of approximately 4.8m over Links B and C, before lowering back to tie in with existing levels at a position adjacent to the current entrance to Cityside Retail Park. A new retaining wall will be required adjacent to existing Cityside complex to support the raised alignment, with a new signalised access provided for Yorkgate Business Park.

Link F comprises a two-lane lane drop from Link E, with a steep downhill gradient used to provide headroom to a new corridor underneath the Dargan Bridge, north of the existing M2 on-slip. A minimum cover of approximately 400mm is provided to the existing pile caps of the Dargan Bridge. The link rises to merge into the M2 foreshore in an alignment adjacent to, but lower than, Link B. Link F is a maximum of approximately 2.5m below the adjacent levels on Link B, with a retaining wall proposed to provide both support and vehicle restraint. The link rises on approach to Dock Street Bridge, with the two lanes on the link reducing to one on approach to a single lane gain onto the northbound M2 foreshore. Widening of the existing Dock Street Bridge will be required to facilitate the alignment of the link.

Link G comprises a lane drop from Link B, opening to two lanes at the back of the diverge nose. The alignment rises to tie in at a proposed signalised junction on Link E. Works are required to replace the existing retaining walls along the back of existing residential properties on Little George's Street to support the raised link.

Link H provides a merge from Corporation Street onto Link A, using a parallel merge arrangement. A ghost island is provided for the right turning movement on Corporation Street and this will require some widening of the existing carriageway on the western side, within the site of the existing Roads Service depot.

Link I provides a direct link from Dock Street to the M3, with some horizontal realignment of the existing link required. The vertical alignment is slightly raised in part over existing levels. The existing off-slip at Nelson Street from the M2 will be closed as part of the layout.

Link J provides an at-grade connection between the M3 and Westlink. The existing carriageway will be largely unchanged, with some additional traffic islands and white lining changes. Vertically, the link is largely at existing levels, rising to approximately 800mm above existing ground level to achieve tie-in with Link E. The raised vertical alignment will be supported by a retaining wall on the south side of the link.

Other works required by the Option include the provision of signalised connection to Nelson Street, both north and south of Link J. This includes the conversion of Nelson Street (south) to permit two-way running, requiring works at the junction of Dunbar Link and Nelson Street to provide a signal controlled right-turning movement. Local regrading of the existing accesses onto York Street will be required to accompany the raised alignment of Link E.

Consultations with Roads Service's Traffic Information and Control Centre (TICC) have led to the identification of indicative gantry locations to service the extension of the Managed Route system on the M1/Westlink onto the M2 foreshore as far as Nelson Street. With regard to infrastructure works within the extent of Option A it is expected that a minimum of three new access gantries will be required along with associated control cabinets and transmission links. The first of these gantries will be required immediately east of North Queen Street Bridge to provide advance direction signage and traffic control for Link G. The second gantry will be required immediately upstream of the diverge for Link C from Link B, again providing advance direction signage and traffic control. With regard to the third gantry, it is proposed to replace an existing gantry on the northbound M2 foreshore with an access gantry of increased span, to accommodate the wider carriageway.

3.3.2.2 *Cost Estimate*

A cost estimate has been prepared for Option A in accordance with the published guidance of Roads Service's RSPPG_E058 entitled "Major Works Estimates" dated June 2011 and summarised in **Table 3.3.3**. Estimates have been prepared with reference to Spon's Civil Engineering and Highway Works Price Book 2011[8] using May 2010 as a base year for estimation purposes along with market rates at November 2011.

[8] "Spon's Civil Engineering and Highway Works Price Book 2011, 25th Edition", David Langdon, Spon Press. ISBN 978 0 415 58847 8. 2011.

TABLE 3.3.3: OPTION A SCHEME ESTIMATE

Item	Sub-Item	2011 Stage 2 Estimate (rounded up to nearest £ 0.1M)
Construction Costs	Preliminary Works	9.9
	Road Works	15.0
	Structures	30.3
	Utilities	4.0
	Other Costs	0.0
Land Costs	Land Purchase Cost	3.1
	Disturbance / Severance / Injurious Affliction / Part 2 Claims	0.5
Consultant Costs	Preparation Costs	5.6
	Supervision Costs	3.1
Risk and Optimism Bias	Risk Allowance	5.1
	Optimism Bias (16.5%)	12.6
	Land Optimism Bias (0%)	0.0
Total Option A Scheme Estimate		**89.3**

It should be noted that the methodology for preparing cost estimates required by Roads Service in its RSPPG E058 differs from the methodology required by the COBA analysis software for economic assessment of the scheme. Accordingly, some adjustments have been made to the above estimate to facilitate entry into the COBA software. The cost estimates used in the COBA assessment are detailed in **Section 7.4** of this report.

3.3.3 *Option B*

3.3.3.1 *Description*

Option B presents the first of two elevated concept designs. The layout provides a full interchange, with Links in both depressed corridors and on elevated overbridge structures.

A plan of the proposed layout is included as **Drawing S105296-R-SK-B-000** with profiles of the various links also included as **Drawings S105296-R-SK-B-100 to 101** inclusive and cross-sections at key locations further included on **Drawings S105296-R-SK-B-200 to 207** inclusive.

For the purposes of describing the principal roadworks required, the convention set out in **Table 3.3.4** has been adopted to describe the various links within the proposed layout.

TABLE 3.3.4: OPTION B LINK NAMING CONVENTION

Link	From	To
A	M2	Westlink
B	Westlink	M2
C	Westlink	M3
D	M3	Westlink
E	York Street (South)	York Street (North)
F	York Street	M2
G	Westlink	York Street
H	Nelson Street	Westlink
I	Dock Street	M3
J	M3	York Street

Option B retains a number of link alignments from Option A, with the following Links having the same horizontal and vertical alignments as their counterparts in Option A (as described in **Section 3.3.2.1**):

- Link B
- Link C
- Link E
- Link F
- Link G.

Link A commences with a 2-lane lane drop from the M2 southbound foreshore leading directly onto the main elevated structure with several spans. This structure spans over Dock Street Bridge and the Lagan and Dargan Bridges, approximately 17.5m above street level. The largest span on the structure is approximately 90m. The structure continues to span over Link E and ties back into the existing Westlink levels at North Queen Street Bridge. Given the level differences between Link A and Link B, retaining solutions will be required in the central median and at the nearside verge to support the new alignment.

Link D introduces grade separation of the M3 to Westlink movement through the provision of an overbridge structure over Link E. In order to achieve the required headroom, the link rises beyond the tie-in with the off-ramp structure on approach to the Dargan Bridge, where the link is raised by a maximum of 1.3m above existing ground level. This limits headroom under the Dargan Bridge to the minimum value of 5.3m. Beyond the Dargan Bridge, the link rises over Link E on an overbridge structure and merges as a lane gain with Link A.

Link H provides a link from Nelson Street to Link A through an additional overbridge structure over Dock Street. To support the new link, retaining walls will be required on either side, with the southbound bus lane on Nelson Street requiring realignment into adjacent lands. In order to access this link, Garmoyle Street will require conversion to two-way running, which will require notable additional works. These works comprise the introduction of a 600mm wide separation island between opposing flows and the introduction of signalised control at a new junction between Garmoyle Street and Nelson Street. Further white lining alterations will be required to convert lane 3 on the Duncrue Street off-slip for use as a dedicated bus lane.

Link J commences with a taper diverge from Link D under the Dargan Bridge. As the link separates from Link D it is lowered from a maximum of 600mm above existing ground level to tie in at a position close to the junction with Little York Street. Beyond this point the link rises to tie in with the raised Link E, a maximum of approximately 800mm above existing ground level, supported by a retaining wall.

Other works required by the Option include the stopping up of Nelson Street and its conversion to permit two-way running, requiring works at the junction of Dunbar Link and Nelson Street to provide a signal controlled right-turning movement. Local regrading of the existing accesses onto York Street will be required to accompany the raised alignment of Link E. Further works will be required to regrade Little York Street into the revised alignment of Link J. In order to provide access to the isolated portion of land between Links A and D, it is proposed to construct a new access road underneath the Lagan Bridge and Dargan Bridge, with connection onto Corporation Street via a priority junction.

Consultations with Roads Service's Traffic Information and Control Centre (TICC) have led to the identification of indicative gantry locations to service the extension of the Managed Route system on the M1/Westlink onto the M2 foreshore as far as Nelson Street. With regard to infrastructure works within the extent of Option B it is expected that a minimum of three new access gantries will be required along with associated control cabinets and transmission links. The first of these gantries will be required immediately east of North Queen Street Bridge to provide advance direction signage and traffic control for Link G. The second gantry will be required immediately upstream of the diverge for Link C from Link B, again providing advance direction signage and traffic control. With regard to the third gantry, it is proposed to replace an existing gantry on the northbound M2 foreshore with an access gantry of increased span, to accommodate the wider carriageway.

3.3.3.2 *Cost Estimate*

A cost estimate has been prepared for Option B in accordance with the published guidance of Roads Service's RSPPG_E058 entitled "Major Works Estimates" dated June 2011 and summarised in **Table 3.3.5**. Estimates have been prepared with reference to Spon's Civil Engineering and Highway Works Price Book 2011[9] using May 2010 as a base year for estimation purposes along with market rates at November 2011.

[9] "Spon's Civil Engineering and Highway Works Price Book 2011, 25th Edition", David Langdon, Spon Press. ISBN 978 0 415 58847 8. 2011.

TABLE 3.3.5: OPTION B SCHEME ESTIMATE

Item	Sub-Item	2011 Stage 2 Estimate (rounded up to nearest £ 0.1M)
Construction Costs	Preliminary Works	11.6
	Road Works	13.5
	Structures	40.5
	Utilities	4.0
	Other Costs	0.0
Land Costs	Land Purchase Cost	0.1
	Disturbance / Severance / Injurious Affliction / Part 2 Claims	0.5
Consultant Costs	Preparation Costs	6.3
	Supervision Costs	3.5
Risk and Optimism Bias	Risk Allowance	4.9
	Optimism Bias (16.5%)	14.0
	Land Optimism Bias (0%)	0.0
Total Option B Scheme Estimate		**99.0**

It should be noted that the methodology for preparing cost estimates required by Roads Service in its RSPPG E058 differs from the methodology required by the COBA analysis software for economic assessment of the scheme. Accordingly, some adjustments have been made to the above estimate to facilitate entry into the COBA software. The cost estimates used in the COBA assessment are detailed in **Section 7.4** of this report.

3.3.4 *Option C*

3.3.4.1 *Description*

Option C presents the second of two depressed concept designs. The layout provides a full interchange, with Links at either existing ground level or in depressed sections.

A plan of the proposed layout is included as **Drawing S105296-R-SK-C-000**, with profiles of the various links also included as **Drawings S105296-R-SK-C-100 to 101** inclusive and cross-sections at key locations further included on **Drawings S105296-R-SK-C-200 to 206** inclusive.

For the purposes of describing the principal roadworks required, the convention set out in **Table 3.3.6** has been adopted to describe the various links within the proposed layout.

TABLE 3.3.6: OPTION C LINK NAMING CONVENTION

Link	From	To
A	M2	Westlink
B	Westlink	M2
C	Westlink	M3
D	M3	Westlink
E	York Street (South)	York Street (North)
F	York Street	M2
G	Westlink	York Street
H	Corporation Street	Westlink
I	Dock Street	M3
J	M3	York Street

Option C is based on Option A, with the following links having the same horizontal and vertical alignments as their counterparts in Option A:

- Link A
- Link B
- Link C
- Link E
- Link F
- Link G
- Link H
- Link I.

It should be noted that the feasibility of the proposed underpass structure underneath the Lagan and Dargan Bridges has been separated examined in the URS report of June 2010 entitled “Evaluation of Underpass Structure (Stage 2)”, report reference S105296/S/02/02. Copies of this report can be made available upon request.

Link D provides the grade separation of the M3 to Westlink movement missing from Option A. To do so, the link is depressed on approach to the Dargan Bridge, from the tie-in point with existing levels at the M3 off-ramp. As the link passes under Dargan Bridge, it is depressed by a maximum of approximately 700mm below existing ground level, with minimum cover to the existing pile cap of 400mm. Beyond the Dargan Bridge, the link lowers into an underpass structure to achieve headroom under Link E. The link remains depressed by a maximum of 6m below existing ground level, before rising to tie-in with Link A. A longer weaving length is the key benefit of the revised merge position.

Link J commences with a single lane taper diverge from Link D and accordingly, is in cutting as it passes under the Dargan Bridge, a maximum of approximately 700mm below existing ground level. This cutting increases to a maximum of approximately 1.5m below existing ground level immediately west of the Dargan Bridge, at a position close to the Nelson Street/Great George’s Street junction. This will require a retaining structure. The link rises out of cutting and meets existing ground level at a position close to the existing junction between Great George’s Street and Little York Street. The link continues to rise to meet the raised alignment of Link E and is a maximum of approximately 800mm above existing ground level at the junction between the links.

Other works required by the Option include the stopping up of Nelson Street and its conversion to permit two-way running, requiring works at the junction of Dunbar Link and Nelson Street to provide a signal controlled right-turning movement. Local regrading of the existing accesses onto York Street will be required to accompany the raised alignment of Link E. Further works will be required to regrade Little York Street into the revised alignment of Link J. In order to provide access to the isolated portion of land between Links A and D, it is proposed to construct a new access road underneath the Lagan Bridge and Dargan Bridge, with connection onto Corporation Street via a priority junction.

Consultations with Roads Service’s Traffic Information and Control Centre (TICC) have led to the identification of indicative gantry locations to service the extension of the Managed Route system on the M1/Westlink onto the M2 foreshore as far as Nelson Street. With regard to infrastructure works within the extent of Option C it is expected that a minimum of three new access gantries will be required along with associated control cabinets and transmission links. The first of these gantries will be required immediately east of North Queen Street Bridge to provide advance direction signage and traffic control for Link G. The second gantry will be required immediately upstream of the diverge for Link C from Link B, again providing advance direction signage and traffic control. With regard to the third gantry, it is proposed to replace an existing gantry on the northbound M2 foreshore with an access gantry of increased span, to accommodate the wider carriageway.

3.3.4.2 *Cost Estimate*

A cost estimate has been prepared for Option C in accordance with the published guidance of Roads Service’s RSPPG_E058 entitled “Major Works Estimates” dated June 2011 and summarised in **Table 3.3.7**. Estimates have been prepared with reference to Spon’s Civil Engineering and Highway Works Price Book 2011[10] using May 2010 as a base year for estimation purposes along with market rates at November 2011.

[10] “Spon’s Civil Engineering and Highway Works Price Book 2011, 25th Edition”, David Langdon, Spon Press. ISBN 978 0 415 58847 8. 2011.

TABLE 3.3.7: OPTION C SCHEME ESTIMATE

Item	Sub-Item	2011 Stage 2 Estimate (rounded up to nearest £ 0.1M)
Construction Costs	Preliminary Works	11.3
	Road Works	15.9
	Structures	36.1
	Utilities	4.6
	Other Costs	0.0
Land Costs	Land Purchase Cost	4.3
	Disturbance / Severance / Injurious Affliction / Part 2 Claims	0.5
Consultant Costs	Preparation Costs	6.5
	Supervision Costs	3.6
Risk and Optimism Bias	Risk Allowance	5.2
	Optimism Bias (16.5%)	14.5
	Land Optimism Bias (0%)	0.0
Total Option C Scheme Estimate		**102.5**

It should be noted that the methodology for preparing cost estimates required by Roads Service in its RSPPG E058 differs from the methodology required by the COBA analysis software for economic assessment of the scheme. Accordingly, some adjustments have been made to the above estimate to facilitate entry into the COBA software. The cost estimates used in the COBA assessment are detailed in **Section 7.4** of this report.

3.3.5 *Option D*

3.3.5.1 *Description*

Option D presents the second of two elevated concept designs. The layout provides a grade separated junction, but not a full interchange, with Links at either existing ground level or on elevated overbridge structures.

A plan of the proposed layout is included as **Drawing S105296-R-SK-D-000**, with profiles of the various links also included as **Drawings S105296-R-SK-D-100 to 101** inclusive and cross-sections at key locations further included on **Drawings S105296-R-SK-D-200 to 206** inclusive.

For the purposes of describing the principal roadworks required, the convention set out in **Table 3.3.8** has been adopted to describe the various links within the proposed layout.

TABLE 3.3.8: OPTION D LINK NAMING CONVENTION

Link	From	To
A	M2	Westlink
B	Westlink	M2
C	Westlink	M3
D	M3	Westlink
E	York Street (South)	York Street (North)
F	York Street	M2
G	Westlink	York Street
H	Nelson Street	Westlink
I	Dock Street	M3
J	M3	York Street

Option D retains a number of link alignments from Option B, with the following Links having the same horizontal and vertical alignments as their counterparts in Option A:

- Link A
- Link D
- Link H
- Link J.

Link B provides grade separation of the Westlink to M2 movement using an elevated overbridge structure over the Dargan Bridge and Lagan Bridge. The link remains at existing levels from its start to North Queen Street Bridge, beyond which it rises rapidly to achieve headroom over Link E, but more importantly, the Dargan Bridge. At its highest point, the link is approximately 17.5m above adjacent street level. The link then drops to tie back into the northbound M2 foreshore immediately north of Dock Street Bridge, with significant works required to the existing bridge to facilitate the tie-in. Narrow (3m) lane widths are proposed on the North Queen Street Bridge, subject to the completion of the same kerb realignment works as the other options. In order to provide the link from M3 to Westlink via Links G and C, the diverge nose will need to be brought further west, which means that the absolute minimum weaving length cannot be provided between the Clifton Street lane gain and the diverge point. Accordingly, in the interests of safety, it is proposed that the Clifton Street lane gain is closed for this Option, with the existing lane gain used as an auxiliary lane for a parallel diverge.

Link C provides an at-grade connection from Link G through to Link I. Levels on the link are similar to existing ground levels, with works required to the existing signal controlled junction to facilitate the new arrangement.

Link E provides a horizontal realignment of York Street to provide three northbound lanes towards the junction with Dock Street. This will require some widening works on the existing carriageway, with levels similar to existing ground levels.

Link F reuses the existing on-slip to the M2 from York Street, albeit with white lining changes to reflect the reduced number of lanes available. Some works will be required to the signal controlled junction where the link starts to accommodate the revised alignment of Link E.

Link G provides a slip road from Link B to Link E. The vertical alignment of Link B requires the link to be elevated over the existing levels generally, with the link some 2m above existing level at the back of the diverge nose. This raised alignment will require significant retaining solutions on both sides of the link, with the construction of walls approximately 5m above the levels of gardens to the rear of properties on Great George's Street. From a technical viewpoint, the construction of such walls given the limited access available presents a major buildability issue that needs to be considered.

Link I provides connection from Dock Street to the M3 along the line of the existing Nelson Street, with a vertical alignment similar to existing levels. The existing off-slip from the M2 at Nelson Street will be closed as part of the works. The existing signalised junction on the link at York Link will be revised as part of the works, with an additional link provided from the junction to Corporation Street, to facilitate city centre access for non-motorway traffic.

Other works required by the Option include the stopping up of Nelson Street and its conversion to permit two-way running, requiring works at the junction of Dunbar Link and Nelson Street to provide a signal controlled right-turning movement. Local regrading of the existing accesses onto York Street will be required to accompany the revised alignment of Link E. Further works will be required to regrade Little York Street into the revised alignment of Link J. In order to provide access to the isolated portion of land between Links A and D, it is proposed to construct a new access road underneath the Lagan Bridge and Dargan Bridge, requiring works to the existing central median on Nelson Street and widening of Shipbuoy Street.

Consultations with Roads Service's Traffic Information and Control Centre (TICC) have led to the identification of indicative gantry locations to service the extension of the Managed Route system on the M1/Westlink onto the M2 foreshore as far as Nelson Street. With regard to infrastructure works within the extent of Option D it is expected that a new access gantry will be required along with associated control cabinets and transmission links. The gantry will be required immediately east of North Queen Street Bridge to provide advance direction signage and traffic control for Link G.

3.3.5.2 *Cost Estimate*

A cost estimate has been prepared for Option D in accordance with the published guidance of Roads Service's RSPPG_E058 entitled "Major Works Estimates" dated June 2011 and summarised in **Table 3.3.9**. Estimates have been prepared with reference to Spon's Civil

Engineering and Highway Works Price Book 2011[11] using May 2010 as a base year for estimation purposes along with market rates at November 2011.

TABLE 3.3.9: OPTION D SCHEME ESTIMATE

Item	Sub-Item	2011 Stage 2 Estimate (rounded up to nearest £ 0.1M)
Construction Costs	Preliminary Works	12.0
	Road Works	11.2
	Structures	47.0
	Utilities	1.6
	Other Costs	0.0
Land Costs	Land Purchase Cost	0.1
	Disturbance / Severance / Injurious Affliction / Part 2 Claims	1.0
Consultant Costs	Preparation Costs	6.6
	Supervision Costs	3.6
Risk and Optimism Bias	Risk Allowance	5.0
	Optimism Bias (16.5%)	14.5
	Land Optimism Bias (0%)	0.0
Total Option D Scheme Estimate		**102.6**

It should be noted that the methodology for preparing cost estimates required by Roads Service in its RSPPG E058 differs from the methodology required by the COBA analysis software for economic assessment of the scheme. Accordingly, some adjustments have been made to the above estimate to facilitate entry into the COBA software. The cost estimates used in the COBA assessment are detailed in **Section 7.4** of this report.

3.3.6 *Alternative York Street Layouts*

A number of alternative layouts for York Street have been identified for Options A, C and D that provide an opportunity to reintroduce two-way running along the entire length of York Street.

An initial assessment of the proposed arrangements, as shown on **Drawings S105296-R-SK-G-115, 117 and 118** indicates the proposal to be feasible from an engineering perspective, but this will require confirmation following further detailed design development of the Preferred Option. The assessment however concluded that the arrangement could not be introduced on Option B.

[11] "Spon's Civil Engineering and Highway Works Price Book 2011, 25th Edition", David Langdon, Spon Press. ISBN 978 0 415 58847 8. 2011.

The alternative layouts on York Street for Options A, C and D propose the introduction of two-way running over the entire length of York Street, through changes in lane configurations and junction layouts.

In the northbound direction, at the junction of York Street and Frederick Street, the present five northbound lanes will be reduced to three, with a physical island introduced to provide separation between the northbound and southbound flows. This separation will continue along York Street with a break provided at the entry to Little Patrick Street, to facilitate the movement of private cars primarily onto the side street. It would not be possible to accommodate the movement of larger rigid body or articulated vehicles from York Street into and out of Little Patrick Street at this location so this movement by such vehicles will require prohibition by order. On approach to the junction between York Street and Great George's Street, York Street would be widened on the western side into the existing Roads Service car park, to provide a further three lanes on approach to the junction. The junction would remain signalised, with lane 1 a designated filter lane to Great George's Street and, in Option A only, the Westlink. Lanes 2 and 3 would be designated for onward northbound travel along York Street, with lanes 3 and 5 designated for onward travel to the M2 (Link F). It is important to note that, to maintain free-flow for the York Street to M2 movement, an atypical junction arrangement is proposed such that the York Street to M2 movement changes over to the offside of the widened York Street (between the existing Great George's Street and Westlink junctions). Several physical islands are proposed to guide vehicles along the proposed changeover movement. North of this junction, two lanes are maintained through to the junction with Link G from the Westlink, which will be a signal controlled arrangement. Continuing north along York Street the existing left-in, left-out junction at Cityside Retail Park will be removed and replaced with a signalised crossroads to maintain access to both the retail park and the Yorkgate Business Park. On approach to the new junction, an additional lane is developed, with the three northbound lanes continuing beyond this point to Dock Street similar to existing conditions.

In the southbound direction, a single lane will be provided, through widening of York Street to the eastern side and a reduction in the existing footway width, which may require relocation of existing NIE and Cable and Wireless services. The lane is maintained south through the new signalised junction at Cityside Retail Park to the priority junction with the M2. At this point, all cars and goods vehicles are required to turn left onto the York Street to M2 link, in a similar arrangement to the present layout. A single lane will be continued southbound along York Street , the use of which will be determined in line with transportation policy for the city centre, to a stop line under signal control north of the junction between York Street and Great George's Street. At this point, the southbound lane changes over across the lanes designated for the York Street to M2 movement before continuing southbound along York Street, separated by a physical island. The southbound lane is terminated at the signalised junction with Frederick Street. At this junction, all turning movements will be permitted through an easing of the curve radii with a straight ahead movement maintained for City Centre bound traffic along York Street.

The proposed southbound lane would provide an enhanced direct connection for public transport and non-motorised users to the Inner Ring. However, it is noted that these proposed alternative arrangements may have reduced traffic performance, due to the junction arrangements proposed and the reduction in northbound capacity along York Street. In addition, the atypical nature of the junction layout will require additional measures to ensure the safety of motorised and non-motorised users. Pending further development of the designs and assessment of these issues, it has been decided to not include them in the options under assessment at Stage 2, but reserve a decision on their inclusion within the Preferred Option until the Stage 3 Scheme Assessment.

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4 CONSULTATIONS

4.1 Introduction

This section provides a summary of the relevant consultations undertaken as part of the Stage 2 Scheme Assessment process. During the course of the development of the options, and the completion of the engineering and environmental assessments, numerous parties were contacted by URS in order to provide information about the scheme and to understand any relevant concerns that the parties may have. Consultations took the form of:

- Correspondence and meetings with statutory and non-statutory bodies as part of the environmental assessment.
- Correspondence and meetings with statutory and non-statutory bodies as part of the engineering assessment.
- A public consultation event to allow the general public and identified key stakeholders to view and comment upon the proposals.

These consultations are described in **Sections 4.2 to 4.4** inclusive.

4.2 Environmental Assessment Consultations

As part of the environmental assessment, the parties listed in **Table 4.1.1** denoted with an ID field of “ENV” were contacted. Copies of correspondence with these parties are included in **Appendix C** where noted.

4.3 Engineering Assessment Consultations

As part of the engineering assessment, the parties listed in **Table 4.1.1** denoted with an ID field of “ENG” were contacted. Copies of correspondence with these parties are included in **Appendix C** where noted.

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy	
			DD	MM	YY				included in App. C	Record ID
ENG	Antrim Road Regeneration Committee (ARRC)		16	05	11	RS	ARRC	Letter	Yes	001
ENG	Antrim Road Regeneration Committee (ARRC)		29	06	11	ARRC	RS	Letter	Yes	002
ENG	Antrim Road Regeneration Committee (ARRC)		05	07	11	RS	ARRC	Letter	Yes	003
ENG	Ashton Community Trust (ACT)		16	05	11	RS	ACT	Letter	Yes	004
ENG	Belfast City Centre Management (BCCM)	Cathedral Quarter Steering Group	30	06	11	BCCM	RS	Letter	Yes	005
ENG	Belfast City Centre Management (BCCM)	Cathedral Quarter Steering Group	04	07	11	RS	BCCM	Letter	Yes	006
ENG	Belfast City Centre Management (BCCM)	City Centre Manager	19	05	11	RS	BCCM	Letter	No	-
ENG	Belfast City Centre Management (BCCM)	City Centre Manager	03	06	11	BCCM	RS	Email	No	-
ENG	Belfast City Centre Management (BCCM)	City Centre Manager	03	06	11	RS	BCCM	Email	No	-
ENG	Belfast City Centre Management (BCCM)	City Centre Manager	06	06	11	RS	BCCM	Email	No	-
ENG	Belfast City Centre Management (BCCM)	City Centre Manager	14	06	11	BCCM	RS	Email	No	-
ENG	Belfast City Centre Management (BCCM)	City Centre Manager	15	06	11	RS	BCCM	Email	No	-
ENG	Belfast City Council (BCC)	Belfast City Councillors	17	05	11	RS	BCC	Letter	Yes	007
ENG	Belfast City Council (BCC)	Chief Executive's Department	19	04	11	RS	BCC	Letter	No	-
ENG	Belfast City Council (BCC)	Chief Executive's Department	17	05	11	RS	BCC	Letter	Yes	008
ENG	Belfast City Council (BCC)	Development Committee	27	06	11	RS	BCC	Meeting	No	-
ENG	Belfast City Council (BCC)	Development Department	13	04	11	RS	BCC	Meeting	No	-
ENG	Belfast City Council (BCC)	Development Department	27	07	11	BCC	RS	Letter	Yes	009

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy included in App. C	Record ID
			DD	MM	YY					
ENG	Belfast City Council (BCC)	Development Department	24	08	11	RS	BCC	Letter	Yes	010
ENG	Belfast City Council (BCC)	Development Department	21	10	11	BCC	RS	Letter	Yes	011
ENG	Belfast City Council (BCC)	Development Department	08	11	11	RS	BCC	Letter	Yes	012
ENG	Belfast City Council (BCC)	Development Department	19	01	12	BCC	RS	Letter	Yes	013
ENG	Belfast City Council (BCC)	Development Department	08	02	12	RS	BCC	Letter	Yes	014
ENG	Belfast City Council (BCC)	Development Department	02	04	12	RS	BCC	Meeting	No	-
ENG	Belfast City Council (BCC)	Director of Property and Projects	17	05	11	RS	BCC	Letter	Yes	015
ENV	Belfast City Council (BCC)	Health and Environmental Services Department	02	04	12	BCC	RS	Meeting	No	-
ENV	Belfast City Council (BCC)	Health and Environmental Services Department	14	03	11	URS	BCC	Letter	Yes	016
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Air Quality)	14	03	11	URS	BCC	Letter	Yes	017
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Air Quality)	27	04	11	BCC	URS	Letter	Yes	018
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Air Quality)	02	04	12	URS/RS	BCC	Meeting	No	-
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Air Quality)	02	04	12	RS	BCC	Email	No	-

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy	Record
			DD	MM	YY				included in App. C	ID
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Air Quality)	11	05	12	RS	BCC	Email	No	-
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Biodiversity Officer)	14	03	11	URS	BCC	Letter	Yes	019
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Biodiversity Officer)	12	05	11	URS	BCC	Letter	Yes	020
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Contaminated Land)	14	03	11	URS	BCC	Letter	Yes	021
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Contaminated Land)	23	03	11	BCC	URS	Letter	Yes	022
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Noise)	14	03	11	URS	BCC	Letter	Yes	023
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Noise)	12	05	11	URS	BCC	Letter	Yes	024
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Noise)	16	05	11	BCC	URS	Telephone Call	Yes	025
ENV	Belfast City Council (BCC)	Health and Environmental Services Department (Noise)	17	05	11	BCC	URS	Letter	Yes	026

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy	
			DD	MM	YY				included in App. C	Record ID
ENG	Belfast City Council (BCC)	Lord Mayor's Office	17	05	11	RS	BCC	Letter	Yes	027
ENV	Belfast City Council (BCC)	Parks and Leisure Department	14	03	11	URS	BCC	Letter	Yes	028
ENV	Belfast City Council (BCC)	Parks and Leisure Department	06	05	11	BCC	URS	Telephone Call	Yes	029
ENV	Belfast City Council (BCC)	Parks and Leisure Department	12	05	11	URS	BCC	Letter	Yes	030
ENG	Belfast Conflict Resolution Consortium (BCRC)		07	07	11	BCRC	RS	Email	Yes	031
ENG	Belfast Conflict Resolution Consortium (BCRC)		08	07	11	RS	BCRC	Email	Yes	032
ENG	Belfast Harbour Commissioners (BHC)		28	04	10	RS	BHC	Meeting	No	-
ENG	Belfast Harbour Commissioners (BHC)		23	02	11	RS	BHC	Meeting	No	-
ENG	Belfast Harbour Commissioners (BHC)		24	04	11	RS	BHC	Letter	No	-
ENG	Belfast Harbour Commissioners (BHC)		17	05	11	RS	BHC	Letter	Yes	033
ENG	Belfast Harbour Commissioners (BHC)		26	05	11	URS	BHC	Telephone Call	No	-
ENG	Belfast Health and Social Care Trust (BHSCT)		17	05	11	RS	BHSCT	Letter	Yes	034
ENG	British Telecom (BT)		08	02	11	URS	BT	Telephone Call	Yes	035
ENG	British Telecom (BT)		29	06	11	URS	BT	Telephone Call	Yes	036
ENG	Cable and Wireless (C&W)		10	06	11	URS	C&W	Telephone Call	Yes	037
ENG	Camberwell Court Residents Committee (CCRC)		16	05	11	RS	CCRC	Letter	Yes	038
ENG	Carrickhill Residents Association (CHRA)		16	05	11	RS	CHRA	Letter	Yes	039
ENV	Centre for Environmental Data and Recording (CEDaR)		11	10	11	URS	CEDaR	Email	Yes	040
ENV	Centre for Environmental Data and Recording (CEDaR)		13	11	11	CEDaR	URS	Email	Yes	041

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy	
			DD	MM	YY				included in App. C	Record ID
ENG	Confederation of British Industry (CBI)		21	04	11	URS	CBI	Letter	Yes	042
ENG	Confederation of British Industry (CBI)		17	05	11	RS	CBI	Letter	Yes	043
ENV	Council for Nature and the Countryside (CNCC)	Chairman	14	03	11	URS	CNCC	Letter	Yes	044
ENV	Council for Nature and the Countryside (CNCC)	Chairman	13	04	11	CNCC	URS	Email	Yes	045
ENG	Crown Estate Commissioners (CEC)		21	04	11	URS	CEC	Letter	Yes	046
ENG	Democratic Unionist Party (DUP)		17	05	11	RS	DUP	Letter	Yes	047
ENG	Democratic Unionist Party (DUP)		18	05	12	RS	DUP	Meeting	No	-
ENV	Department of Agriculture and Rural Development (DARD)	Countryside Management Branch	14	03	11	URS	DARD	Letter	Yes	048
ENV	Department of Agriculture and Rural Development (DARD)	Countryside Management Branch	12	05	11	URS	DARD	Letter	Yes	049
ENV	Department of Agriculture and Rural Development (DARD)	Countryside Management Branch	13	05	11	DARD	URS	Email	Yes	050
ENV	Department of Agriculture and Rural Development (DARD)	Countryside Management Branch	11	07	11	DARD	URS	Email	Yes	051
ENV	Department of Culture, Arts and Leisure (DCAL)	Central Management Unit – Fisheries Operations and Technical Support	14	03	11	URS	DCAL	Letter	Yes	052
ENV	Department of Culture, Arts and Leisure (DCAL)	Central Management Unit – Fisheries Operations and Technical Support	06	05	11	DCAL	URS	Email	Yes	053
ENG	Department of Finance and Personnel (DFP)	Central Procurement Directorate	27	10	11	URS/RS	DFP	Meeting	No	-

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ID	Organisation	Department/Section	Date			From	To	Description	Copy included in App. C	Record ID
			DD	MM	YY					
ENG	Department of Finance and Personnel (DFP)		14	04	11	URS/RS	DFP	Meeting	No	-
ENG	Department for Regional Development (DRD)	Permanent Secretary	17	05	11	RS	DRD	Letter	Yes	054
ENG	Department for Regional Development (DRD)	Rapid Transit Team	17	05	11	RS	DRD	Letter	Yes	055
ENG	Department for Regional Development (DRD)	Regional Planning and Transportation Unit	17	05	11	RS	DRD	Letter	Yes	056
ENG	Department for Social Development (DSD)	Belfast City Centre Regeneration Directorate	17	05	11	RS	DSD	Letter	Yes	057
ENG	Department for Social Development (DSD)	Belfast City Centre Regeneration Directorate	23	06	11	RS	DSD	Meeting	No	-
ENG	Department for Social Development (DSD)	Headquarters	04	04	11	RS	DSD	Meeting	No	-
ENG	Department for Social Development (DSD)	Headquarters	17	05	11	RS	DSD	Letter	Yes	058
ENG	Department for Social Development (DSD)	Minister for Social Development	15	05	11	RS	DSD	Meeting	No	-
ENG	Department of Education (DENI)		21	04	11	URS	DENI	Letter	Yes	059
ENG	Department of Enterprise, Trade and Investment (DETI)		21	04	11	URS	DETI	Letter	Yes	060
ENG	Disabled Drivers Association (DDA)		21	04	11	URS	DDA	Letter	Yes	061
ENG	Driver and Vehicle Agency (DVA)		29	03	11	URS/RS	DVA	Meeting	No	-
ENG	Driver and Vehicle Agency (DVA)		17	05	11	RS	DVA	Letter	Yes	062
ENG	Economic, Planning and Environmental Consultants Ltd (EPEC)		02	06	11	EPEC	RS	Email	Yes	063
ENG	Economic, Planning and Environmental Consultants Ltd (EPEC)		06	06	11	RS	EPEC	Email	Yes	064

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy included in App. C	Record ID
			DD	MM	YY					
ENG	Economic, Planning and Environmental Consultants Ltd (EPEC)		06	06	11	EPEC	RS	Email	Yes	065
ENG	Federation of Small Businesses (FSB)		21	04	11	URS	FSB	Letter	Yes	066
ENG	Focus Security Solutions (FSS)		27	05	11	URS/RS	FSS	Meeting	No	-
ENG	Fortwilliam Youth Centre (FYC)		17	05	11	RS	FYC	Letter	Yes	067
ENG	Forum for Alternative Belfast (FAB)		02	06	11	RS	FAB	Meeting	No	-
ENG	Forum for Alternative Belfast (FAB)		01	07	11	FAB	RS	Email	Yes	068
ENG	Forum for Alternative Belfast (FAB)		01	07	11	RS	FAB	Email	Yes	069
ENG	Forum for Alternative Belfast (FAB)		31	08	11	RS	FAB	Email	Yes	070
ENG	Freight Transport Association (FTA)		21	04	11	URS	FTA	Letter	Yes	071
ENG	Freight Transport Association (FTA)		17	05	11	RS	FTA	Letter	Yes	072
ENG	Freight Transport Association (FTA)		01	06	11	RS	FTA	Letter	No	-
ENV	Geological Survey of Northern Ireland (GSNI)		14	03	11	URS	GSNI	Letter	Yes	073
ENV	Geological Survey of Northern Ireland (GSNI)		21	04	11	GSNI	URS	Email	Yes	074
ENV	Geological Survey of Northern Ireland (GSNI)		12	05	11	URS	GSNI	Letter	No	-
ENG	Groundwork NI (GNI)		16	05	11	RS	GNI	Letter	Yes	075
ENG	Helm Housing (HH)		04	04	11	RS	HH	Meeting	No	-
ENG	Helm Housing (HH)		17	05	11	RS	HH	Letter	Yes	076
ENG	Highway Management Maintenance (HMM)		08	12	11	URS	HMM	Telephone Call	Yes	077
ENV	Historic Buildings Council (HiBC)	Secretariat	14	03	11	URS	HiBC	Letter	Yes	078

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy included in App. C	Record ID
			DD	MM	YY					
ENV	Historic Buildings Council (HiBC)	Secretariat	12	05	11	URS	HiBC	Letter	Yes	079
ENV	Historic Buildings Council (HiBC)	Secretariat	24	05	11	HiBC	URS	Email	Yes	080
ENV	Historic Monuments Council (HiMC)	Secretariat	14	03	11	URS	HiMC	Letter	Yes	081
ENV	Historic Monuments Council (HiMC)	Secretariat	12	05	11	URS	HiMC	Letter	Yes	082
ENV	Historic Monuments Council (HiMC)	Secretariat	18	05	11	HiMC	URS	Email	Yes	083
ENG	Indian Community Centre (ICC)		16	05	11	RS	ICC	Letter	Yes	084
ENG	Inner North Neighbourhood Renewal Partnership (INNRP)		16	05	11	RS	INNRP	Letter	Yes	085
ENG	Invest NI (INI)		21	04	11	RS	INI	Letter	Yes	086
ENG	Irish Business and Employers Confederation (IBEC)		21	04	11	RS	IBEC	Letter	Yes	087
ENG	Jack Kirks Garage (JK)		27	05	11	RS	JK	Meeting	No	-
ENG	Jennymount Community Association (JCA)		16	05	11	RS	JCA	Letter	Yes	088
ENG	Loughview Community Action Partnership (LCAP)		16	05	11	RS	LCAP	Letter	Yes	089
ENG	Lower Duncairn Community Forum (LDCF)		16	05	11	RS	LDCF	Letter	Yes	090
ENG	Lower North Belfast Community Council (LNBCC)		16	05	11	RS	LNBCC	Letter	Yes	091
ENG	Lower North Queen Street Residents Association (LNQRA)		16	05	11	RS	LNQRA	Letter	Yes	092
ENG	Lower Oldpark Community Association (LNQRA)		16	05	11	RS	LNQRA	Letter	Yes	093
ENG	Ministry of Defence		21	04	11	URS	LNQRA	Letter	Yes	094

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ID	Organisation	Department/Section	Date			From	To	Description	Copy included in App. C	Record ID
			DD	MM	YY					
ENG	Mount Vernon Community Development Forum (MVCDF)		16	05	11	RS	MVCDF	Letter	Yes	095
ENG	Musgrave Park Hospital (MPH)		17	05	11	RS	MPH	Letter	Yes	096
ENG	New Lodge Community Forum (NLCF)		16	05	11	RS	NLCF	Letter	Yes	097
ENG	New Lodge Housing Forum (NLHF)		16	05	11	RS	NLHF	Letter	Yes	098
ENG	Newington Residents Association (NRA)		16	05	11	RS	NRA	Letter	Yes	099
ENG	North Belfast Partnership (NBP)		16	05	11	RS	NBP	Letter	Yes	100
ENG	North Belfast Partnership (NBP)		29	06	11	NBP	RS	Email	Yes	101
ENG	North Belfast Partnership (NBP)		01	07	11	RS	NBP	Letter	Yes	102
ENG	Northern Ireland Ambulance Service (NIAS)		14	04	11	URS/RS	NIAS	Meeting	No	-
ENG	Northern Ireland Ambulance Service (NIAS)		17	05	11	RS	NIAS	Letter	Yes	103
ENV	Northern Ireland Badger Group (NIBdG)		14	03	11	URS	NIBdG	Letter	Yes	104
ENV	Northern Ireland Badger Group (NIBdG)		12	05	11	URS	NIBdG	Letter	Yes	105
ENV	Northern Ireland Bat Group (NIBtG)	Records Secretary	14	03	11	URS	NIBtG	Letter	Yes	106
ENV	Northern Ireland Bat Group (NIBtG)	Records Secretary	22	03	11	NIBtG	URS	Email	Yes	107
ENG	Northern Ireland Council for Voluntary Action (NICVA)		19	05	11	RS	NICVA	Letter	Yes	108
ENG	Northern Ireland Electricity (NIE)		06	04	11	URS	NIE	Meeting	No	-
ENV	Northern Ireland Environment Agency (NIEA)	Built Heritage (Historic Buildings Unit)	14	03	11	URS	NIEA	Letter	Yes	109

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ID	Organisation	Department/Section	Date			From	To	Description	Copy	
			DD	MM	YY				included in App. C	Record ID
ENV	Northern Ireland Environment Agency (NIEA)	Built Heritage (Historic Buildings Unit)	16	03	11	NIEA	URS	Letter	Yes	110
ENV	Northern Ireland Environment Agency (NIEA)	Built Heritage (Historic Monuments Unit)	14	03	11	URS	NIEA	Letter	Yes	111
ENV	Northern Ireland Environment Agency (NIEA)	Built Heritage (Historic Monuments Unit)	12	05	11	URS	NIEA	Letter	Yes	112
ENV	Northern Ireland Environment Agency (NIEA)	Built Heritage (Historic Monuments Unit)	06	06	11	NIEA	URS	Email	Yes	113
ENV	Northern Ireland Environment Agency (NIEA)	Built Heritage (Historic Monuments Unit)	07	06	11	URS	NIEA	Email	Yes	114
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit	14	03	11	URS	NIEA	Letter	Yes	115
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Industrial Pollution & Radiochemical Inspectorate	14	03	11	URS	NIEA	Letter	Yes	116
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Industrial Pollution & Radiochemical Inspectorate	12	05	11	URS	NIEA	Letter	Yes	117
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Industrial Pollution & Radiochemical Inspectorate	16	05	11	NIEA	URS	Email	Yes	118
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Land and Resource Management Unit	14	03	11	URS	NIEA	Letter	Yes	119

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy	
			DD	MM	YY				included in App. C	Record ID
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Land and Resource Management Unit	12	05	11	URS	NIEA	Letter	Yes	120
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Water Management Unit	14	03	11	URS	NIEA	Letter	Yes	121
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Water Management Unit	15	03	11	NIEA	URS	Letter	Yes	122
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Water Management Unit	16	03	11	NIEA	URS	Email	Yes	123
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Water Management Unit	28	03	11	NIEA	URS	Telephone Call	Yes	124
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Water Management Unit	29	03	11	NIEA	URS	Email	Yes	125
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Water Management Unit	01	04	11	NIEA	URS	Email	Yes	126
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit - Water Management Unit	08	04	11	NIEA	URS	Letter	Yes	127
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit – Air & Environmental Quality	14	03	11	URS	NIEA	Letter	Yes	128

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy	Record
			DD	MM	YY				included in App. C	ID
ENV	Northern Ireland Environment Agency (NIEA)	Environmental Protection Unit – Air & Environmental Quality	29	03	11	NIEA	URS	Letter	Yes	129
ENV	Northern Ireland Environment Agency (NIEA)	Natural Heritage	14	03	11	URS	NIEA	Letter	Yes	130
ENV	Northern Ireland Environment Agency (NIEA)	Natural Heritage	15	03	11	NIEA	URS	Letter	Yes	131
ENV	Northern Ireland Environment Agency (NIEA)	Natural Heritage	18	03	11	NIEA	URS	Letter	Yes	132
ENG	Northern Ireland Environment Link (NIEL)		01	06	11	NIEL	RS	Letter	No	-
ENG	Northern Ireland Fire and Rescue Service (NIFRS)		21	04	11	URS/RS	NIFRS	Meeting	No	-
ENG	Northern Ireland Fire and Rescue Service (NIFRS)		17	05	11	RS	NIFRS	Letter	Yes	133
ENG	Northern Ireland Hotels Federation (NIHF)		01	06	11	NIHF	RS	Letter	No	-
ENG	Northern Ireland Housing Executive (NIHE)		04	05	11	URS/RS	NIHE	Meeting	No	-
ENG	Northern Ireland Housing Executive (NIHE)		17	05	11	RS	NIHE	Letter	Yes	134
ENV	Northern Ireland Tourist Board (NITB)		14	03	11	URS	NITB	Letter	Yes	135
ENV	Northern Ireland Tourist Board (NITB)		14	04	11	NITB	URS	Email	Yes	136
ENG	Northern Ireland Transport Holding Company (NITHCo)		21	04	11	URS	NITHCo	Letter	Yes	137
ENG	Northern Ireland Transport Holding Company (NITHCo)		17	05	11	RS	NITHCo	Letter	Yes	138
ENG	Northern Ireland Transport Holding Company (NITHCo)		06	07	12	URS/RS	NITHCo	Meeting	No	-
ENG	Northern Ireland Water (NIW)		04	06	10	URS/RS	NIW	Meeting	No	-
ENG	Northern Ireland Water (NIW)		02	03	11	URS	NIW	Telephone Call	Yes	139

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy	Record
			DD	MM	YY				included in App. C	ID
ENG	Northern Ireland Water (NIW)		15	04	11	URS/RS	NIW	Meeting	No	-
ENG	Northern Ireland Water (NIW)		21	04	11	URS	NIW	Letter	Yes	140
ENG	Northern Ireland Water (NIW)		17	05	11	RS	NIW	Letter	Yes	141
ENG	Northern Ireland Water (NIW)		17	10	11	NIW	URS	Telephone Call	Yes	142
ENG	Northern Ireland Water (NIW)		25	10	11	NIW	RS	Letter	Yes	143
ENG	Northern Ireland Water (NIW)		21	11	11	URS/RS	NIW	Meeting	No	-
ENG	Parkside Community Association (PCA)		16	05	11	RS	PCA	Letter	Yes	144
ENV	Planning NI (PNI)	BMAP Manager	14	03	11	URS	PNI	Letter	Yes	145
ENV	Planning NI (PNI)	BMAP Manager	12	05	11	URS	PNI	Letter	Yes	146
ENG	Planning NI (PNI)	Chief Executive	17	05	11	RS	PNI	Letter	Yes	147
ENV	Planning NI (PNI)	Divisional Planning Manager	14	03	11	URS	PNI	Letter	Yes	148
ENV	Planning NI (PNI)	Divisional Planning Manager	12	05	11	URS	PNI	Letter	Yes	149
ENV	Planning NI (PNI)	Landscape Architects Branch	14	03	11	URS	PNI	Letter	Yes	150
ENV	Planning NI (PNI)	Landscape Architects Branch	12	05	11	URS	PNI	Letter	Yes	151
ENV	Planning NI (PNI)	Minerals Unit	14	03	11	URS	PNI	Letter	Yes	152
ENV	Planning NI (PNI)	Minerals Unit	03	05	11	PNI	URS	Email	Yes	153
ENV	Planning NI (PNI)	Tree Preservation Orders	14	03	11	URS	PNI	Letter	Yes	154
ENV	Planning NI (PNI)	Tree Preservation Orders	16	03	11	PNI	URS	Email	Yes	155
ENG	Police Service of Northern Ireland (PSNI)	Road Policing Unit	08	04	11	URS/RS	PSNI	Meeting	No	-
ENG	Police Service of Northern Ireland (PSNI)	Road Policing Unit	12	04	11	RS	PSNI	Letter	No	-
ENG	Police Service of Northern Ireland (PSNI)	Road Policing Unit	17	05	11	RS	PSNI	Letter	Yes	156

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy	
			DD	MM	YY				included in App. C	Record ID
ENG	Pragma Planning Ltd (PP)		01	06	11	PP	RS	Letter	No	-
ENG	Rivers Agency (RA)		12	02	11	URS	RA	Telephone Call	Yes	157
ENG	Rivers Agency (RA)		17	05	11	URS	RA	Letter	Yes	158
ENG	Rivers Agency (RA)		16	11	11	URS	RA	Meeting	No	-
ENG	Rivers Agency (RA)		22	03	12	URS	RA	Meeting	No	-
ENG	Road Haulage Association (RHA)		21	04	11	URS	RHA	Letter	Yes	159
ENG	Road Haulage Association (RHA)		17	05	11	RS	RHA	Letter	Yes	160
ENG	Sinn Féin (SF)		17	05	11	RS	SF	Letter	Yes	161
ENG	Skegoneill Community Group (SCG)		17	05	11	RS	SCG	Letter	Yes	162
ENG	Social, Democratic and Labour Party (SDLP)		17	05	11	RS	SDLP	Letter	Yes	163
ENG	Stephen Wood Consultancy (SWC)		01	06	11	SWC	RS	Letter	No	-
ENG	Strategic Investment Board (SIB)		17	05	11	RS	SIB	Letter	Yes	164
ENV	Sustrans Northern Ireland (SUST)		14	03	11	URS	SUST	Letter	Yes	165
ENV	Sustrans Northern Ireland (SUST)		12	05	11	URS	SUST	Letter	Yes	166
ENV	Sustrans Northern Ireland (SUST)		17	05	11	RS	SUST	Letter	Yes	167
ENG	The Automobile Association (AA)		21	04	11	URS	AA	Letter	Yes	168
ENV	The National Trust (NT)	Land Use Planning Advisor	14	03	11	URS	NT	Letter	Yes	169
ENV	The National Trust (NT)	Land Use Planning Advisor	19	04	11	NT	URS	Letter	Yes	170
ENV	The Royal Society for the Protection of Birds (RSPB)		14	03	11	URS	RSPB	Letter	Yes	171
ENV	The Royal Society for the Protection of Birds (RSPB)		04	04	11	RSPB	URS	Email	Yes	172
ENV	The Woodland Trust (WT)		14	03	11	URS	WT	Letter	Yes	173
ENV	The Woodland Trust (WT)		18	03	11	WT	URS	Email	Yes	174

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy included in App. C	Record ID
			DD	MM	YY					
ENG	Tigers Bay Concerned Residents Group (TBCRG)		16	05	11	RS	TBCRG	Letter	Yes	175
ENG	Translink	Northern Ireland Railways	23	03	10	URS/RS	TL	Meeting	No	-
ENG	Translink	Northern Ireland Railways	22	06	10	URS/RS	TL	Meeting	No	-
ENG	Translink	Northern Ireland Railways	08	12	10	URS/RS	TL	Meeting	No	-
ENG	Translink	Northern Ireland Railways	17	05	11	RS	TL	Letter	Yes	176
ENG	Translink	Ulsterbus/Metro	01	03	11	URS/RS	TL	Meeting	No	-
ENG	Translink	Ulsterbus/Metro	17	05	11	URS/RS	TL	Letter	Yes	177
ENG	Translink	Ulsterbus/Metro	06	12	11	URS/RS	TL	Telephone Call	Yes	178
ENG	TSA Planning (TSA)		06	06	11	RS	TSA	Telephone Call	No	-
ENV	Ulster Angling Federation (UAF)		14	03	11	URS	UAF	Letter	Yes	179
ENV	Ulster Angling Federation (UAF)		05	05	11	UAF	URS	Letter	Yes	180
ENG	Ulster Unionist Party (UUP)		17	05	11	RS	UUP	Letter	Yes	181
ENV	Ulster Wildlife Trust (UWT)		14	03	11	URS	UWT	Letter	Yes	182
ENV	Ulster Wildlife Trust (UWT)		12	05	11	URS	UWT	Letter		
ENG	University of Ulster (UU)	Faculty of Art, Design and the Built Environment	01	06	11	UU	RS	Letter	No	-
ENG	University of Ulster (UU)	Greater Belfast Development Project Team	28	06	11	UU	RS	Letter	Yes	183
ENG	University of Ulster (UU)	Greater Belfast Development Project Team	26	07	11	UU	RS	Email	No	-
ENG	University of Ulster (UU)	Greater Belfast Development Project Team	27	07	11	URS/RS	UU	Meeting	No	-
ENG	University of Ulster (UU)	Greater Belfast Development Project Team	28	07	11	UU	URS	Letter	No	-

TABLE 4.1.1: SUMMARY OF CONSULTATIONS AS PART OF STAGE 2 SCHEME ASSESSMENT PROCESS

ID	Organisation	Department/Section	Date			From	To	Description	Copy included in App. C	Record ID
			DD	MM	YY					
ENG	University of Ulster (UU)	Greater Belfast Development Project Team	01	08	11	UU	URS	Letter	No	-
ENG	University of Ulster (UU)	Greater Belfast Development Project Team	07	09	11	UU	RS/URS	Letter	Yes	184
ENG	University of Ulster (UU)	Greater Belfast Development Project Team	26	09	11	RS	UU	Letter	Yes	185
ENG	University of Ulster (UU)	Greater Belfast Development Project Team	28	05	12	UU	RS	Telephone Call	No	-
ENG	Victoria Residents Association (VRA)		16	05	11	RS	VRA	Letter	Yes	186

4.4 Public Consultation

4.4.1 *Public Consultation Event*

A period of public consultation was launched in June 2011 with an event held at the Ramada Encore Hotel in Belfast. The public consultation event was preceded by a programme of advertising comprising:

- The publication of notices advertising the event in local newspapers for two consecutive weeks (w/c 16 May 2011 and w/c 23 May 2011) in advance of the event.
- The production and distribution of 16,750 event flyers to business and residential properties in the area in the week commencing 16 May 2011.
- The provision of additional event flyers in Roads Service's Eastern Division Headquarters and its North Belfast Section Office at Corporation Street.
- The publication of an electronic copy of the flyer on the scheme's webpage on the Department's website at:

  http://www.drdni.gov.uk/ysi_public_consultation_event_2011
- The production and distribution of press packs to various media organisations (print/television/radio) as part of a Ministerial press release made through the Department's Press Office.
- The invitation to 111 local elected representatives, community representatives and other key stakeholders to attend an advance presentation of the scheme options on the morning of 1 June 2011, culminating with a question and answer session with the project team.

The public consultation event was subsequently opened to the general public at 2pm on 1 June 2011 amid notable press and television coverage. The event closed at 9pm on the evening of 1 June 2011 and reopened at 10am on 2 June 2011, closing at 9pm that evening. At the event, a series of presentation boards were on display to the public highlighting the background to the scheme, its progress to date, the various options and the process going forward. These display boards were complemented by a series of high-resolution digital animations of the various options and an interactive journey planner that allowed visitors to compare the changes to any movements through the junction for each option. Members of the Roads Service and URS project team were present to give further detailed information on the scheme options as required.

At the event, a public information leaflet was prepared that summarised the information on display along with a summary of the key features of the scheme options. Copies of the leaflet were distributed to visitors at the event, made available at Roads Service's Eastern Division Headquarters and its North Belfast Section Office at Corporation Street and made available on the scheme's webpage on the Department's website at:

http://www.drdni.gov.uk/ysi_public_consultation_event_2011

A questionnaire was distributed to visitors to allow them to express their comments on the proposals, to be completed and returned by the advertised closing date for public consultation of 30 June 2011. Comments were also accepted by separate representation to the Department at a published point of contact. Over the two day event, 174 visitors registered their attendance, with a total of 84 responses received by the close of the consultation window.

Of the 84 total responses received, 67 responses were via a validated questionnaire format. Questionnaires returned were determined valid if the required personal information was provided. It should be noted that all personal information provided was treated in accordance with the Department's Personal Information Statement published on the questionnaire. Of the validated questionnaires returned, the notable findings were that:

- 50% of respondents were motorised users of the junction (whether by private car or public transport).
- 19% of respondents were non-motorised users of the junction (pedestrians or cyclists).
- 17% of respondents were local residents.
- 86% of respondents used the junction on daily or weekly basis.
- 78% of respondents agreed with the need for road improvements between the strategic Westlink, M2 and M3 routes.
- Respondents considered that reducing traffic congestion should be the most important factor in the development of the scheme, ahead of other factors including the improvement of regeneration opportunities, the social and environmental impact on the area and the value for money offered.
- Of the 67 validated questionnaires returned, 60 identified a preferred option from the four available. Of those 60 responses, 46% favoured Option C, ahead of Option B (28%), Option A (14%) and Option D (12%).
- Respondents preferred solutions that provided full, rather than partial, grade separation of the strategic flows, with depressed links in underpasses preferred rather than elevated overbridges.
- Respondents raised concerns with the potential closure of slip roads at Clifton Street.
- Respondents desire improvements to pedestrian and cyclist journeys through the junction as part of the scheme.
- Respondents raised concerns with the potential for community severance, blight and the sterilisation of development opportunities (particularly for the elevated options).
- A number of respondents raised concerns over the development of the scheme by Roads Service rather than a collective interdisciplinary team of engineers and urban planners from various government departments.

4.4.2 *Public Consultation Report*

The separately published Public Consultation Report dated November 2011 provides a detailed summary of the responses received during the public consultation period and will be made available on the scheme's webpage (in conjunction with this report) at:

http://www.drdni.gov.uk/yorkstreet

4.5 Future Consultations

4.5.1 *Consultations during Detailed Design*

Following the selection and public announcement of the Preferred Option, the relevant layout will be subject to detailed engineering design to develop a specimen design. As part of this process, the project team will enter into consultations with the relevant statutory bodies and public utility companies to reach agreement on specific aspects of the engineering design, including drainage, service diversions and restrictions on the appointed contractor during construction. As the design advances, the project team will also consult with directly affected landowners to advise them of the impact of the proposals on their interests.

4.5.2 *Statutory Procedures*

When the design is sufficiently advanced, preparation of the three key documents under the statutory procedures required to implement the scheme will commence. These documents are the draft Direction/Designation Order, establishing the layout of the scheme, the draft Vesting Order, establishing the land that Roads Service intends to vest for the scheme and the draft Environmental Statement, reporting the impact of the scheme on the environment and proposed mitigation measures. The preparation of these documents will be informed by consultations with affected landowners and the relevant statutory authorities. Once the draft documents are ready, Roads Service will publish notices in the local press informing the public that the draft documents have been prepared and are available for viewing over a set period. A further public consultation event will normally be held at time of the notice publication to view the proposed layout. During the set period, members of the general public will have the opportunity to submit objections to the scheme. Depending on the number and nature of objections, the Minister for Regional Development may decide to hold a public inquiry into the scheme. The public inquiry process provides all objectors with a fair opportunity for their objections to the scheme to be heard by the appointed Inspector, who will prepare and submit an Inspector's Report making recommendations in relation to the scheme. On the basis of these recommendations, Roads Service will decide to confirm, modify or reject the scheme. Further information on the opportunities for public consultation in the scheme development process is provided in Roads Service's guide entitled "Planning New Roads in Northern Ireland" available on the Department's website at:

http://www.drdni.gov.uk/roadimprovements

Further documents available at the above website from Roads Service offer guidance to landowners on the procedures followed by Roads Service in the acquisition of land for major road development and their rights to compensation where affected by the Vesting Order.

5 ENGINEERING ASSESSMENT

5.1 Introduction

This section presents the findings of the engineering assessment of the four scheme options being considered. This engineering assessment covers a number of aspects, including road geometry, junction geometry, pavement design, ground conditions, drainage, public utilities and structures.

The geometry of the links and junction arrangements provided in the various options are reported along with an assessment against the relevant engineering standards for road and junction geometry and pavement design in the DMRB. An assessment of required Departures from Standard for these aspects is included for information. This assessment has been completed in a manner commensurate with the level of design detail at this stage and focuses on Departures from the key engineering standards that the line and level of the roads are developed against.

The climate of the study area is reported along with an assessment of the impact of the scheme options on the existing topography. Based on the published Preliminary Sources Study of 2008 and subsequent investigations, an assessment of the impact of the expected ground conditions is made, along with an assessment of the proposals to deal with surface water run-off.

5.2 Road Geometry

5.2.1 *Relevant GeometryStandards*

The DMRB provides a suite of engineering documents to be used for the development of trunk road schemes in the United Kingdom. The DMRB comprises several volumes, of which Volume 6, Road Geometry, is most relevant to road designers when developing scheme options at a preliminary stage.

The documents in the DMRB fall under two categories, Standards and Advice Notes. Standards establish requirements for trunk road schemes and, since 2006, have taken the form of a combined document that provides advice and guidance to designers along with mandatory requirements (as outlined within the Standard through use of black outline boxes). These mandatory requirements must be complied with unless mitigated through the Relaxations or Departures from Standards process. In comparison, Advice Notes give advice on particular requirements of the Design Standards. The information contained within the various Advice Notes is treated as guidance to designers and is therefore not subject to the Relaxations and Departures process.

The options have been developed from their counterparts at Stage 1 using the various Standards (TDs) and Advice Notes (TAs) in Volume 6 as appropriate. However, for the purposes of the Stage 2 engineering assessment of the road geometry of the options, the following TDs are considered in particular:

- TD 22/06 – “Layout of Grade Separated Junctions”
- TD 27/05 – “Cross Sections and Headrooms”
- TD 9/93 – “Highway Link Design”

Across these standards, reference is made to a common set of key parameters used by designers in road design, namely:

- Design Speed

- Horizontal Alignment
- Vertical Alignment
- Sight Distance.

These parameters are briefly explained in **Section 5.2.2**.

5.2.2 ***Key Design Parameters***

5.2.2.1 *Design Speed*

Research carried out in the development of the DMRB has shown that road users adjust their travelling speed in response to their perception of the road ahead. This perception is influenced by constraints on both the layout (including the width or the road and the frequency of accesses) and the alignment (including the bendiness of the road and average visibility). For any given road the Design Speed is considered to be, based on driver perception of the constraints ahead, the speed at which 85% of all drivers are expected to be travelling at or under on any given road. It is accordingly termed the 85th percentile speed.

Within the DMRB, Design Speed is an index which links road function, traffic flow and terrain to the design parameters of sight distance and curvature to ensure that a driver is presented with a reasonably consistent speed environment. In practice, most roads will only be constrained to minimum parameter values over short sections or on specific geometric elements.

The selected Design Speed should be consistent with the speeds that drivers are likely to expect on a given road. The Design Speed of a road has a direct impact on the cost, safety and quality of the finished project. In the designs developed, the Design Speed selected was as high as practicable to attain a specified degree of safety, mobility and efficiency while taking into consideration constraints of environmental quality, social and political impacts, economics and aesthetics.

The relevant engineering standard in the DMRB for the selection of Design Speeds for interchange links is TD 22/06. In accordance with paragraph 4.5 of this standard, a Design Speed of 85A kph was selected for the urban Westlink and M3 mainlines with the rural M2 mainline initially assigned a Design Speed of 120 kph.

Under paragraph 4.5 of TD 22/06, Design Speeds on connector roads within interchanges are determined on the basis of the connecting mainline and the nature of the connector road.

5.2.2.2 *Horizontal Alignment*

The horizontal alignments of road links are a careful compromise between safety, cost and environmental impact. For all new road schemes, designers will attempt to create alignments that minimise the impact on the existing natural and built environment, using circular curves in the horizontal plane linked to other circular curve or straight line elements by way of clothoid curves called transitions. The resultant alignment is considered the master control string about which all other aspects of the road design are based.

Design Standard TD 9/93 of the DMRB establishes a standard approach to the selection of curves used in horizontal alignment design taking into account the requirements for both drainage and safety. To this end, the concepts of camber, crossfall and superelevation are introduced along with requirements for their application.

On a straight, or nearly straight, single carriageway road, camber of 2.5% is required such that the control line, known as the “master string” which forms the road centreline is higher than the two outer channels, thereby generating a crown in the centre of the road. The camber introduced encourages the removal of surface water run-off from the crown to the outer channels where it can be collected, treated and ultimately discharged in an appropriate manner.

On dual carriageways, with one-way travel along each carriageway, the master string is typically located in the central reserve, beyond the channels. Where dual carriageways are horizontally aligned in a straight or nearly straight manner, a normal crossfall of 2.5% is required such that the offside channel is higher than the nearside channel, creating a fall across the carriageway. Surface water run-off is accordingly collected at the lower nearside channel, treated and subsequently discharged.

Where horizontal curves are used, Design Standard TD 9/93 of the DMRB introduces the V^2/R criterion to determine at what point transition curves and superelevation must be used to enable road users to negotiate the curve comfortably. In this criterion, the V element is the Design Speed of the road in kilometres per hour and R is the radius of the curve in metres.

Transition curves are spiral curve elements used to allow road users to adjust to the change in direction in a comfortable manner, based on accepted rates of centripetal acceleration. A basic minimum length for transitions curves is established in the DMRB as a function of the radius of the curve and the rate of centripetal acceleration, with a recommendation to limit their length where the curves are substandard. This is to limit driver acceleration approaching the horizontal curve.

Over transition curves, designers typically remove camber or normal crossfall and replace it with superelevation, whereby the outer channels are lifted/lowered in an appropriate manner to provide a crossfall towards the inside of the curve. Superelevation is introduced and removed gradually within recommended limits to ensure a smooth change in the edge profile of the channels whilst providing a minimum longitudinal gradient for drainage purposes. The basic minimum transition length calculated using the formula in the DMRB is often insufficient to provide a change in edge profile within the recommended limits and so the transitions are lengthened as appropriate.

Therefore, for any given horizontal curve on a road, the following approach is taken:

- if the curve's $V^2/R < 5$, the road can remain in camber/normal crossfall and will not require transitions
- if the curve's V^2/R is between 5 and 7, transitions should be provided with adverse camber removed and replaced with favourable crossfall of 2.5%
- if the curve's $V^2/R > 7$, transitions should be provided with superelevation of more than 2.5%.

A maximum limit exists for superelevation such that it is limited in rural areas to 7%, whilst in urban areas with at-grade junctions and side accesses it is limited to 5%.

The curve at which $V^2/R = 14.14$ is termed the Desirable Minimum radius, corresponding with a superelevation of 5%. A procedure exists within the DMRB to permit a relaxed standard of provision, in number of steps below the established Desirable Minimum. Dependant on the number of steps below the Desirable Minimum standard, a Relaxation or Departure from Standard is required which requires the prior approval of Roads Service as the Overseeing Organisation. With regard to horizontal alignments, an Absolute Maximum radius is established at typically 1 step below the Desirable Minimum radius, such that the resultant $V^2/R > 20$. Depending on the radius of the horizontal curve, designers are required to allow for the swept path of longer vehicles and so lane widths are increased accordingly. Furthermore, in order to provide the required Sight Distance, as described in **Section 5.2.2.4**, verge widths must be increased by an appropriate amount. Therefore, a substandard horizontal alignment can have a major impact on cost, land take and environmental impact.

Under the Design Standard TD 22/06 that applies to grade separated junctions, designers are required to develop horizontal alignments that are compliant with TD 9/93, unless a lesser standard has been agreed with Roads Service through the Relaxations and Departures process.

5.2.2.3 *Vertical Alignment*

To produce a control master string, a vertical alignment is applied to the horizontal alignment developed within the constraints. The vertical alignment of a road must be carefully designed around the existing topography and ground conditions to achieve a cut/fill balance whilst maintaining an adequate longitudinal profile for drainage and appropriate sight distance. Limits are established in DMRB TD 9/93 for minimum and Desirable Maximum longitudinal gradients. A minimum longitudinal gradient of 0.5% applies to all types of road, whilst the Desirable Maximum gradient can lie between 3% and 6%, depending on the road category. The use of gradients in excess of the Desirable Maximum can make significant savings in construction or environmental costs, but will reduce the benefits offered to the road user in terms of delays (due to slower moving vehicles), fuel economy and safety. Accordingly, TD 9/93 establishes an Absolute Maximum gradient, which is linked to the type of road. The same Departure from Standards process exists to permit a further increase in gradients above the stated Absolute Maximum, which will require the approval of Roads Service.

For a vertical alignment to exist, changes in longitudinal gradients are connected by vertical parabolic curves large enough to provide comfort and sight distance. Design Standard TD 9/93 establishes permitted vertical curve radii that will normally provide the necessary sight distance, so long as the interaction between the cross-section, superelevation and obstructions does not combine to reduce it.

The appropriate length of curve to be used is a function of a criterion known as the “K value” included in TD 9/93. The minimum curve length can then be determined by multiplying the K value for the relevant Design Speed by the algebraic change of gradient expressed as a percentage.

Two types of curves exist; crest curves used to link an uphill gradient with a downhill gradient in the forward direction and sag curves used to link a downhill gradient to an uphill gradient in the forward direction. For crest curves, two factors affect the choice of crest curvature, visibility and comfort. For Design Speeds of 50kph and above the crest in the road will reduce forward sight distance to the Desirable Minimum value and consequently the K values derived are based upon visibility criteria.

For sag curves, visibility is not normally obstructed unless overbridges, signs or other features are present. For these curves, K values are derived on the basis of accepted comfort criteria. However, for Design Speeds less than or equal to 70kph, the Absolute Minimum K values to be used ensure that, in unlit conditions, vehicle headlamps illuminate the road surface for a distance which is not more than 1 step below the Desirable Minimum Stopping Sight Distance.

Vertical curvature is subject to both the Relaxations and Departure from Standards process set out in the DMRB whereby a lesser provision can be made with the prior approval of Roads Service.

Under the Design Standard TD 22/06 that applies to grade separated junctions, designers are required to develop vertical alignments that are compliant with TD 9/93, unless a lesser standard has been agreed with Roads Service through the Relaxations and Departures process. However, it should be noted that TD 22/06 increases the Absolute Maximum gradient for motorway connector roads from the 4% stated in TD 9/93 to 6%.

5.2.2.4 *Sight Distance*

Sight Distance is the forward visibility provided to drivers as they travel along a road to enable them to respond to the conditions ahead. Two types of Sight Distance are set out in Design Standard TD 9/93 of the DMRB:

- Stopping Sight Distance
- Full Overtaking Sight Distance.

Stopping Sight Distance (SSD) is the theoretical forward sight distance required by a driver in order to stop when faced with an unexpected hazard on the carriageway. The distance is the sum of the following components:

- the distance travelled from the time when the driver sees the hazard and realises that it is necessary to stop – the perception distance
- the distance travelled during the time taken for the brakes to be applied to the vehicle – the reaction distance
- the distance travelled whilst slowing the vehicle to a stop – the braking distance.

Stopping Sight Distance is measured within an envelope such that drivers of low vehicles can see other low objects whilst drivers of high vehicles can see a significant portion of other vehicles. The envelope comprises a driver's eye height of between 1.05m and 2.0m and an object height of 0.26m to 2.0m, both measured above the road surface and separated by the required SSD.

With regard to the eye height range, the lower bound value of 1.05m has been arrived at following UK research into the distribution of driver eye heights, with 95% of drivers eye heights found to be above this minimum value. The upper bound value of 2.0m is considered to represent the eye height of a driver of a large vehicle.

The lower bound 0.26m object height is considered to represent the rear tail lights of other vehicles, with a 1.05m object height considered to present the tops of other vehicles. The upper bound 2.0m object height ensures that a significant portion of a vehicle ahead can be seen to identify it as such.

Stopping Sight Distance is directly related, on a straight section of road, to the vertical and horizontal alignments provided and accordingly it is checked in both planes in the centre of each running lane. A Desirable Minimum SSD is established in TD 9/93 for various Design Speeds that is required along each lane. In order to provide the required SSD on horizontal curves, it is necessary to provide additional verge widening and the relocation of street furniture or other obstructions beyond the SSD envelope.

The same hierarchy for Relaxations and Departures from Standards is available to designers for use with regard to SSD in difficult circumstances, subject to the approval of Roads Service as the Overseeing Organisation.

Full Overtaking Sight Distance (FOSD) is relevant to the design of single carriageways. The provision of FOSD on sections within an alignment provides drivers with safe overtaking opportunities, improving safety and journey time reliability. It is measured using a similar envelope approach to that of SSD, but the object height requirement is relaxed to a height between 1.05m and 2.0m. Design Standard TD 9/93 requires various minimum FOSD distances to be provided on overtaking sections, relative to the Design Speed, to which the

Relaxations and Departures hierarchy does not apply. Since FOSD is considerably greater than SSD, it can normally only be provided in relatively flat terrain where the combination of vertical and horizontal alignment permits the design of a flat and relatively straight road design.

As the majority of links within the proposed interchange are one-way connector roads between the three mainlines, SSD provision will be more relevant than FOSD provision. Under the Design Standard TD 22/06 that applies to grade separated junctions, designers are required to provide the Desirable Minimum SSD on all connector roads, unless a lesser standard has been agreed with Roads Service through the Relaxations and Departures process.

With regard to SSD provision over merge and diverge arrangements within a grade separated junction, designers must make reference to both standards. Design Standard TD 9/93 establishes requirements for Stopping Sight Distance on the approach to merges and diverges, whilst TD 22/06 makes provision for Stopping Sight Distance over merges and diverges within a grade separated junction and onward connector roads.

In accordance with Design Standard TD 9/93, the SSD on the mainline upstream of the tip of a diverge nose or the back of a merge nose must attain the Desirable Minimum value over a distance equivalent to 1.5 times the SSD value.

Design Standard TD 22/06 requires that, for diverges, the SSD for the mainline design speed, termed SSD_1, is maintained through the diverge to the back of the diverge nose. Beyond the back of the diverge nose, there must be clear visibility along the connector road to a position equal to SSD_1. In addition, the reduced SSD for the reduced Design Speed on the connector road, termed SSD_2, must be provided from a distance equal to the difference between SSD_1 and SSD_2 downstream of the back of the diverge nose. This reduced SSD_2 must then be maintained through to the end of the link. In the case where the distance between the back of the diverge nose and its termination with an at-grade junction is less than SSD_1, then the full SSD_1 must be provided from the give way line to a position at a distance of SSD_1 upstream of the give way line. Figures 4/3A and 4/3B of TD 22/06 illustrate these requirements.

In contrast, for merges, TD 22/06 requires that the SSD on the connector road is maintained up to the back of the merge nose, at which point the SSD for the mainline must be provided through the merge arrangement.

5.2.3 ***Assessment of Option A***

5.2.3.1 *Design Speeds*

In Option A, links to and from the M2 and Westlink mainlines are considered interchange links, as defined by paragraph 1.16 of TD 22/06. In addition, the connector road between the Westlink and the M3 can be considered an interchange link, as it is grade separated. The connector road between the M3 and Westlink, however, is considered a slip road, as the movement between the two mainlines is not grade separated. Based on the initially selected upstream mainline Design Speed of 120A kph (for the M2), a Design Speed of 85 kph was accordingly identified for the M2 to Westlink link (Link A). However, given the substandard geometry and cross-section of the links provided in underpasses in all of the Options, it was discussed and agreed with Roads Service that such links should be subject to speed restriction in the interests of road user safety. A speed limit of 40mph was selected as being the most appropriate to the underpasses. Consideration could also be given to a short 50mph buffer zone on the city (south) bound carriageway of the M2 motorway from Duncrue Street to help road users adjust their speed ahead of entry into the underpass. In the opposite direction, on the country (north) bound carriageway, it was agreed that the carriageway should remain subject to national speed limits without speed restriction.

Following agreement on the introduction of speed limits, the selected Design Speed for the M2 mainline was reassessed on the basis of its reclassification as an urban motorway subject to speed limits. In accordance with paragraph 4.1 of TD 22/06, a Design Speed of 85 kph was selected. This would accordingly reduce the Design Speed of Link A to 70 kph. Link A was accordingly designed on this basis.

Following agreement on the speed limits to be introduced, Link B, the Westlink to M2 link, was assigned a Design Speed of 70kph along with Link C between the Westlink and M3.

All other links to the three mainlines, including Link D from York Street to Westlink, have been considered to be slip roads, rather than interchange links, in accordance with paragraph 1.30 of TD22. They have therefore been generally assigned a Design Speed of 60 kph, which is also in accordance with their classification as restricted roads subject to a speed limit of 30mph.

The existing streets within the Option, including Link E between York Street (South) and York Street (North) are considered urban single carriageways and therefore subject to a Design Speed of 60 kph.

Table 5.2.1 summarises the selected Design Speeds for the various links in Option A. These Design Speeds and the proposed locations of speed limits have been illustrated on **Drawing S105296-R-SK-A-002**.

TABLE 5.2.1: OPTION A SPEED LIMITS AND DESIGN SPEEDS

Link	From	To	Relevant Mainline and Design Speed	Road Classification	Design Speed	Speed Limit
A	M2	Westlink	M2 Urban 85 kph	Interchange Link	70 kph	40 mph
B	Westlink	M2	Westlink Urban 85 kph	Interchange Link	70 kph	40 mph
C	Westlink	M3	Westlink Urban 85 kph	Interchange Link	70 kph	40 mph
D	M3	Westlink	Westlink Urban 85 kph	Slip Road	60 kph	30 mph / 40 mph
E	York Street (South)	York Street (North)	York Street Urban 60 kph	Single Carriageway	60 kph	30 mph
F	York Street	M2	M2 Rural 120 kph	Slip Road	70 kph	30 mph / National
G	Westlink	York Street	Westlink Urban 85 kph	Slip Road	60 kph	40 mph / 30 mph
H	Corp. Street	Westlink	Westlink Urban 85 kph	Slip Road	60 kph	30 mph / 40 mph
I	Dock Street	M3	M3 Urban 85 kph	Slip Road	70 kph*	40 mph / 50 mph

TABLE 5.2.1: OPTION A SPEED LIMITS AND DESIGN SPEEDS						
Link	**From**	**To**	**Relevant Mainline and Design Speed**	**Road Classification**	**Design Speed**	**Speed Limit**
J	M3	York Street	M3 Urban 85 kph	Slip Road	60 kph	50 mph / 30 mph

* The speed limits to be applied to the various slip roads joining links in underpasses were agreed with Roads Service in advance of design development. Through these discussions, it was agreed that in order to provide consistency with the Westlink to M3 interchange link (Link C) the slip road from Dock Street to the M3 (Link I) should have a similar speed limit and hence Design Speed of 70kph. As the link is classified as a slip road rather than an interchange link, this will be contrary to the specific requirements of TD 22/06 (60kph) and require a Departure from Standard. The option remains to revisit this particular Design Speed in the future following further consultation with Roads Service.

5.2.3.2 *Alignments*

5.2.3.2.1 ***Link A (M2 to Westlink)***

Master String Location

The master string for Link A is situated on the nearside edge of lane 1, commencing on the M2 motorway and terminating on the Westlink at the back of the Clifton Street off-slip. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The horizontal alignment commences with a 305m straight two-lane lane drop arrangement from the M2 motorway across a new Dock Street overbridge. On approach to the proposed underpass, the alignment transitions into a right hand curve of 160m radius, as measured on the nearside edge of carriageway line. The proposed 160m radius is Three Steps below the Desirable Minimum radius of 360m for the proposed 70kph Design Speed. There is an alternative under consideration to implement a 180m radius, 2 Steps below the Desirable Minimum, in lieu of the 160m radius, pending further design development in relation to the proposed underpass structure. The offside channel line through the underpass will have a minimum radius of 152m. The right hand curve terminates at a position close to the end of the merge arrangement from Corporation Street. The alignment transitions beyond this into a nearly straight right hand curve of 2040m to a position east of North Queen Street Bridge. The alignment transitions to match the existing alignment of the Westlink over North Queen Street Bridge, with a left hand curve of 341.7m on the master control string for the alignment. This radius, to match the existing alignment, is substandard and is One Step below Desirable Minimum.

Vertical Alignment

The vertical alignment comprises a crest curve on the diverge with a K value of 30, leading into a 6% downhill gradient into a sag curve in the underpass, with a K value of 20. The alignment exits the underpass with a gradient of 6% matching into the existing crest curve with a K value of 30 on North Queen Street Bridge. A 2% downhill grade is then provided to tie-in with existing levels at Clifton Street. The proposed use of a 6% maximum gradient is in excess of the 4% Absolute Maximum for all purpose roads. It should be noted that Departures are not required for vertical gradients less than 8% and in any event, TD 22/06 permits the adoption of 6% as an absolute maximum on motorway connector roads.

Stopping Sight Distance

The Stopping Sight Distance (SSD) on the link is substandard in a number of locations and will require Departures from Standard given the frequency of merges and diverges along the alignment. For the diverge arrangement from the M2, the proposed crest curve on the new Dock Street overbridge limits forward SSD from 120m (Desirable Minimum for 70kph) to 90m. This is One Step below Desirable Minimum and will require a Departure from Standard given its location over a diverge arrangement.

On approach to the underpass, SSD gradually reduces from 90m to 70m, limited by the offside verge width as the alignment passes through the pinch point under the Lagan Bridge. This reduction in SSD to 70m extends over 65m of the alignment. At a position near to the end of the merge taper from Corporation Street, the minimum SSD increases to 160m, in excess of the Desirable Minimum requirement. This 160m SSD is continued under the proposed York Street overbridge before reducing to 120m on the approach to the merge arrangement from York Street. This is the Desirable Minimum standard and is extended through to the approach to the Clifton Street off-slip, where the width of the downstream Westlink canyon section reduces the SSD to the existing 90m value. The reduction in SSD on approach to the Clifton Street diverge will require a Departure from Standard.

Transitions and Superelevation

Transitions have been provided in accordance with the requirements of TD 9/93.

Superelevation up to 7% has been provided on the link at the 160m radius in the underpass. It is noted that there is scope to further reduce this to 5%, based on the presence of at-grade junctions, in accordance with TD 9/93, however, the superelevation proposes represents the worst-case scenario for outline design purposes. Opportunities to reduce the superelevation where favourable will be explored at detailed design stage following selection of a Preferred Option.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at four locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at six locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.2 ***Link B (Westlink to M2)***

Master String Location

The master string for Link B is situated on the offside edge of lane 2, commencing on the Westlink at the back of the Clifton Street merge nose and terminating at the tip of the existing merge nose from York Street onto the M2 foreshore. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

Link B commences with a right hand curve of 352m in radius to match the existing cross-section at Clifton Street. This is slightly below the Desirable Minimum value of 360m for the 70kph Design Speed. East of North Queen Street Bridge, the alignment transitions into a straight approximately 35m in length before transitioning into a left hand curve of 250m radius. This radius is Two Steps below Desirable Minimum and is maintained through the proposed underpass, extending to a position east of the Dargan Bridge. On approach to the merge nose with the motorway, the alignment transitions into a straight and terminates at the tip of the merge nose.

Vertical Alignment

The vertical alignment commences with a short (35m) grade of 2% to tie in with the existing road level before transitioning to a crest curve with a K value of 30, achieving the Desirable Minimum value. This crest curve continues for 240m on the alignment beyond the North Queen Street Bridge, where a 6% downhill gradient is introduced. This gradient extends for 80m, leading into a sag curve with a K value of 13 at the lowest point in the underpass. The proposed radius is One Step below the Absolute Minimum value of 20 for the proposed Design Speed. To the east of the underpass a crest curve with a K value of 30 is introduced to provide a minimum cover of 400mm to the existing bases to the Dargan Bridge. This will require a Departure from Standard for the higher 120kph Design Speed on the M2 motorway that will be applied from the back of the merge nose. On approach to the tie in with the M2 motorway, the vertical alignment follows the existing road level, with a sag curve with a K value of 13 and an uphill gradient of 4.6% used. The proposed K value will require a Departure from Standard for the higher 120kph Design Speed.

Stopping Sight Distance

The Stopping Sight Distance (SSD) on the link is substandard in a number of locations and will require Departures from Standard given the frequency of merges and diverges along the alignment. At the start of the alignment, the existing 70m SSD is maintained on the alignment through to a position east of the North Queen Street Bridge. This SSD is Two Steps below Desirable Minimum and is constrained by the existing cross-section. A Departure from Standard will be required for the substandard SSD over the merge arrangement. Beyond the North Queen Street Bridge, the SSD increases to a minimum of 90m (One Step below Desirable Minimum) on the downhill gradient and subsequently to 120m on approach to the lane drop to York Street. However, a Departure from Standard will be required as 90m SSD will be provided in the approach zone to the diverge arrangement. The limited nearside verge width reduces SSD in the proposed underpass to 90m (One Step below Desirable Minimum). A Departure from Standard will therefore be required for a substandard SSD in the approach zone to the diverge arrangement for Link C. Upon exit from the underpass, the SSD reduces further, under the Dargan Bridge, to 70m (Two Steps below Desirable Minimum) due to the constraint introduced by the vehicle restraint system proposed adjacent to the bridge piers. The Stopping Sight Distance gradually increases on approach to the merge nose to a minimum of 120m. This will be Three Steps below the Desirable Minimum value for the proposed Design Speed of 120kph at the merge arrangement and will require a Departure from Standard.

Transitions and Superelevation

Transitions have been provided in accordance with the requirements of TD 9/93.

Superelevation of up to 7% has typically been provided on the link based on the radii of selected horizontal curves. It is noted that there is scope to further reduce this to 5%, based on the presence of at-grade junctions, in accordance with TD 9/93, however, the superelevation proposes represents the worst-case scenario for outline design purposes. Opportunities to reduce the superelevation where favourable will be explored at detailed design stage following selection of a Preferred Option.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at seven locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at thirteen locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.3 ***Link C (Westlink to M3)***

Master String Location

The master string for Link C commences at the tip of the diverge nose from Link B and is situated along the nearside edge of lane 1 on the link, becoming the centreline of the two lane slip road to M3 that terminates at the back of the merge nose on the Lagan Bridge. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The link commences with a straight alignment on the diverge arrangement from Link B, transitioning into a right hand curve of 90m radius. The proposed radius is limited by the proximity of the Dargan Bridge substructure and is Four Steps below Desirable Minimum. It is noted that radii as low as 50m are permitted for loops from All-Purpose mainline roads in accordance with paragraph 4.6 of TD 22/06, subject to the provision of full visibility across the extent of the loop. However, the link cannot be considered a loop as it does not comply with any of the layouts shown in Figure 4/1 of TD 22/06 (owing to the proposed offside diverge). Therefore, a Departure from Standard is required for the proposed 90m horizontal radii on the link. Beyond the 90m radius, the alignment transitions into a right hand curve of 1020m radius which is maintained through the merge arrangement with Link I and onto the existing on-slip ramp structure. This radius exceeds the Desirable Minimum requirements. Beyond this point, the horizontal alignment matches the existing alignment, with a 720m left hand curve, exceeding the Desirable Minimum requirement, providing the tie in to the back of the existing merge nose.

Vertical Alignment

The vertical alignment of the link is constrained by the requirement to achieve cover to the existing bases of the Dargan Bridge and the M2 to Westlink underpass over a relatively short horizontal alignment. At the start of the alignment, the link is on a sag curve with a K value of 30, matching the alignment on Link B. This K value is One Step below the Absolute Minimum value for the 70kph Design Speed. The alignment transitions to a crest curve on exit from the underpass, with a K value of 30 used that is equal to the Desirable Minimum for the Design Speed selected. This crest curve is continued on the alignment to a sag curve located at the merge nose with Link I. The K value of the sag curve is 20, the Absolute Minimum value. To achieve tie-in with the existing road level on the ramp structure, a crest curve with a K value of 17 is subsequently introduced. This K value is One Step below Desirable Minimum for a 70kph Design Speed.

Stopping Sight Distance

The Stopping Sight Distance (SSD) on the link is substandard in a number of locations and will require Departures from Standard given the frequency of merges and diverges along the alignment. Over the diverge nose from Link B, the SSD is 120m, reducing gradually to 90m and ultimately 70m over the pinch point between the Dargan Bridge substructure. The piers to the Dargan Bridge present obstructions that reduce the SSD. Beyond this pinch point, the SSD increases to a minimum of 120m on approach to the merge nose with Link I. Given the proximity of the merge from Dock Street to the pinch point, a Departure from Standard will be required for the 70m SSD (Two Steps below Desirable Minimum) provided in the approach zone to the merge. The provision of 120m SSD on approach to the merge nose on the M3 will similarly require a Departure from Standard as it will be One Step below the Desirable Minimum value for the 85kph Design Speed proposed.

Transitions and Superelevation

Transitions have been provided in accordance with TD 9/93. However, a transition has not been provided at the end of the alignment for the curve of 720m horizontal radius, to match the existing alignment, which will require a Departure from Standard.

Superelevation on the link has been limited to 5%.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at four locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at six locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.4 *Link D (M3 to Westlink)*

Master String Location

The master string for Link D is situated on the centreline of the slip road, commencing at the junction with York Street and terminating at the tip of the merge nose with Link A. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The link has a straight alignment leaving the junction with York Street and transitions to a left hand curve of 125m radius which forms the merge nose with Link A. The radius has been used to smooth the connection between the two elements, since the nose angle is large, but will require a Departure from Standard as it is Four Steps below Desirable Minimum.

Vertical Alignment

The vertical alignment comprises a sag curve with a K value of 9 leading away from the junction with York Street which transitions to an uphill gradient of 6% to match the gradient on the adjacent Link A at the merge nose. The proposed sag curve's K value is One Step below the Absolute Minimum value for the proposed 60kph Design Speed.

Stopping Sight Distance

The Stopping Sight Distance on the link is a minimum of 90m, limited by the presence of a barrier in the nearside verge. On approach to the merge with Link A, the SSD increases to 120m, One Step below Desirable Minimum value for the 70kph Design Speed beyond the merge nose. The substandard SSD on approach to the merge arrangement will require a Departure from Standard. Beyond the merge nose, the Stopping Sight Distance is at least the Desirable Minimum value of 120m.

Transitions and Superelevation

Transitions have been provided in accordance with the requirements of TD 9/93.

Superelevation of up to 5% has typically been provided on the link based on the radii of selected horizontal curves.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD meet the requirements of paragraph 1.24 of TD 9/93 and therefore no Departures from Standard are anticipated.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at two locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.5 ***Link E (York Street (South) to York Street (North))***

Master String Location

The master string for Link E is situated on the offside of lane 3, commencing from a position immediately north of the junction with Little York Street and terminating at the junction with Dock Street. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The link has a flowing, nearly straight horizontal alignment with a series of three curves of 1020m radius used to introduce a relocation of York Street to the east of its present position, to facilitate the provision of a retaining solution for its raised vertical alignment. Briefly, the horizontal alignment commences with a straight section along York Street, before changing on approach to the junction with Great George's Street into a right hand curve of 1020m radius. This curve extends to a position approximately midway along the proposed York Street overbridge before reversing into a left hand curve of 1020m radius. This left hand curve extends along the link to a point on approach to the entrance into Cityside Retail Park, where a right hand curve is used to tie in with the existing centreline of York Street. The existing alignment is maintained through to the junction with Dock Street. All horizontal elements exceed the Desirable Minimum radius for the selected Design Speed.

Vertical Alignment

The vertical alignment of the link is constrained by the requirements for headroom over a relatively short distance to the underlying links whilst tying in with the existing vertical alignment at the junction with Little Patrick Street (to the south) and the entrance to Cityside Retail Park (to the north). Accordingly, the vertical alignment commences with a downhill gradient of 0.6% at the tie in with York Street to the southern extent, before continuing into a sag curve with a K value of 9. The proposed sag curve's K value is One Step below the Absolute Minimum value for the proposed 60kph Design Speed. The sag curve continues into a crest curve, with its high-point positioned above the Westlink to M3 link, with a K value of 11. The proposed K value is One Step below Desirable Minimum value and creates an instantaneous gradient of 7.0%. The proposed gradient is in excess of the Desirable Maximum value of 6% on a All-Purpose link (ref TD 9/93, paragraph 4.1), but less than the 8% threshold for a Departure from Standard. On the northern side of the bridge, a sag curve with a K value of 9, One Step below the Absolute Minimum is used to facilitate vertical tie-in with existing levels at the entrance to Cityside Retail Park. The instantaneous gradient at the tangent points between the curves is 7.4%. This is again in excess of the 6% Desirable Maximum value, but below the 8% threshold for a Departure from Standard. Beyond the entrance to Cityside Retail Park, the vertical alignment follows that of the existing street, with a generous crest curve (K value = 100) used that maintains a minimum longitudinal gradient in excess of 0.5%.

Stopping Sight Distance

The Stopping Sight Distance (SSD) on the link is substandard over the main crest curve and will require Departures from Standard given the frequency of at-grade junctions along the alignment, to which the crest curve forms part of the approach. On approach to the new York Street overbridge from the south, the SSD reduces gradually from 160m to 70m, from the junction with the M3 to York Street link (Link J). This is due to the K value of the selected crest curve. The 70m SSD is maintained over the new overbridge into the new signalised junction with the off-slip from Westlink to York Street (Link G). Coming off the crest curve, the SSD increases up to 215m, in excess of the Desirable Minimum value of 90m. This value is maintained to the end of the alignment.

Transitions and Superelevation

Transitions have been provided in accordance with the requirements of TD 9/93.

Normal camber of 2.5% has been provided on the link based on the radii of selected horizontal curves.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at one location along the alignment and require a Departure from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at four locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.6 ***Link F (York Street to M2)***

Master String Location

The master string for Link F is situated on the nearside of lane 4 on the new York Street alignment that becomes lane 1 of the slip road onto the M2. The master string commences at the tip of the diverge nose from Link E and terminates at the end of the merge arrangement onto the M2 foreshore. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The link's horizontal alignment is dictated by the location of the existing Dargan Bridge piers, requiring substandard elements to be used in order to fit the alignment within the space available. The link commences with a short 1020m radius curve matching that of Link E on the York Street overbridge, before introducing a 180m right hand curve that reverses to a 150m left hand curve in advance of the Dargan Bridge, at a position close to the priority junction for the southbound lane on York Street. The 150m radius is maintained under the Dargan Bridge before transitioning into a straight as the link continues toward Dock Street overbridge. On approach to Dock Street, the alignment transitions to match the existing left hand curve on the M2, with a horizontal radius of approximately 560m.

Vertical Alignment

The vertical alignment of the link is constrained by the requirement for headroom over the underlying Westlink to M2 link (Link B) at the start of the alignment and the subsequent requirement to achieve headroom to the Dargan Bridge over a short (70m) distance between the two structures. The link commences with a crest curve with a K value of 11, matching that on Link E, before changing to a short 2% downhill gradient over the extent of the diverge nose. Beyond the diverge nose, a crest curve with a K value of 10 is used to continue the alignment into a 7% downhill gradient to achieve headroom under the Dargan Bridge. The proposed K value of 10 is One Step below Desirable Minimum for the proposed 60kph Design Speed at that position. The proposed 7% downhill gradient is in excess of the 6% limit imposed by Design Standard TD 22/06 for motorway connector roads. As this link would be considered a motorway slip road, this gradient will therefore require a Departure from Standard. It should be noted that the proposed gradient remains below the 8% threshold for a Departure for an all-purpose single carriageway under Design Standard TD 9/93. As the link passes under the Dargan Bridge, a sag curve with a K value of 9 is introduced. This proposed K value is 2 Steps below Absolute Minimum for the increased Design Speed of 70kph at this point. As the link continues beyond the Dargan Bridge, it rises on a 3.6% gradient before matching into the existing crest curve over Dock Street Bridge. The existing crest curve has a K value of approximately 18, Four Steps below the Desirable Minimum for 120kph, requiring a Departure from Standard.

Stopping Sight Distance

Stopping Sight Distance on the link is limited initially by the crest curve used on the York Street overbridge to 70m, One Step below Desirable Minimum for the selected 60kph Design Speed at that position. Beyond the crest curve, SSD increases to 120m over the downhill section but is subsequently limited to 70m as the link passes under the Dargan Bridge. The width of the nearside verge and the presence of the existing bridge piers are the constraints that govern this 70m SSD which is 2 Steps below Desirable Minimum for the 70kph Design Speed at that position on the alignment. As the link rises beyond the Dargan Bridge to tie in with the Dock Street Bridge, the SSD increases to 90m and up to a maximum of 120m at the changeover to the higher 120kph mainline Design Speed. Both these values are below their respective Desirable Minimum and require Departures from Standard.

Transitions and Superelevation

Transitions have been provided on the link in general accordance with TD 9/93. However, a transition has not been provided at the connection between the curves of 180m and 150m horizontal radius respectively. This will require a Departure from Standard.

Superelevation on the link has been limited to 5%.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at eleven locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at eleven locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.7 ***Link G (Westlink to York Street)***

Master String Location

The master string for Link G is situated on the offside of lane 2 of the slip road, commencing at the tip of the diverge nose from Link B and terminating at the signalised junction with York

Street (Link E). All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The alignment commences with a straight as part of the diverge arrangement from the Westlink to M2 (Link B) mainline. The straight transitions into a left hand curve of 255m radius, the Desirable Minimum value for the selected Design Speed of 60kph on the link. This radius is continued to the end of the alignment.

Vertical Alignment

Over the diverge arrangement, the link matches the vertical alignment on the adjacent Westlink to M2 (Link B) mainline. Therefore, the vertical alignment commences with a downhill gradient of approximately 6%. Beyond the diverge arrangement, a sag curve with a K value of 9, One Step below Absolute Minimum, is introduced to connect into a 4% uphill gradient on approach to the at-grade junction with Link E.

Stopping Sight Distance

Over the diverge arrangement from the Westlink to M2 mainline (Link B), a 120m SSD is provided on the link that meets the Desirable Minimum value. On the slip road, where the Design Speed is reduced to 60kph, the SSD is gradually reduced to 90m, the Desirable Minimum value. This provision is maintained to the end of the alignment.

Transitions and Superelevation

Transitions have been provided on the link in general accordance with TD 9/93. However, the transition length provided at the back of the diverge nose is substandard and will require a Departure from Standard.

Superelevation of up to 5% has typically been provided on the link based on the radii of selected horizontal curves.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at one location along the alignment and require a Departure from Standard accordingly.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at three locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.8 ***Link H (Corporation Street to Westlink)***

Master String Location

The master string for Link H is situated on the offside of lane 2 of the slip road, commencing at the channel line on Corporation Street and terminating at the tip of the merge nose onto the

M2 to Westlink mainline (Link A). All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The alignment comprises a single straight.

Vertical Alignment

The vertical alignment commences with a crest curve with a K value of 10 at the at-grade junction with Corporation Street. This crest curve is used to limit the gradient on the immediate departure away from the junction to under 2%. However, the proposed K value is One Step below Desirable Minimum for the 60kph Design Speed at that position. As the Design Speed increases to 70kph at the back of the merge nose, the K value therefore becomes Two Steps below Desirable Minimum for 70kph. On approach to the merge arrangement, a 6% downhill gradient is introduced that matches the vertical alignment on the adjacent mainline.

Stopping Sight Distance

Stopping Sight Distance is 160m initially on departure from Corporation Street. With the provided crest curve, this reduces to 120m over the remainder of the link, meeting or exceeding the Desirable Minimum value for the two Design Speeds of 60kph and 70kph.

Transitions and Superelevation

As a single element forms the alignment, transitions are not required.

Superelevation of up to 7% has typically been provided on the link based on the radii of selected horizontal curves. It is noted that there is scope to further reduce this to 5%, based on the presence of at-grade junctions, in accordance with TD 9/93, however, the superelevation proposes represents the worst-case scenario. Opportunities to reduce the superelevation where favourable will be explored at detailed design stage following selection of a Preferred Option.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD meet the requirements of paragraph 1.24 of TD 9/93 and therefore no Departures from Standard are anticipated.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at two locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.9 ***Link I (Dock Street to M3)***

Master String Location

The master string for Link I is situated on the offside of lane 1 of the slip road, commencing at the Dock Street junction and terminating at the back of the merge nose onto the M3 mainline on the Lagan Bridge. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The alignment commences with a straight away from the Dock Street junction, transitioning into a nearly straight right hand curve of 1020m, exceeding the Desirable Minimum for the selected Design Speed of 70kph. This right hand curve transitions into a left hand curve with a radius of 260m, which forms the merge nose onto Link C. The proposed curve radius is One Step below Desirable Minimum for the selected Design Speed.

Vertical Alignment

The vertical alignment commences with a 1% uphill gradient away from Dock Street leading into a crest curve with a K value of 100, over the underlying M2 to Westlink link (Link A). This K value exceeds the Desirable Minimum requirement. On approach to the existing ramp structure, a sag curve with a K value of 9 is used to link into the existing uphill gradient on the structure. The proposed K value on the sag curve is One Step below Absolute Minimum for the selected Design Speed.

Stopping Sight Distance

Stopping Sight Distance is 160m initially on departure from Dock Street, reducing through 120m to 90m on the overbridge above Link A. The available SSD is limited by the available nearside verge width, which is constrained by headroom requirements to the underlying link. The proposed SSD is One Step below Desirable Minimum for the selected Design Speed. As the link approaches the existing ramp structure, the SSD increases to 120m and matches the existing provision at the back of the merge nose.

Transitions and Superelevation

Transitions have been provided in accordance with TD 9/93.

Superelevation of up to 7% has typically been provided on the link based on the radii of selected horizontal curves. It is noted that there is scope to further reduce this to 5%, based on the presence of at-grade junctions, in accordance with TD 9/93, however, the superelevation proposes represents the worst-case scenario. Opportunities to reduce the superelevation where favourable will be explored at detailed design stage following selection of a Preferred Option.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD meet the requirements of paragraph 1.24 of TD 9/93 and therefore no Departures from Standard are anticipated.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at two locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.2.10 ***Link J (M3 to York Street)***

Master String Location

The master string for Link I is situated in the centreline of the link, on the offside of lane 2 on the slip road from M3 to York Street. The string commences at a position on the existing off-slip approximately 60m back from the junction with Nelson Street and continues along the centre of Great George's Street, terminating at the junction with York Street.

Horizontal Alignment

The horizontal alignment reflects that of the existing alignment of the M3 off-slip and Great George's Street. Accordingly, the alignment commences with a 90m left hand curve to match the existing alignment of the off-slip from the M3, to the junction with Nelson Street. The proposed curve radius is 3 Steps below Desirable Minimum for the selected Design Speed of 60kph. West of Nelson Street, the radius on the left hand curve increases from 90m to 350m, exceeding the Desirable Minimum requirement. The curve is subsequently reversed into a right hand curve of 720m radius, in excess of the Desirable Minimum, which is continued through to the junction with York Street (Link E).

Vertical Alignment

The vertical alignment largely reflects that of the existing alignment of the M3 off-slip and Great George's Street. The vertical alignment commences with a 4.9% downhill gradient on the slip road that connects to a sag curve with a K value of 9, One Step below Desirable Minimum for the 60kph Design Speed. A crest curve with a K value of 55 is subsequently introduced that continues to a point approximately midway along the alignment. The proposed K value exceeds the Desirable Minimum value. On approach to the junction with York Street, a sag curve with a K value of 13 is used to connect the crest curve with another crest curve with a K value of 17. This crest curve connects into York Street (Link E) with an uphill gradient of 2%. Both the sag and crest K values meet the Absolute Minimum and Desirable Minimum values respectively.

Stopping Sight Distance

Stopping Sight Distance is limited on the nearside verge by the presence of the Dargan Bridge piers, which restrict SSD to 50m at the start of the alignment on approach to the junction with Nelson Street. The proposed SSD is 2 Steps below Desirable Minimum for the Design Speed. Beyond the junction with Nelson Street, the SSD increases to 160m, reducing to 120m due to the provided combination of crest and sag curves on the immediate approach to the York Street junction. This provision is in excess of the Desirable Minimum value.

Transitions and Superelevation

Transitions have not been provided on the link to match the existing alignment and will require a Departure from Standard.

Superelevation of up to 2% has typically been provided on the link based on the radii of selected horizontal curves and its proximity to at-grade junctions.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at two locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at two locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table A.1** in **Appendix D**.

5.2.3.3 *Cross-Sections*

5.2.3.3.1 ***Link A (M2 to Westlink)***

Based on the projected traffic flows and the purpose of the link as an interchange link connector road from an Urban Motorway, the link would be classified as IL2B in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a two lane interchange link with urban hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 2.75m wide hard shoulder
- 2 no. 3.65m wide traffic lanes
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 3.3m wide hard shoulder (matching existing provision on M2), reducing to a 700mm wide hardstrip at the pinch point under the Dargan Bridge
- 2 no. 3.65m wide traffic lanes
- 1 no. offside hardstrip, of varying width between 700mm and 1m
- nearside paved verges with a typical width of 2m, reducing to 1.05m at constrained positions
- offside paved verges with a typical width of 1.5m, reducing to 1.05m at constrained positions.

Where the proposed provision falls below the minimum requirements, it is due to the constraints imposed on the depressed section as it passes between the substructure of the existing Lagan Bridge. Over the extent of this pinch point, a paved width of 8.7m is maintained with the required New Construction Headroom of 7.3m (in addition to sag curve compensation). The proposed minimum verge width of 1.05m matches the verge provision on the recently completed Broadway and Grosvenor Road underpasses, which also housed communications ducting.

As the proposed provision does not match the requirements of TD 27/05, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.2 ***Link B (Westlink to M2)***

Based on the projected traffic flows and the purpose of the link as an interchange link connector road to a Rural Motorway, the link would be classified as IL2A in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a two lane interchange link with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 2 no. 3.65m wide traffic lanes
- 1 no. 1m wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 300mm wide nearside hardstrip, with a 1m wide nearside hardstrip provided in the proposed Westlink to M2/M3 underpass
- 2 no. 3.65m wide traffic lanes, with 3 no. 3m lanes between Clifton Street and York Street
- 1 no. offside hardstrip, of varying width between 700mm and 1m
- nearside paved verges with a typical width of 2m, reducing to 1.5m at constrained positions
- offside paved verges with a typical width of 1.05m.

A hard shoulder and full width 3.65m lanes cannot be provided on the Westlink mainline between Clifton Street and York Street without widening of the northern side of North Queen Street bridge. For this reason, the existing 300mm nearside hardstrip on the structure has been maintained along with existing lane widths. With regard to the proposed Westlink to M2/M3 underpass, a hard shoulder is not provided due to the footprint requirements of the proposed abutment to the York Street overbridge and the limited width subsequently available between the Dargan Bridge substructure. For these reasons, a nearside hardstrip is proposed over the underpass's 260m length. Over the extent of this pinch point, a minimum paved width of 9.32m is maintained with the New Construction Headroom of 7.3m (in addition to sag curve compensation). The proposed minimum verge width of 1.05m matches the verge provision on the recently completed Broadway and Grosvenor Road underpasses, which also housed communications ducting.

As the proposed provision does not match the requirements of TD 27/05, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.3 ***Link C (Westlink to M3)***

Based on the projected traffic flows and the purpose of the link as an interchange link connector road to an Urban Motorway, the link would be classified as IL1B in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a single lane interchange link with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 1 no. 3.7m wide traffic lane
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 3.3m wide hard shoulder
- 1 no. 3.7m wide traffic lane, with curve widening to 3.95m
- 1 no. 300mm wide offside hardstrip
- nearside paved verge with a typical width of 1.05m, widening to 1.75m
- offside paved verge with a typical width of 5m (for forward visibility).

The proposed provision is largely in accordance with the requirements of TD 27/05, albeit that the nearside verge width would not meet the minimum requirements of 2m for communications ducting and cabling. The proposed minimum verge width of 1.05m has been selected as it matches the verge provision on the recently completed Broadway and Grosvenor Road underpasses, which also housed communications ducting. As the proposed nearside verge provision does not match the requirements of TD 27/05, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.4 ***Link D (M3 to Westlink)***

Based on the projected traffic flows and the purpose of the link as a slip road connector road to an Urban All-Purpose Road, the link would be classified as MG2F in accordance with Table 3/1a of Design Standard TD22/06, This requires the provision of a two lane slip road with hardstrips.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 1m wide nearside hardstrip
- 2 no. 3.65m wide traffic lanes
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 300mm (minimum) wide nearside hardstrip widening to a 2m hard shoulder on approach to the merge nose with Link A

- 2 no. 3.65m wide traffic lanes, reducing to a single 3.65m traffic lane in accordance with TD 22/06 on approach to the back of the merge nose with Link A
- 1 no. 300mm (minimum) wide offside hardstrip, widening as lane 2 is reduced on approach to the merge nose in accordance with TD 22/06
- nearside paved verge with a typical width of 2.5m
- offside paved verge with a typical width of 2m.

The proposed provision is largely in accordance with the requirements of TD 27/05, albeit that the nearside hardstrip width is not the minimum 1m provision but typically a minimum of 1m in width over its length. However, as the provision does not match the requirements of TD 27/05, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.5 ***Link E (York Street (South) to York Street (North))***

The proposed provision for York Street is a single carriageway, with five traffic lanes to match existing provision. With reference to TD 27/05, it is noted that the standard detail for a single carriageway is the provision of 3.65m traffic lanes without hardstrips. However, as the proposed horizontal alignment is nearly straight, it is proposed to reduce lane widths below the standard 3.65m to 3.25m on the proposed York Street overbridge structure. The proposed 3.25m width has been selected as it is the Desirable Minimum width prescribed by the legal requirements of Chapter 8 of the Traffic Signs Manual for traffic lanes being used by all vehicle types under any future temporary traffic management arrangements. The proposed lane width is within the 3-3.65m range permitted by TD 50/04 for signal controlled junctions. Hardstrips are not proposed. This provision is necessary to limit the overall width of the structure to provide headroom to the underlying links and also serves to limit the cost of the structure. A footway of 2m width is provided on the western side of the carriageway, with a paved verge of 2m width provided on the eastern side. The paved verge on the eastern side of the carriageway on the overbridge structure is not intended for use as a footway, given the free-flow nature of lanes 4 and 5 on the structure towards the M2. If the eastern verge were to be utilised as a footway, significant changes would be required to the layout on York Street, notably the introduction of an additional signal controlled junction on lanes 4 and 5 (Link F) to provide a controlled crossing point for pedestrians. The introduction of additional signal control on lanes 4 and 5 (Link F) would reduce the overall benefits offered by the scheme.

It is noted that the proposed provision for pedestrians on York Street reflects current provision, albeit that the proposed footway width is the minimum required by Design Standard HD 39/01. At detailed design stage, the potential to increase the footway width will be explored further.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.6 ***Link F (York Street to M2)***

Based on the projected traffic flows and the purpose of the link as a slip road connector road to a Rural Motorway, the link would be classified as MG2C in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a two lane slip road with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder

- 2 no. 3.65m wide traffic lanes
- 1 no. 1m wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 1m wide nearside hardstrip, increasing to a 3.3m hard shoulder beyond the Dargan Bridge
- 2 no. 3.65m wide traffic lanes, reducing to a single 3.65m traffic lane in accordance with TD 22/06 on approach to the back of the merge nose with Link B
- 1 no. 300mm (minimum) wide offside hardstrip, widening as lane 2 is reduced on approach to the merge nose in accordance with TD 22/06
- nearside paved verge with a minimum width of 1.4m under the Dargan Bridge, typically 3.5m wide
- offside paved verge with a minimum width of 1.09m under the Dargan Bridge.

A hard shoulder cannot be provided under the Dargan Bridge within the width available between adjacent bridge piers. Therefore a hardstrip has been provided that widens out to a hard shoulder beyond the pinch point. The hard shoulder is continued to tie in with the existing hard shoulder on the M2 foreshore carriageway. Over the extent of this pinch point, a paved width of 8.62m is maintained with the required New Construction Headroom of 7.3m (in addition to sag curve compensation). The proposed minimum verge widths exceed the verge provision on the recently completed Broadway and Grosvenor Road underpasses, which also housed communications ducting.

As the proposed provision does not match the requirements of TD 27/05, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.7 ***Link G (Westlink to York Street)***

Based on the projected traffic flows and the purpose of the link as a slip road connector road from an Urban All-Purpose Road, the link would be classified as DG1D in accordance with Table 3/1a of Design Standard TD22/06, This requires the provision of a single lane slip road with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 1 no. 3.7m wide traffic lane
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 1m wide nearside hardstrip
- 2 no. 3.65m wide traffic lanes
- 1 no. 300mm wide offside hardstrip

- nearside paved verge with a typical width of 2m
- offside paved verge with a typical width of 1.75m.

Based on projected traffic volumes, the link should comprise a single traffic lane in accordance with the requirements of TD 22/06. However, the proposed provision has been selected to meet the minimum requirements for a two lane slip road with hardstrip from TD 27/05, i.e. DG2F. This was considered necessary to mitigate the risk that queues on the off-slip at the signal controlled junction extend back onto the Westlink mainline.

As the proposed provision does not match the requirements of TD 27/05, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.8 ***Link H (Corporation Street to Westlink)***

Based on the projected traffic flows and the purpose of the link as a slip road connector road to an Urban All-Purpose Road, the link would be classified as DG1D in accordance with Table 3/1a of Design Standard TD22/06, This requires the provision of a single lane slip road with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 1 no. 3.7m wide traffic lane
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. nearside hardstrip, a maximum of 3m in width
- 1 no. 3.65m (minimum) wide traffic lane
- no offside hardstrip
- nearside paved verge with a typical width of 2m
- offside paved verge with a typical width of 2m.

The proposed provision maintains a minimum paved width of 6.5m on the slip road, however, the proposed configuration will require a Departure from Standard.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.9 ***Link I (Dock Street to M3)***

Based on the projected traffic flows and the purpose of the link as a slip road connector road to an Urban Motorway, the link would be classified as MG1B in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a single lane slip road with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder

- 1 no. 3.7m wide traffic lane
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 300mm (minimum) wide nearside hardstrip
- 2 no. 3.65m wide traffic lanes, reducing to a single 3.65m traffic lane in accordance with TD 22/06 on approach to the back of the merge nose with Link C
- 1 no. 300mm (minimum) wide offside hardstrip, widening as lane 2 is reduced on approach to the merge nose in accordance with TD 22/06
- nearside paved verge with a typical width of 2m
- offside paved verge with a typical width of 2m.

Two lanes have been provided on the slip road in order to match the existing lane designations on Dock Street for both westbound and eastbound traffic. To provide a single lane would require a similar reduction in lanes on Dock Street, which would have a direct impact on the operation of the various junctions.

As the proposed provision does not match the requirements of TD 27/05, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.3.10 ***Link J (M3 to York Street)***

The proposed cross-section on the M3 off-slip to Nelson Street and its onward connection to York Street matches closely the existing provision. Therefore four lanes of 3.5m width are provided on the slip road from the M3 to Nelson Street. Beyond the junction, four no. 3m wide lanes are provided, with additional auxiliary lanes provided on approach to the junction with York Street. New Construction Headroom is maintained to the Dargan Bridge.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table A.2** in **Appendix D**.

5.2.3.4 *Junction Layouts*

5.2.3.4.1 ***Grade Separation Provision***

It is recognised that the proposed layout is a grade separated junction, but not a full interchange as the link between the M3 mainline and Westlink mainline will still be via a series of signal controlled junctions on the surface street network. However, grade separated interchange links are provided between the two Westlink and M2 mainlines and for the Westlink to M3 movement.

5.2.3.4.2 ***M2 Foreshore Diverge (Link A)***

Diverge Type

Based on the projected traffic flows on the M2 mainline and the diverging flows to Link A, with reference to Figure 2/3AP of TD 22/06, a type D "tiger-tail" ghost island diverge for lane drop should be provided in accordance with Figure 2/6.3 of TD 22/06. This requires a single lane drop to Link A, with three lanes provided southbound toward the M3. However, the downstream capacity is fixed by the width of the Lagan Bridge, therefore only two downstream lanes can be provided. As the existing carriageway upstream has four lanes, it follows that the diverge from the M2 foreshore has been designed as a higher capacity type E two lane drop, in accordance with TD 22/06. This will require a Departure from Standard.

Diverge Layout

With the provision of a 50mph limit on the M2 mainline, the classification of the M2 southbound carriageway becomes that of an urban motorway, i.e. a motorway with a speed limit of 60mph or less within a built up area, as defined in TD 22/06. Therefore, with reference to Table 4/4 of TD 22/06, the layout should comprise:

- a 40m long nose with a minimum nose ratio of 1:12
- a minimum 1000m radius on the edge line at the tip of the nose.

A 85m long nose has been provided with a minimum nose ratio of 1:15, with a 1000m radius used at the tip of the nose. This has been provided to accommodate a downstream straight alignment of the proposed Dock Street overbridge, requiring a nosing that is both wider and longer than the minimum requirements. The provided geometry is akin to the requirements for a rural motorway within an interchange, but the proposed over provision requires a Departure from Standard.

A 40m straight has been provided beyond the back of the diverge nose, in accordance with the requirements of paragraph 2.46 of TD 22/06.

Spacing to Adjacent Junctions

The provision of the lane drop at the selected position reduces the distance between the lane drop to Duncrue Street and the lane drop to the Westlink (Link A) by approximately 215m to approximately 475m (measured between tips of diverge noses). It should be noted that both are separate diverges that do not form part of the same interchange and are therefore not subject to minimum spacing distance requirements of TD 22/06.

Weaving Sections

No new weaving sections are created by the junction.

SSD on Diverge Arrangement

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 160m downstream of the back of the diverge nose cannot be met due to the vertical alignment of the link, which reduces the SSD to 90m. Therefore a Departure from Standard TD 22/06 will be required.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.3 ***Corporation Street/Westlink Merge (Links A/H)***

Merge Type

Based on the projected traffic flows on the Link A mainline and the merging flows from Corporation Street, with reference to Figure 2/3AP of TD 22/06, a type A or type D taper merge layout should be provided. However, it is proposed to provide a type B parallel merge layout to Figure 2/4.1 of TD 22/06, which will require a Departure from Standard. A parallel merge has been provided to assist gap finding in the mainline flow, given the presence of a discontinuous hard shoulder on entry to the enclosed section of the underpass. This over provision will require a Departure from Standard.

Merge Layout

The parallel merge layout proposed is set out in accordance with the geometric requirements of Table 4/3 of TD 22/06 for an urban road with a speed limit of 50mph or less, comprising:

- a 40m long nose with a minimum nose ratio of 1:12
- a 100m long auxiliary lane
- a 40m long auxiliary lane taper.

A straight alignment has been provided to the back of the merge nose however, the link is too short in overall length to provide the full 40m requirement in accordance with paragraph 2.34 of TD 22/06. Therefore, a Departure from Standard will be required.

The auxiliary lane taper terminates on entry to the enclosed section of the underpass, with a 700mm nearside hardstrip provided as outlined in **Section 5.2.3.3.1**.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges or diverges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the diverge nose on Link A and the merge nose on Link H is approximately 430m. This exceeds the 262.5m minimum requirement for the 70kph Design Speed.

Weaving Sections

No new weaving sections are created by the junction.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.4 ***Merge from M3/York Street (Links A/D)***

Merge Type

Based on the projected traffic flows on the Link A mainline and the merging flows from York Street, with reference to Figure 2/3AP of TD 22/06, a type F lane gain with ghost island merge to Figure 2/4.4 of TD 22/06 would appear to be the preferred provision. However, ghost island merges are not permitted on urban roads in accordance with paragraph 2.28 of TD 22/06. Accordingly, it is proposed to provide a type E single lane gain merge layout to Figure 2/4.3 of TD 22/06, with a 2 lane urban merge detail to Figure 2/4.2 of TD 22/06 used to reduce the two lanes on the off-slip in advance of the merge nose. It is considered that a Departure from Standard is not required for this under provision.

Merge Layout

With regard to the details for the merge layout onto the mainline, the required 40m long nose with a minimum nose ratio of 1:12 has been provided. However, with regard to the geometric details of the 2 lane urban merge on the slip road, it is not possible to fully meet all the geometric requirements set out in TD 22/06.

With reference to the requirements of paragraph 2.34 of TD 22/06, a straight of 90m in length is provided upstream of the back of the merge nose, which exceeds the nose length and is therefore compliant with standards. However, with reference to Table 4/3 of TD 22/06, the slip road lane reduction taper used is developed at a ratio of 1:10 c.f. the preferred minimum of 1:40, thereby requiring a Departure from Standard. Furthermore, it is not possible, given the overall length of the link, to conclude the lane reduction by a point 50m upstream of the back of nose, as required by Figure 2/4.2 of TD 22/06. The maximum distance that can be provided is 35m, requiring a Departure from Standard.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges or diverges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the merge nose from Link H and that of Link D is approximately 440m. This exceeds the 262.5m minimum requirement for the 70kph Design Speed.

Weaving Sections

The provision of the merge from M3/York Street creates a weaving section in conjunction with the downstream Clifton Street diverge. The assessment of this weaving section is included in the assessment of the Clifton Street diverge arrangement reported in **Section 5.2.3.4.5**.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.5 ***Diverge to Clifton Street (Link A)***

Diverge Type

Based on the projected traffic flows on the Link A mainline and the diverging flows to Clifton Street, with reference to Figure 2/5AP of TD 22/06, a type A taper diverge with three mainline lanes continuing southbound to Figure 2/6.1 of TD 22/06 is the required provision for the diverge arrangement to Clifton Street.

It is not possible to provide three southbound lanes on the Westlink within the existing width of the canyon section without recourse to major engineering works to widen the Westlink. Such works were considered as part of the assessment of alternative schemes at the time of the Stage 1 assessment and discounted on the basis of the engineering challenges and resultant costs. For a more detailed report of this assessment reference should be made to Section 3.5.2 of the scheme's Preliminary Options Report dated March 2009.

Instead, it is proposed to convert the existing taper diverge to a lane drop, such that two southbound lanes are maintained on the Westlink in the canyon section. The proposed diverge layout will require a Departure from Standard.

Diverge Layout

A 40m nose of minimum nose ratio has been provided in accordance with the requirements of Table 4/4 of TD 22/06, along with a near straight of 40m beyond the back of the diverge nose, in accordance with the requirements of paragraph 2.46 of TD 22/06. The required 1000m radii on the edge line at the tip of the diverge nose cannot be provided, with a 200m radius used in lieu. This will require a Departure from Standard TD 22/06.

Spacing to Adjacent Junctions

The diverge creates a weaving section, the assessment of which subsequently follows in a separate sub-section.

Weaving Sections

Identified Weaving Sections

The provision of the lane gain from Link D coupled with the proposed lane drop to Clifton Street creates a weaving section within the junction layout. Under TD 22/06, the process for designing a weaving section between merge and diverge layouts is to first estimate the weaving flows and use this information to establish an actual weaving length that must be provided. Once this actual weaving length is determined, it is used with the weaving flows to calculate the number of lanes required over that weaving section. It should be noted that in accordance with TD 22/06, even the lowest weaving flow has an impact on traffic demand of up to three times its numerical value.

Calculation of Weaving Flows

The estimated weaving flows are typically prepared by the factoring up of current weaving flows from origin/destination surveys. In the development of the traffic survey proposals used for the traffic and economic assessment, the practicalities of undertaking an origin/destination survey at the existing junction were investigated in detail. However, it was found that the number of lanes and high traffic volumes on the existing junction make it extremely difficult to undertake accurate origin/destination studies with current techniques. On this basis, such surveys have not been carried out at time of this Stage 2 assessment.

Calculation of Actual Weaving Length

To calculate the actual weaving length, a Desirable Minimum weaving length and an Absolute Minimum weaving length should be established using the calculated weaving flows. The larger of these two figures should then be selected and incorporated into the layout along with an additional "d" distance as per Figures 4/10 to 4/12 of TD 22/06. This "d" value is 100m for Design Speeds above 85kph, and 50m for Design Speeds 85kph and below.

In the absence of calculated weaving flows, an approximation was made of the Desirable Minimum weaving length using projected traffic flows and Figure 4/14 of TD 22/06. This approximation identified that the Desirable Minimum weaving length would be of the order of 350m. In contrast, the Absolute Minimum weaving length for the length is approximately 170m, using Figure 4/14. It is not possible to provide a 400m (350m Desirable Minimum weaving length plus 50m "d" distance) weaving length within the weaving section. Therefore, the weaving section provides a total 220m weaving length (170m Absolute Minimum weaving length plus 50m "d" distance) between opposing merge/diverge noses. Should it subsequently become possible to determine the weaving flows and complete the weaving flow calculations, the information will only serve to confirm the Desirable Minimum for the purposes of informing the anticipated Departure from Standard.

It is important to note that if selected as the Preferred Option, the junction layout will be subject to a Road Safety Audit in accordance with Design Standard HD 19/03. As part of this process, the appointed Auditor makes recommendations for the design in the interests of road user safety. Recommendations may therefore be made by the Auditor in relation to the weaving length provided and appropriate mitigation measures.

Calculation of Number of Lanes on Weaving Section

Using the actual weaving length provided, incorporating the Absolute Minimum weaving length, the next step in the design of the weaving section would be to identify the number of lanes required. As stated previously, estimated weaving flows are not available, so an approximation was made using projected traffic flows on the links, subject to a number of assumptions. This approximation would suggest that five lanes should be provided over the weaving section to facilitate weaving movements over the proposed weaving length.

Within the existing Westlink canyon section, it is only possible to provide a maximum of three lanes on this weaving section, with the nearside lane diverging to Clifton Street as a proposed lane drop. Should it subsequently become possible to determine the weaving flows and complete the weaving flow calculations, the information will only serve to confirm the number of lanes required for the purposes of informing the anticipated Departure from Standard.

SSD on Diverge Arrangement

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 120m downstream of the back of the diverge nose is met.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.6 ***Merge from Clifton Street (Link B)***

Merge Type

In Option A, the Clifton Street on-slip is retained along with the existing lane gain onto the Westlink mainline (Link B). With reference to Figure 2/3AP of TD 22/06, based on the projected traffic flows on the Link B mainline and the merging flows from Clifton Street, with reference to Figure 2/3AP of TD 22/06, a type E lane gain to Figure 2/4.3 of TD 22/06 is the required provision, and therefore is compliant with standards.

Merge Layout

The geometric layout of the lane gain from Clifton Street is to an urban road standard, with a 40m merge nose from Clifton Street. Therefore no Departure from Standard is considered necessary. A straight alignment of 40m length has also been provided in advance of the back of the merge in accordance with the requirements of paragraph 2.34 of TD 22/06.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges or diverges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the northbound diverge nose to Clifton Street and the retained northbound merge nose from Clifton Street is approximately 480m. This exceeds the 450m minimum requirement for the 70kph Design Speed as per the requirements of paragraph 4.30 of TD 22/06.

Weaving Sections

The provision of the merge from Clifton Street creates a weaving section in conjunction with the downstream York Street diverge. The assessment of this weaving section is included in the assessment of the York Street diverge arrangement reported in **Section 5.2.3.4.7**.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.7 ***Diverge to York Street (Links B/G)***

Diverge Type

With regard to the layout of the diverge from Westlink to York Street (Link G), based on the projected traffic flows on the Link B mainline and the diverging flows to York Street, with reference to Figure 2/5AP of TD 22/06, a type A taper diverge to Figure 2/6.2 of TD 22/06 should be provided along with three lanes continuing downstream on Link B. However, it is not possible to provide the required number of downstream lanes, since the cross-section on the link is limited by the piers of the Dargan Bridge. Therefore a type C lane drop at taper diverge to Figure 2/6.2 of TD 22/06 is provided, with a lane drop to York Street. The proposed provision will require a Departure from Standard.

Diverge Layout

The lane drop layout is set out in accordance with the geometric requirements of Table 4/4 of TD 22/06 for an urban road with a speed limit of 50mph or less, comprising:

- a 40m long nose with a minimum nose ratio of 1:12
- a 90m taper to develop two lanes at the tip of the diverge nose
- a minimum 1000m radius on the edge line at the start of the taper
- a minimum 1000m radius on the edge line at the tip of the diverge nose.

It is not possible to provide a near straight 40m long beyond the back of the diverge nose in accordance with the requirements of paragraph 2.46 of TD 22/06, therefore a Departure from Standard will be required.

In the proposed layout, it is not possible within the space available to provide the full 90m taper length to develop the two lanes. The maximum taper length possible is 65m and this has been provided, but will require a Departure from Standard. All other elements in the diverge layout have been provided in accordance with the above requirements.

Spacing to Adjacent Junctions

The requirements of paragraph 4.30 of TD 22/06 do not apply to this scenario.

Weaving Sections

Identified Weaving Sections

The lane gain, in conjunction with the diverge to York Street (Link G) creates a weaving section on the Westlink mainline. As described in **Section 5.2.3.4.5**, a calculation of the weaving flows has not been possible and in any event, would not have any bearing on the developed layout given the constraints imposed by the upstream Westlink canyon section, limiting the width of the weaving section to three lanes.

Calculation of Actual Weaving Length

The length available for weaving is constrained by the close proximity of the Clifton Street on-slip to the diverge to York Street, which cannot be improved significantly within any of the options. Therefore, the Absolute Minimum weaving length used in the design represents the maximum weaving length possible for the section. Accordingly, the weaving section on the northbound carriageway comprises the Absolute Minimum weaving length of 170m for the selected Design Speed of 70kph is met, in addition to the required “d” distance of 50m, creating a total 220m weaving length between opposing merge/diverge noses.

In the absence of estimated weaving flows, an approximation was made of the Desirable Minimum weaving length using projected traffic flows and Figure 4/14 of TD 22/06. This approximation indicates that the Desirable Minimum weaving length would be of the order of 100m. In contrast, the Absolute Minimum weaving length for the length is approximately 170m, using Figure 4/14. Therefore, the proposed use of the Absolute Minimum weaving length would appear to be compliant with standards. Should it subsequently become possible to determine the weaving flows and complete the weaving flow calculations, it may be found that the Desirable Minimum exceeds the Absolute Minimum value. However, as it is not possible to increase the length of the weaving section, this additional information will only inform the related Departure from Standard. It has been assumed at this time that a Departure from Standard will be required.

Calculation of Number of Lanes on Weaving Section

As stated previously, estimated weaving flows are not available, so an approximation was made using projected traffic flows on the links, subject to a number of assumptions. This approximation would suggest that four lanes should be provided over the weaving section to facilitate weaving movements over the provided weaving length. Within the existing Westlink canyon section, it is only possible to provide a maximum of three lanes on this weaving section, with the nearside lane diverging to York Street as a proposed lane drop. Should it subsequently become possible to determine the weaving flows and complete the weaving flow calculations, the information will only serve to confirm the number of lanes required for the purposes of informing the assumed Departure from Standard.

It is important to note that if selected as the Preferred Option, the junction layout will be subject to a Road Safety Audit in accordance with Design Standard HD 19/03. As part of this process, the appointed Auditor makes recommendations for the design in the interests of road user safety. Recommendations may therefore be made by the Auditor in relation to the weaving length provided and appropriate mitigation measures.

SSD on Diverge Arrangement

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 120m downstream of the back of the diverge nose is met, along with the requirement for a 90m SSD 30m downstream of the back of the nose.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.8 ***M2 Merge (Link B)***

Merge Type

Based on the projected traffic flows on the M2 mainline and the merging flows from Link B, with reference to Figure 2/3MW of TD 22/06, a type G 2 lane gain with ghost island merge layout to Figure 2/4.5 of TD 22/06 would appear to be the preferred provision. However, ghost island merges are not permitted on urban roads in accordance with paragraph 2.28 of TD 22/06. Accordingly, it is proposed to provide a type E double lane gain merge layout similar to that shown in Figure 2/4.3 of TD 22/06. A Departure from Standard is not considered necessary for this provision.

Merge Layout

With the retention of the national speed limits on the M2 mainline northbound carriageway, its classification remains that of a rural motorway, i.e. a motorway not subject to a speed limit, as defined in TD 22/06. Therefore, with reference to Table 4/4 of TD 22/06, the layout should reflect that of a rural motorway within an interchange, comprising a 75m long hose with a minimum nose ratio of 1:25. The proposed merge arrangement has been designed to match the existing merge arrangement, to limit works. Accordingly, the existing nose length of 100m with a nose ratio of 1:25 has been maintained. This provision will require a Departure from Standard.

It is not possible to provide the required 75m long near straight on approach to the back of the merge nose in accordance with the requirements of paragraph 2.34 of TD 22/06, therefore a Departure from Standard will be required.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges or diverges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the diverge nose on Link C and the tip of the merge nose on Link B is approximately 300m, above the 262.5m minimum requirement for the 70kph Design Speed.

Weaving Sections

The alignment of the link is such that the merge from Link B matches the current position of the merge from York Street. Therefore the same weaving section between York Street and Fortwilliam is maintained with the same weaving length of approximately 2km. No Departures from Standard are considered necessary for maintaining the existing provision.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.9 ***Westlink/M3 Diverge (Links B/C)***

Diverge Type

The proposed location of the diverge from the Westlink to the M3 is on the offside of Link B. This reflects the existing junction arrangement whereby traffic intending to travel onwards to the M3 must diverge on the offside of lane 2 on the Westlink on approach to the York Street junction.

It is noted that the provision of offside diverges are not recommended, but not prohibited, by paragraph 2.10 of TD 22/06. In order to provide a grade separated movement between the Westlink and M3, given the horizontal and vertical alignment of adjacent links, an offside diverge is the only feasible solution.

Based on the projected traffic flows on the Link B mainline and the diverging flows to the M3, with reference to Figure 2/5AP of TD 22/06, a type D lane drop layout should be provided. However, given the constraints on carriageway width imposed by the constraints, it is not possible to provide a lane drop. There is insufficient space to provide a type B ghost island diverge, therefore, a type A taper diverge layout to Figure 2/6.1 of TD 22/06 has been provided. This provision will require a Departure from Standard.

Diverge Layout

The taper diverge layout is subject to the geometric requirements of Table 4/3 of TD 22/06 for an urban road with a speed limit of 50mph or less, comprising:

- a 75m exit taper
- a 40m long nose with a minimum nose ratio of 1:12
- a minimum 1000m radius on the edge line at the start of the taper

Within the constraints of the site, the maximum length of exit taper that can be provided is 70m, requiring a Departure from Standard. All other elements have been provided to the above requirements. With regard to the requirements of paragraph 2.46 of TD 22/06, it is not possible to provide the required near straight of 40m length downstream of the back of the diverge nose, therefore a Departure will be required.

For the proposed diverge arrangement, the SSD over the defined approach is a minimum of 90m, One Step below Desirable Minimum. Therefore a Departure from Standard TD 9/93 will be required. In addition, the vertical curvature on Link B over this approach is also substandard, although this could be encompassed by the same Departure application.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges or diverges on a connector road or mainline within an interchange, it is noted that this distance is below the 262.5m minimum requirement for the 70kph Design Speed. Therefore a Departure from Standard will be required. It is also noteworthy that the proposed separation between the two diverge points is shorter than the Absolute Minimum weaving length for a standard nearside merge/diverge layout at a Design Speed of 70kph (170m).

Weaving Sections

The proposed layout requires any driver wishing to cross from Clifton Street on-slip to the M3 to use the provided 220m weaving length to weave from lane 1 on the weaving section to lane 2 prior to the tip of the diverge nose to York Street. Beyond this point, a further distance of approximately 160m is provided in advance of the diverge nose for Link C to allow a driver to undertake a further weave manoeuvre into lane 2 of the underpass.

The Highways Agency have confirmed, that in layouts such as that proposed, the distance between the lane gain from Clifton Street and the diverge to the M3 is not considered a weaving length as defined on Figures 2/9 and 4/9 to 4/14 inclusive of TD 22/06. Accordingly, the Highways Agency has confirmed that the weaving length calculations referred to in TD 22/06 cannot be applied to such layouts. Therefore, whilst the offside diverge layout with total, staggered, weaving length of approximately 380m is not advised by TD 22/06, it is not subject to a Departure from Standard.

SSD on Diverge Arrangement

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 120m downstream of the back of the diverge nose cannot be met, along with the requirement for a 90m SSD 30m downstream of the back of the nose. Therefore a Departure from Standard will be required.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.10 ***At-grade Junctions on York Street (Link E)***

The design of the at-grade junctions on Link E has taken cognisance of the relevant requirements of TD 42/95 and TD 41/95, in relation to the design of priority junctions and the requirements of TD 50/04, relevant to signal controlled junctions.

Where specific Departures from Standard TD 41/95 or TD 42/95 or TD 50/04 have been identified, these are included in **Appendix D** as **Table A.4**.

5.2.3.4.11 ***At-Grade Junction at Galway House (Link F)***

Several Departures from Standard TD 9/93 will be required due to the substandard vertical geometry and resultant SSD over the designated approach zone to the priority junction. In addition, a Departure from Standard TD 42/95 will be required for the visibility splay to the right for traffic southbound on York Street at the junction, as a 70m splay, One Step below Desirable Minimum, is the maximum possible.

5.2.3.4.12 ***M2 Merge (Link F)***

Merge Type

Based on the projected traffic flows on the M2 mainline and the merging flows from Link F, with reference to Figure 2/3MW of TD 22/06, a type F two lane gain with ghost island merge layout to Figure 2/4.4 of TD 22/06 would appear to be the preferred provision. However, ghost island merges are not permitted on urban roads in accordance with paragraph 2.28 of TD 22/06. Accordingly, it is proposed to provide a type E single lane gain merge layout similar to that shown in Figure 2/4.3 of TD 22/06. A Departure from Standard is not considered necessary for this provision.

Merge Layout

With the retention of the national speed limits on the M2 mainline northbound carriageway, its classification remains that of a rural motorway, i.e. a motorway not subject to a speed limit, as defined in TD 22/06. Therefore, with reference to Table 4/4 of TD 22/06, the layout should reflect that of a rural motorway within an interchange, comprising a 75m long hose with a minimum nose ratio of 1:25. The proposed merge arrangement has been designed to match these requirements, therefore a Departure from Standard is not considered necessary. A near straight of 75m length has been provided in advance of the back of the merge nose in accordance with the requirements of paragraph 2.34 of TD 22/06.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the merge nose from Link B and that of Link F is approximately 140m, below the 450m minimum requirement for the 120kph mainline Design Speed. This is the maximum possible without widening the M2 northbound carriageway on the western side, which is not considered feasible. Therefore a Departure from Standard will be required.

Weaving Section

The alignment of the link is such that the merge from Link F is positioned approximately 150m north of the present merge from York Street. Therefore the same weaving section between York Street and Fortwilliam is maintained with a slightly reduced weaving length of approximately 1.9km. A Departure from Standard will be required for the reduction below 2km, the Desirable Minimum weaving length for a Rural Motorway, in accordance with paragraph 4.35 of TD 22/06.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.13 ***Westlink / York Street Signalised Junction (Links G/E)***

The junction between Link G and York Street (Link E) has been designed taking cognisance of the requirements of TD 50/04 in relation to signal controlled junctions.

Where specific Departures from Standard have been identified, these are included in **Appendix D** as **Table A.4**.

5.2.3.4.14 ***Corporation Street to Westlink Ghost Island Junction***

The proposed ghost island junction on Corporation Street is subject to the requirements of Design Standard TD 42/95.

Where specific Departures from Standard TD 42/95 have been identified, these are included in **Appendix D** as **Table A.4**.

5.2.3.4.15 ***Dock Street to M3 Merge (Links I/C)***

Merge Type

Based on the projected traffic flows on Link C and the merging flows from Link I, with reference to Figure 2/3MW of TD 22/06, a type E lane gain to Figure 2/4.3 of TD 22/06 is required. Therefore the proposed provision is compliant with standards.

Merge Layout

The layout requirement for the merge layout is, with reference to Table 4/3 of TD 22/06, a nose of 40m in length with a minimum angle of 1:12. However, the proposed nose length is 70m to suit the alignment of the merging slip road. Therefore a Departure from Standard will be required. Furthermore, it is not possible to provide a 40m near straight upstream of the merge arrangement in accordance with paragraph 2.34 of TD 22/06, requiring a Departure from Standard.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges or diverges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the diverge nose on Link C and the tip of the merge nose from Link I is approximately 260m, marginally below the 262.5m minimum requirement for the 70kph Design Speed. Therefore a Departure from Standard will be required. Similarly, the Link C/Link I merge is approximately 210m upstream of the tip of the merge nose onto the Lagan Bridge. This spacing is below the 262.5 minimum requirement and will require a Departure from Standard.

Weaving Sections

No weaving sections are created by the junction.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.3.4.16 ***M3 to York Street Diverge (Link J)***

The diverge from the M3 to York Street is essentially unchanged from its present arrangement, with some changes to the movements permitted at the existing signalised junction to accommodate local access. Whilst the alignment has not changed, the requirements for SSD on approach to the junctions on the link have been considered, with Departures from Standard TD 9/93 identified where necessary. These Departures are listed in **Table A.1** included in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included as **Table A.4** in **Appendix D**.

In order to maintain access to lands at Shipbuoy Street/ Nile Street and existing properties on Nelson Street, it is proposed to convert the remaining section of Nelson Street, south of the junction with Link J, to two-way operation. It is proposed to reduce the number of southbound lanes to two at the junction with Link J, opening to three on approach to the junction with Dunbar Link. Two lanes would then be provided in the opposing direction, facilitated with works to the existing junction on Dunbar Link to provide a right-turning facility and to ease the corner radius for the eastbound movement on Great Patrick Street. It is not proposed to provide physical separation between the flows. At the junction with Link J, access across the link into lands at Shipbuoy Street and Nile Street would be provided through use of the truncated sections of Nelson Street remaining under the Lagan Bridge and Dargan Bridge. A left-turn filter lane would remain, similar to existing provision, to enable vehicles on Link J to turn into the southbound lanes on Nelson Street.

5.2.4 ***Assessment of Option B***

5.2.4.1 *Design Speeds*

In Option B, links to and from the three mainlines are considered interchange links, as defined by paragraph 1.16 of TD 22/06. In Option B, the M2 to Westlink link is provided with an improved horizontal radius, in contrast to the radii offered by the underpass in Option A. For this reason, it was agreed with Roads Service that the existing national speed limits should be retained on both northbound and southbound carriageways on the M2. This would classify the M2 as a rural motorway. In accordance with paragraph 4.1 of TD 22/06, a Design Speed of 85 kph was selected for the link, which was designed on this basis.

For the M3 to Westlink link, to maintain consistency with the speed limit on Link A, a speed limit of 50mph would also be applied to the link, as agreed with Roads Service. However, in accordance with paragraph 4.1 of TD 22/06, a Design Speed of 70 kph was selected for the link, which was designed on this basis.

All other speed limits and Design Speeds would be similar to their counterparts in Option A.

Table 5.2.2 summarises the selected Design Speeds for the various links in Option B. These Design Speeds and the proposed locations of speed limits have been illustrated on **Drawing S105296-R-SK-B-002**.

TABLE 5.2.2: OPTION B SPEED LIMITS AND DESIGN SPEEDS

Link	From	To	Relevant Mainline and Design Speed	Road Classification	Design Speed	Speed Limit
A	M2	Westlink	M2 – Rural 120 kph	Interchange Link	85 kph	50 mph
B	Westlink	M2	Westlink – Urban 85 kph	Interchange Link	70 kph	40 mph
C	Westlink	M3	Westlink – Urban 85 kph	Interchange Link	70 kph	40 mph
D	M3	Westlink	M3 – Urban 85 kph	Interchange Link	70 kph	50 mph
E	York Street (South)	York Street (North)	York Street Urban 60 kph	Single Carriageway	60 kph	30 mph
F	York Street	M2	M2 – Rural 120 kph	Slip Road	70 kph	30 mph / National
G	Westlink	York Street	Westlink – Urban 85 kph	Slip Road	60 kph	40 mph / 30 mph
H	Nelson Street	Westlink	Westlink – Urban 85 kph	Slip Road	60 kph	30 mph / 40 mph
I	Dock Street	M3	M3 – Urban 85 kph	Slip Road	70 kph*	40 mph / 50 mph

TABLE 5.2.2: OPTION B SPEED LIMITS AND DESIGN SPEEDS						
Link	**From**	**To**	**Relevant Mainline and Design Speed**	**Road Classification**	**Design Speed**	**Speed Limit**
J	M3	York Street	M3 – Urban 85 kph	Slip Road	60 kph	50 mph / 30 mph

* The speed limits to be applied to the various slip roads joining links in underpasses were agreed with Roads Service in advance of design development. Through these discussions, it was agreed that in order to provide consistency with the Westlink to M3 interchange link (Link C) the slip road from Dock Street to the M3 (Link I) should have a similar speed limit and hence Design Speed of 70kph. As the link is classified as a slip road rather than an interchange link, this will be contrary to the specific requirements of TD 22/06 (60kph) and require a Departure from Standard. The option remains to revisit this particular Design Speed in the future following further consultation with Roads Service.

5.2.4.2 *Alignments*

5.2.4.2.1 ***Link A (M2 to Westlink)***

Master String Location

The master string for Link A is situated on the nearside edge of lane 1, commencing on the M2 motorway and terminating on the Westlink at the back of the Clifton Street off-slip. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The horizontal alignment on the link commences with a straight on the diverge from the M2, transitioning to a long right hand curve of 300m radius, Two Steps below Desirable Minimum for the selected Design Speed. On approach to the Westlink, the curve transitions into a straight at the merge from M3 (Link D) before transitioning into the existing left hand curve of 350m radius on the Westlink which is maintained to the end of the alignment.

Vertical Alignment

The vertical alignment commences with a sag curve with a K value of 180 to match the existing provision on the M2 foreshore. This existing sag curve is One Step below Desirable Minimum for the 120kph Design Speed at that position and maintained to the end of the diverge arrangement. Beyond the back of nose, a crest curve with a K value of 55, equal to the Desirable Minimum, is introduced to achieve headroom over Dock Street. Beyond Dock Street, a sag curve with a K value of 26 is introduced. This K value exceeds the Desirable Minimum requirement. A long crest curve with a K value of 30 is subsequently introduced to provide clearance over the underlying Lagan Bridge and Dargan Bridge. The proposed K value is One Step below Desirable Minimum for the selected Design Speed, with an instantaneous gradient at the tangent point between the two curves of approximately 6%. The crest curve leads into a sag curve with a K value of 22.5 on approach to the merge with Link D. The proposed K value on the sag curve exceeds the Absolute Minimum requirement and generates an instantaneous gradient at the tangent point of the crest curve of approximately 6%. Beyond the sag curve, the vertical alignment closely matches that of the existing Westlink over North Queen Street Bridge, with a crest curve used with a K value of 30. This K value is One Step below Desirable Minimum. At the alignment approaches the tie-in at Clifton Street, a downhill 2.25% gradient is used to provide a smooth transition to the existing alignment.

Stopping Sight Distance

The SSD provided over the diverge nose is limited to a minimum of 120m, 3 Steps below Desirable Minimum for the mainline Design Speed. This will require a Departure from Standard. Beyond the back of nose, the SSD reduces further to a minimum of 90m, limited by the width of the offside verge on the overbridge structure. This provision is maintained on the overbridge above the Lagan Bridge and Dargan Bridge. The proposed 90m minimum SSD is Two Steps below Desirable Minimum for the reduced Design Speed of 85kph on the connector road. It is not possible to provide any further improvement in SSD on the overbridge structure without significant widening of the offside verge on the structure. This would incur significant additional costs and would require the vertical alignment to be further raised to maintain headroom to underlying road and rail links.

As the horizontal alignment straightens, on the western side of the overbridge, the minimum SSD increases, with the Desirable Minimum met or exceeded on the downhill departure from the structure. As the horizontal alignment transitions into the existing left hand curve on the Westlink, the minimum SSD progressively reduces to a minimum of 90m, Two Steps below Desirable Minimum, which is maintained to the end of the link.

Transitions and Superelevation

Transitions have been provided in accordance with the requirements of TD 9/93.

Superelevation of up to 7% has typically been provided on the link based on the radii of selected horizontal curves. It is noted that there is scope to further reduce this to 5%, based on the presence of at-grade junctions, in accordance with TD 9/93, however, the superelevation proposes represents the worst-case scenario. Opportunities to reduce the superelevation where favourable will be explored at detailed design stage following selection of a Preferred Option.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at seven locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at six locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.2 ***Link B (Westlink to M2)***

The alignment of Link B in Option B is identical to its counterpart in Option A, as described in **Section 5.2.3.2.2**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.3 ***Link C (Westlink to M3)***

The alignment of Link C in Option B is identical to its counterpart in Option A, as described in **Section 5.2.3.2.3**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.4 ***Link D (M3 to Westlink)***

Master String Location

The master string for Link D is situated on the offside edge of lane 1, commencing on the tip of diverge nose on the M3 motorway and terminating at the tip of the merge nose with Link A. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The horizontal alignment commences with a right hand curve of 510m radius, matching the existing radius on the diverge nose and meeting the Desirable Minimum requirement. The radius transitions to a smaller 300m radius beyond the back of the diverge nose, Two Steps below Desirable Minimum for the selected Design Speed. On approach to the diverge to York Street, the alignment reverses into a left hand curve with a radius of 127m, limited by the Dargan Bridge substructure. The proposed radius is Three Steps below Desirable Minimum for the reduced Design Speed of 70kph on the connector road. This curve is maintained to the back of the diverge nose to York Street. Beyond the diverge, the horizontal alignment reverses to a 360m right hand curve, which extends to a position east of the crossing above York Street. The alignment subsequently reverses into a left hand curve of 200m radius that forms the merge nose with Link A.

Vertical Alignment

The vertical alignment of the link seeks to match the existing vertical alignment of the existing diverge and off-slip to York Street. To that end, the vertical alignment on the Lagan Bridge structure comprises an initial uphill gradient of 0.5% leading into a crest curve with a K value of 12, Three Steps below Desirable Minimum. The existing downhill gradient on the ramp structure of approximately 6.25% is maintained, but beyond the abutment a sag curve with a K value of 9 is introduced to link into a 7.5% uphill gradient to achieve clearance over York Street, whilst maintaining headroom to the Dargan Bridge. The proposed K value on the sag curve is Two Steps below Absolute Minimum for the 70kph Design Speed. Although gradients of up to 8% are permitted under TD 9/93, TD 22/06 limits gradients on motorway connector roads to 6%, therefore a Departure from Standard TD22/06 will be required. Over York Street, a crest curve with a K value of 12 is introduced, Two Steps below Desirable Minimum, to connect into a downhill gradient of 2.6% that is maintained into the merge arrangement at the end of the alignment.

Stopping Sight Distance

Over the existing diverge arrangement, the SSD provision matches the existing scenario. Therefore, the SSD is initially a minimum of 70m, limited by the width of the offside raised verge on the structure. This provision will require a Departure from Standard. As the vertical alignment continues downhill, the SSD increases to a minimum of 120m, the Desirable Minimum for the selected Design Speed. The location of the piers to the Dargan Bridge on the nearside verge limit SSD on approach to the left hand curve under the bridge progressively to 50m, the minimum SSD allowed by TD 9/93 and Three Steps below Desirable Minimum, over a 35m distance underneath the Dargan Bridge. This provision will require a Departure from Standard. Beyond the Dargan Bridge, SSD increases progressively to 160m over a short distance at the beginning of the uphill section of the alignment before being progressively reduced to a minimum of 70m due to the crest curve, which is maintained to the back of the merge nose, at which point SSD increases to 160m at the lane gain merges with Link A.

Transitions and Superelevation

Transitions have been provided in general accordance with TD 9/93 however, the departure transition from the curve with a horizontal radius of 300m, on the existing ramp structure, is substandard in length. The provided 41m transition length will require a Departure from Standard.

Superelevation has been limited to 5% on the link.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at eight locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at fifteen locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.5 ***Link E (York Street (South) to York Street (North))***

The alignment of Link E in Option B is identical to its counterpart in Option A, as described in **Section 5.2.3.2.5**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.6 ***Link F (York Street to M2)***

The alignment of Link F in Option B is identical to its counterpart in Option A, as described in **Section 5.2.3.2.6**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.7 ***Link G (Westlink to York Street)***

The alignment of Link G in Option B is identical to its counterpart in Option A, as described in **Section 5.2.3.2.7**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.8 ***Link H (Nelson Street to Westlink)***

Master String Location

The master string for Link H is situated on the offside edge of lane 1, commencing on the tip of diverge nose on Nelson Street and terminating at the tip of the merge nose with Link A. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The horizontal alignment commences with a left hand curve of 720m radius over the diverge nose from the proposed junction arrangement on Nelson Street, exceeding the Desirable Minimum requirement. The alignment then reverses into a right hand curve of 255m radius, meeting the Desirable Minimum. This curve is maintained on the alignment above York Street, before transitioning to a straight alignment that terminates at the tip merge nose with Link A.

Vertical Alignment

The vertical alignment commences with a sag curve with a K value of 20 over the diverge arrangement, connecting into a 6% uphill gradient. The proposed sag K value exceeds the Absolute Minimum requirement. The 6% gradient is maintained to a position immediately north of Dock Street, at which point a crest curve with a K value of 17 is introduced and continued over Dock Street. This meets the Desirable Minimum requirement for the 60kph Design Speed at that position. As the alignment approaches the merge arrangement, a sag curve with a K value of 21.5 is used to match the vertical alignment of the Link A mainline. This provision exceeds the Absolute Minimum requirement.

Stopping Sight Distance

The SSD at the start of the alignment is 215m initially, progressively reducing to 120m by the back of the diverge nose from Nelson Street. At this point, the provision exceeds the Desirable Minimum requirement for the Design Speed. As the 6% uphill gradient is introduced, in conjunction with the onward crest curve, the SSD reduces to 90m on the approach to the crest, the Desirable Minimum value, before reducing to 70m over the crest, limited by the width of the structure and its horizontal alignment. This provision is One Step below Desirable Minimum. Beyond the high point on the crest curve, the SSD increases momentarily to 215m, before reducing progressively to a minimum of 120m at the back of the merge nose with Link A, One Step below Desirable Minimum for the mainline Design Speed of 85kph. The SSD at this point is limited by the width of the overbridge structure and its horizontal alignment. This provision is maintained to the end of the merge arrangement.

Transitions and Superelevation

Transitions have been provided in accordance with TD 9/93.

Superelevation on the link has been limited to 5% on the overbridge structure above Dock Street, increasing to 7% on the merge arrangement with Link A to match its provision.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at one location along the alignment and require a Departure from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at two locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.9 ***Link I (Dock Street to M3)***

The alignment of Link I in Option B is identical to its counterpart in Option A, as described in **Section 5.2.3.2.9**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.2.10 ***Link J (M3 to York Street)***

Master String Location

The master string for Link J is situated on the offside edge of lane 1, commencing on the tip of diverge nose on Link D and terminating at a signalised junction with Link E. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The diverge nose is formed with a left hand curve with a radius of 127m, matching the alignment of the Link D mainline. The proposed radius is Three Steps below Desirable Minimum for 70kph. Beyond the back of the diverge nose, the alignment transitions into a straight before transitioning into a right hand curve with a radius of 360m, exceeding the Desirable Minimum for 60kph.

Vertical Alignment

The vertical alignment commences with a sag curve with a K value of approximately 8 used that is Three Steps below Desirable Minimum, requiring a Departure from Standard. This radius has been used to match the profile of the Link D edge line, based on its vertical alignment and superelevation. The sag curve is continued to a point approximately halfway along the diverge nose at which point a crest curve with a K value of 30, the Desirable Minimum value for 70kph, is introduced. This crest curve is continued to a point just beyond the back of the diverge nose, at which point a sag curve is introduced with a K value of 30, exceeding the Desirable Minimum. This subsequently connects into a sag curve of equal K value that is maintained up to the approach to the junction with Link E. At this point, a crest curve with a K value of 17, the Desirable Minimum for 60kph, is used to provide a level dwell area on approach to the junction.

Stopping Sight Distance

On approach to the diverge nose, the SSD provided will be limited by the obstructions presented by the Dargan Bridge substructure. Therefore, only 50m SSD can be provided initially up to the tip of the diverge nose, which will require a Departure from Standard. At the tip of the diverge nose, the SSD opens to 160m, in excess of the Desirable Minimum value. This provision is maintained to the end of the alignment.

Transitions and Superelevation

Transitions have been provided in accordance with TD 9/93.

Superelevation has been limited to 5% on the link.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at one location along the alignment and require a Departure from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at one location and require a Departure from Standard accordingly.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table B.1** in **Appendix D**.

5.2.4.3 *Cross-Sections*

5.2.4.3.1 ***Link A (M2 to Westlink)***

Based on the projected traffic flows and the purpose of the link as an interchange link connector road from a Rural Motorway, the link would be classified as IL2A in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a two lane interchange link with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 2 no. 3.65m wide traffic lanes
- 1 no. 1m wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 3.3m wide hard shoulder
- 2 no. 3.65m wide traffic lanes
- 1 no. 700mm wide offside hardstrip
- nearside paved verges with a typical width of 2m
- offside paved verge with a typical width of 1m.

The reduced cross-section provision was discussed with Roads Service and agreed prior to design development, with the proposed cross-section on the overbridge structure matching provision on the recently completed overbridges at Stockmans Lane on the M1 motorway. However, as the proposed provision does not match the requirements of TD 27/05, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.2 ***Link B (Westlink to M2)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.2**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.3 ***Link C (Westlink to M3)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.3**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.4 ***Link D (M3 to Westlink)***

Based on the projected traffic flows and the purpose of the link as an interchange link connector road from an Urban Motorway, the link would be classified as IL2B in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a two lane interchange link with urban hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 2.75m wide hard shoulder
- 2 no. 3.65m wide traffic lanes
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 3.3m wide hard shoulder
- 2 no. 3.65m wide traffic lanes, reducing to a single 3.65m traffic lane in accordance with TD 22/06 on approach to the back of the merge nose with Link A
- 1 no. 300mm (minimum) wide offside hardstrip, widening as lane 2 is reduced on approach to the merge nose in accordance with TD 22/06
- nearside paved verges with a typical width of 2m
- offside paved verge with a typical width of 1m.

Given the limitations on the southbound capacity of the Westlink, it is only possible to provide a single lane gain and therefore the number of traffic lanes on the new overbridge to York Street must be reduced to one, albeit with sufficient paved width of 8.18m to allow for future maintenance. The proposed provision will require a Departure from Standard.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.5 ***Link E (York Street (South) to York Street (North))***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.5**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.6 ***Link F (York Street to M2)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.6**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.7 ***Link G (Westlink to York Street)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.7**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.8 ***Link H (Nelson Street to Westlink)***

Based on the projected traffic flows and the purpose of the link as a slip road connector road to an Urban All-Purpose Road, the link would be classified as MG1D in accordance with Table 3/1a of Design Standard TD22/06, This requires the provision of a single lane slip road with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 1 no. 3.7m wide traffic lane
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. nearside hardstrip of 300mm width, widening out to a 3.3m hard shoulder on approach to the merge with Link A
- 2 no. 3.65m (minimum) wide traffic lanes, reducing to a single 3.7m lane on approach to the back of the merge with Link A
- 1 no. 300mm (minimum) wide offside hardstrip, widening as lane 2 is reduced on approach to the merge nose in accordance with TD 22/06
- nearside paved verge with a typical width of 2m
- offside paved verge with a typical width of 1m.

The proposed provision maintains a minimum paved width of 7.3m on the overbridge, however, the proposed configuration will require a Departure from Standard.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.9 ***Link I (Dock Street to M3)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.9**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.3.10 ***Link J (M3 to York Street)***

Based on the projected traffic flows and the purpose of the link as a slip road connector road from an Urban All-Purpose Road, the link would be classified as DG1D in accordance with

Table 3/1a of Design Standard TD22/06, This requires the provision of a single lane slip road with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 1 no. 3.7m wide traffic lane
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. nearside hardstrip of 300mm (minimum) width, widening out to a 3.3m hard shoulder at its widest point beyond the back of the diverge nose, reducing back to a 300mm hardstrip to allow development of an additional 3m lane beyond back of nose
- 2 no. 3.95m (minimum) wide traffic lane to the back of the diverge nose, with reduction in lane width to 3m thereafter
- 1 no. 300mm (minimum) wide offside hardstrip
- nearside paved verge with a typical width of 2m and a minimum width of 1.5m
- offside paved verge with a minimum width of 1m.

The proposed provision maintains a minimum paved width of 6.32m past the pinch point at the back of the diverge nose, however, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table B.2** in **Appendix D**.

5.2.4.4 *Junction Layouts*

5.2.4.4.1 ***Grade Separation Provision***

The proposed layout is a full interchange as movements between the three mainlines are grade separated.

5.2.4.4.2 ***M2 Foreshore Diverge (Link A)***

Diverge Type

Based on the projected traffic flows on the M2 mainline and the diverging flows to Link A, with reference to Figure 2/3AP of TD 22/06, a type D “tiger-tail” ghost island diverge for lane drop should be provided in accordance with Figure 2/6.3 of TD 22/06. This requires a single lane drop to Link A, with three lanes provided southbound toward the M3. However, the downstream capacity is fixed by the width of the Lagan Bridge, therefore only two downstream lanes can be provided. As the existing carriageway upstream has four lanes, it follows that the diverge from the M2 foreshore has been designed as a higher capacity type E two lane drop, in accordance with TD 22/06. This will require a Departure from Standard.

Diverge Layout

With the retention of national speed limits on the M2 mainline, the classification of the M2 southbound carriageway becomes that of a rural motorway, as defined in TD 22/06. Therefore, with reference to Table 4/4 of TD 22/06, the layout should comprise:

- a 70m long nose with a minimum nose ratio of 1:15
- a minimum 1000m radius on the edge line at the tip of the nose.

A 85m long nose has provided with a minimum nose ratio of 1:15, with a 1000m radius used at the tip of the nose. This has been provided to accommodate the downstream alignment of the overbridge above Dock Street and into land owned by Roads Service, requiring a nosing that is both wider and longer than the minimum requirements. The over provision requires a Departure from Standard.

A 70m near straight has been provided beyond the back of the diverge nose, in accordance with the requirements of paragraph 2.46 of TD 22/06.

Spacing to Adjacent Junctions

The provision of the lane drop at the selected position reduces the distance between the lane drop to Duncrue Street and the lane drop to the Westlink (Link A) by approximately 215m to approximately 475m (measured between tips of diverge noses). It should be noted that both are separate diverges that do not form part of the same interchange and are therefore not subject to minimum spacing distance requirements of TD 22/06.

Weaving Sections

No new weaving sections are created by the junction.

SSD on Diverge Arrangement

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 295m downstream of the back of the diverge nose cannot be met due to the combination of horizontal and vertical alignments on the link, which reduces the SSD to 90m. Therefore a Departure from Standard TD 22/06 will be required.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

5.2.4.4.3 ***Nelson Street/Westlink Merge (Links A/H)***

Merge Type

Based on the projected traffic flows on the Link A mainline and the merging flows from Nelson Street, with reference to Figure 2/3AP of TD 22/06, a type A or type D taper merge layout should be provided. However, it is proposed to provide a type B parallel merge layout to Figure 2/4.1 of TD 22/06, which will require a Departure from Standard. A parallel merge has been provided to assist gap finding in the mainline flow, given the vertical gradient on the merge arrangement and the restricted SSD on approach to the merge on Link H. This over provision will require a Departure from Standard.

Merge Layout

The parallel merge layout should be set out in accordance with the geometric requirements of Table 4/3 of TD 22/06 for an urban road with a speed limit of 50mph or less, comprising:

- a 40m long nose with a minimum nose ratio of 1:12

- a 100m long auxiliary lane
- a 40m long auxiliary lane taper.

An 80m long nose has been provided with a minimum nose ratio of 1:12. The longer nose has been provided to allow a smoother alignment change between the connector road and the mainline. This will however require a Departure from Standard. The requirements for auxiliary lane length and auxiliary taper length have been met. It is not possible to provide a 40m near straight on approach to the back of the merge nose in accordance with paragraph 2.34 of TD 22/06. Therefore, a Departure from Standard will be required.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges or diverges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the diverge nose on Link A and the tip of the merge nose on Link H is approximately 320m, marginally above the 319.5m minimum requirement for the 85kph Design Speed.

Weaving Sections

No new weaving sections are created by the junction.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.4.4.4 ***Merge from M3 (Links A/D)***

Merge Type

Based on the projected traffic flows on the Link A mainline and the merging flows from York Street, with reference to Figure 2/3AP of TD 22/06, a type F lane gain with ghost island merge to Figure 2/4.4 of TD 22/06 would appear to be the preferred provision. However, ghost island merges are not permitted on urban roads in accordance with paragraph 2.28 of TD 22/06. Accordingly, it is proposed to provide a type E single lane gain merge layout to Figure 2/4.3 of TD 22/06, with a 2 lane urban merge detail to Figure 2/4.2 of TD 22/06 used to reduce the two lanes on the off-slip in advance of the merge nose. It is considered that a Departure from Standard is not required for this under provision.

Merge Layout

With regard to the details for the merge layout onto the mainline, a 40m long nose with a minimum nose ratio of 1:12 is the TD 22/06 requirement. The proposed layout uses a 55m long nose with a minimum nose ratio of 1:7 has been provided and a Departure from Standard is required for the over provision.

With regard to the geometric details of the 2 lane urban merge on the slip road, it is not possible to fully meet all the geometric requirements set out in TD 22/06. With reference to the requirements of paragraph 2.34 of TD 22/06, a near straight of 40m cannot be provided upstream of the back of the merge nose, requiring a Departure from Standard. However, with reference to Table 4/3 of TD 22/06, the slip road lane reduction taper used is developed at a ratio of 1:40, thereby complying with standards. Furthermore, the lane reduction is concluded at a point 50m upstream of the back of nose, as required by Figure 2/4.2 of TD 22/06.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the merge nose on Link H and the merge nose on Link D is approximately 480m, exceeding the 319.5m minimum requirement for the 85kph Design Speed. Similarly, for Link D, the spacing between the diverge nose for Link J and the tip of the merge nose onto Link A is approximately 340m, exceeding the 262.5 minimum requirement for the 70kph Design Speed.

Weaving Sections

The provision of the merge from the M3 creates a weaving section in conjunction with the downstream Clifton Street diverge. The assessment of this weaving section is included in the assessment of the Clifton Street diverge arrangement reported in **Section 5.2.4.4.5**.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table A.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table A.4**.

5.2.4.4.5 ***Diverge to Clifton Street (Link A)***

Diverge Type

The merge/diverge type is the same as its counterpart in Option A, as described in **Section 5.2.3.4.5**. Therefore a single lane drop is provided in lieu of the type A taper diverge with three downstream mainline lanes required by TD 22/06. This provision will require a Departure from Standard.

Diverge Layout

The diverge to Clifton Street has been designed with the same geometry as its counterpart in Option A and so a number of Departures from Standard will be required.

Spacing to Adjacent Junctions

The diverge creates a weaving section, the assessment of which is presented below.

Weaving Sections

Identified Weaving Sections

A weaving section between the merge from the M3 (Link D) and the proposed lane drop to Clifton Street is proposed for Option B. As described in **Section 5.2.3.4.5**, a calculation of the weaving flows has not been possible and in any event, would not have any bearing on the developed layout given the constraints imposed by the downstream Westlink canyon section, limiting the width of the weaving section to three lanes.

Calculation of Actual Weaving Length

In a similar manner to Option A, the actual weaving length for the urban road would be calculated using Figure 4/14 of TD 22/06. However, for Option B, the increased Design Speed of 85kph on Link A increases the Absolute Minimum weaving length for the section to 245m, therefore the total distance between the tip of the merge nose and diverge nose should be a minimum of 295m (allowing for the "d" value of 50m as per Figure 4/10 of TD 22/06).

It is not possible to provide a 295m length between the noses within the constraints, with the maximum weaving length proposed being 220m. A 220m length is noted as the Absolute Minimum weaving length for a 70kph Design Speed, the next step down in Design Speeds.

The possibility of closing the diverge to Clifton Street was discussed with Roads Service and it was agreed that both slip roads should be retained where feasible within the constraints of the site. Since the proposed weaving length is approximately two-thirds of the required minimum weaving length, it was proposed to retain the off-slip and apply for a Departure from Standard.

It is important to note that if selected as the Preferred Option, the junction layout will be subject to a Road Safety Audit in accordance with Design Standard HD 19/03. As part of this process, the appointed Auditor makes recommendations for the design in the interests of road user safety. Recommendations may therefore be made by the Auditor in relation to the weaving length provided and appropriate mitigation measures.

Calculation of Number of Lanes on Weaving Section

Using the actual weaving length provided, the next step in the design of the weaving section would be to identify the number of lanes required. As stated previously, estimated weaving flows are not available, so an approximation was made using projected traffic flows on the links, subject to a number of assumptions. This approximation would suggest that five lanes should be provided over the weaving section to facilitate weaving movements over the proposed weaving length.

<u>**SSD on Diverge Arrangement**</u>

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 160m downstream of the back of the diverge nose is met.

<u>**Summary Departures from Standard**</u>

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

5.2.4.4.6 ***Merge from Clifton Street (Link B)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.6**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

5.2.4.4.7 ***Diverge to York Street (Links B/G)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.7**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

5.2.4.4.8 ***M2 Merge (Link B)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.8**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

5.2.4.4.9 ***Westlink/M3 Diverge (Links B/C)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.9**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

5.2.4.4.10 ***At-grade Junctions on York Street (Link E)***

The layouts of the various junctions are identical to their counterparts in Option A as described in **Section 5.2.3.4.10**. Where specific Departures from Standard TD 41/95 or TD 42/95 or TD 50/04 have been identified, these are included in **Appendix D** as **Table B.4**.

5.2.4.4.11 ***At-grade Junction at Galway House (Link F)***

The layout of the junction is identical to its counterpart in Option A as described in **Section 5.2.3.4.11**. Where specific Departures from Standard TD 41/95 or TD 42/95 or TD 50/04 have been identified, these are included in **Appendix D** as **Table B.4**.

5.2.4.4.12 ***M2 Merge (Link F)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.12**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

5.2.4.4.13 ***Westlink/York Street Signalised Junction (Links G/E)***

The junction is identical to its counterpart in Option A as described in **Section 5.2.3.4.13**. Where specific Departures from Standard have been identified, these are included in **Appendix D** as **Table B.4**.

5.2.4.4.14 ***Nelson Street to Westlink Signalised Junction***

The assessment of the merge between Link A and Link H is reported under Link A in **Section 5.2.4.4.3**.

It should be noted that in order to provide the link from Nelson Street to the Westlink, it will be necessary to introduce two-way running over the present one-way system along Whitla Street and Garmoyle Street. It is proposed to reduce the number of southbound running lanes to two, with two lanes provided heading northbound. Separation between opposing flows will be provided on Whitla Street by way of a traffic island, reducing to a hatched separation strip on Garmoyle Street to facilitate access in and out of existing commercial properties. Changes to the junction at Dock Street will be required to provide a suitable traffic island to locate a secondary traffic signal head for the southbound movement to Corporation Street/Dock Street and to ease the junction radii for traffic heading northbound from Dock Street, to replicate the movement lost with the closure of the existing two-way stretch on Nelson Street. The proposed two-way running system will terminate at a signal controlled junction to facilitate the southbound running lane on Nelson Street (the existing contra-flow bus lane). The operational impacts of the loss of southbound capacity on Whitla Street and Garmoyle Street will be reflected in the traffic and economic performance of the option, as reported in **Section 7** of this report.

5.2.4.4.15 ***Dock Street to M3 Merge (Links I/C)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.15**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

5.2.4.4.16 ***M3 to York Street Diverge (Link J)***

<u>Diverge Type</u>

Based on the projected traffic flows on the Link D mainline and the diverging flows to York Street, with reference to Figure 2/5AP of TD 22/06, a type A taper diverge to Figure 2/6.1 of TD 22/06 is required and has been provided.

<u>Diverge Layout</u>

The taper diverge should be set out in accordance with the geometric requirements of Table 4/4 of TD 22/06 for an urban road with a speed limit of 50mph or less, comprising:

- 75m long exit taper
- 40m long nose with a minimum nose ratio of 1:12
- a minimum 1000m radius on the edge line at the tip of the diverge nose.

Within the space available under the Dargan Bridge, the required 75m exit taper and 40m nose at the minimum ratio have been provided, however, the required radius on the edge line cannot be provided and has been limited to a radius of 80m. This will require a Departure from Standard. The required near straight of 40m length beyond the back of the diverge nose has been provided in accordance with the requirements of paragraph 2.46 of TD 22/06.

Spacing to Adjacent Junctions

The distance between the tip of the diverge nose for the interchange link, on the Lagan Bridge, and the tip of the diverge nose to York Street is 240m, below the 262.5m minimum requirement for the selected 70kph Design Speed on the connector road. Therefore a Departure from TD 22/06 will be required.

The spacing between the tip of the diverge nose to York Street and the back of the merge nose with Link A is approximately 340m, exceeding the 262.5m minimum requirement for the selected Design Speed.

Weaving Sections

No new weaving sections are created by the junction.

SSD on Diverge Arrangement

The Desirable Minimum SSD of 120m has been provided at the back of the diverge nose in accordance with the requirements of TD 22/06 and this provision is maintained through to the end of the link, in excess of the 90m requirement for the reduced Design Speed on the slip road.

For Link J, the proposed SSD on the diverge arrangement meets the Desirable Minimum requirement. However, the vertical curvature is substandard, requiring a Departure from Standard TD 9/93.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table B.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table B.4**.

Changes to Access Arrangements

In order to maintain access to lands at Shipbuoy Street/ Nile Street, it is proposed to construct a new access road located underneath the Lagan Bridge and Dargan Bridge that ties into the truncated sections of carriageway on Nelson Street. The access road will be aligned around the piers of the Lagan Bridge and connect to Corporation Street at the existing entrance to the Roads Service Corporation Street car parks. These existing car parks will be closed to provide the necessary land for the access.

To maintain access to existing properties on Nelson Street, it is proposed to convert the remaining section of Nelson Street, south of the junction with Link J, to two-way operation. It is proposed to reduce the number of southbound lanes to two at the junction with Link J, opening to three on approach to the junction with Dunbar Link. Two lanes would then be provided in the opposing direction, facilitated with works to the existing junction on Dunbar Link to provide a right-turning facility and to ease the corner radius for the eastbound movement on Great Patrick Street. It is not proposed to provide physical separation between the flows. Access onto Link J is not proposed, in the interests of road user safety at the diverge and accordingly, Nelson Street will be stopped up with a turning head at its northern extent. Therefore, the existing left-turn from Link J onto Nelson Street will not be maintained, with an alternative route via Great George's Street, North Queen Street, Frederick Street and Great Patrick Street.

5.2.5 ***Assessment of Option C***

5.2.5.1 *Design Speeds*

In Option C, links to and from the three mainlines are considered interchange links, as defined by paragraph 1.16 of TD 22/06.

Option C can be considered an extension of Option A, with grade separation of the M3 to Westlink movement via an interchange link in a depressed underpass corridor. Accordingly, the same principles with regard to speed limits and Design Speeds have been applied to the connector roads in the option.

Table 5.2.3 summarises the selected Design Speeds for the various links in Option C. These Design Speeds and the proposed locations of speed limits have been illustrated on **Drawing S105296-R-SK-C-002**.

TABLE 5.2.3: OPTION C SPEED LIMITS AND DESIGN SPEEDS

Link	From	To	Relevant Mainline and Design Speed	Road Classification	Design Speed	Speed Limit
A	M2	Westlink	M2 Urban 85 kph	Interchange Link	70 kph	40 mph
B	Westlink	M2	Westlink Urban 85 kph	Interchange Link	70 kph	40 mph
C	Westlink	M3	Westlink Urban 85 kph	Interchange Link	70 kph	40 mph
D	M3	Westlink	Westlink Urban 85 kph	Interchange Link	70 kph	40 mph
E	York Street (South)	York Street (North)	York Street Urban 60 kph	Single Carriageway	60 kph	30 mph
F	York Street	M2	M2 Rural 120 kph	Slip Road	70 kph	30 mph / National
G	Westlink	York Street	Westlink Urban 85 kph	Slip Road	60 kph	40 mph / 30 mph
H	Corp. Street	Westlink	Westlink Urban 85 kph	Slip Road	60 kph	30 mph / 40 mph
I	Dock Street	M3	M3 Urban 85 kph	Slip Road	70 kph*	40 mph / 50 mph
J	M3	York Street	M3 Urban 85 kph	Slip Road	60 kph	50 mph / 30 mph

* The speed limits to be applied to the various slip roads joining links in underpasses were agreed with Roads Service in advance of design development. Through these discussions, it was agreed that in order to provide consistency with the Westlink to M3 interchange link (Link C) the slip road from Dock Street to the M3 (Link I) should have a similar speed limit and hence Design Speed of 70kph. As the link is classified as a slip road rather than an interchange link, this will be contrary to the specific requirements of TD 22/06 (60kph) and require a Departure from Standard. The option remains to revisit this particular Design Speed in the future following further consultation with Roads Service.

5.2.5.2 *Alignments*

5.2.5.2.1 ***Link A (M2 to Westlink)***

The alignment of Link A in Option C is identical to its counterpart in Option A, as described in **Section 5.2.3.2.1**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.2.2 ***Link B (Westlink to M2)***

The alignment of Link B in Option C is identical to its counterpart in Option A, as described in **Section 5.2.3.2.2**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.2.3 ***Link C (Westlink to M3)***

The alignment of Link C in Option C is identical to its counterpart in Option A, as described in **Section 5.2.3.2.3**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.2.4 ***Link D (M3 to Westlink)***

Master String Location

The master string for Link D is situated on the offside edge of lane 1, commencing on the tip of diverge nose on the M3 motorway and terminating at the tip of the merge nose with Link A. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The horizontal alignment commences with a right hand curve of 510m radius, matching the existing radius on the diverge nose and meeting the Desirable Minimum requirement. The radius transitions to a smaller 300m radius beyond the back of the diverge nose, Two Steps below Desirable Minimum for the selected Design Speed. On approach to the diverge to York Street, the alignment reverses into a left hand curve with a radius of 200m, limited by the Dargan Bridge substructure. The proposed radius is Two Steps below Desirable Minimum for the reduced Design Speed of 70kph on the connector road. This curve is maintained to a position approximately halfway along the diverge nose to Link J, where it subsequently transitions into a straight which is maintained to the approach with the merge nose. To effect the change in direction smoothly at the merge nose, the straight transitions to a left hand curve of 180m radius, Two Steps below Desirable Minimum.

Vertical Alignment

The vertical alignment of the link seeks to match the existing vertical alignment of the existing diverge and off-slip to York Street. To that end, the vertical alignment on the Lagan Bridge structure comprises an initial uphill gradient of 0.5% leading into a crest curve with a K value of 12, Three Steps below Desirable Minimum. Beyond the crest curve, a sag curve with a K value of 105 is introduced, considerably in excess of the Absolute Minimum requirement. The instantaneous gradient at the tangent point between the crest curve and the sag curve is approximately 6%, matching the existing downhill gradient. This sag curve carries through the cutting under the Dargan Bridge to a tighter sag curve under the proposed York Street overbridge. At the end of the sag curve, this gradient is reduced to approximately 4%. The radius of the sag curve is subsequently tightened, with the K value reducing to 9 under the proposed York Street overbridge. A K value of 9 for a sag curve is Two Steps below Absolute Minimum for the selected Design Speed. To achieve tie in with the Link A mainline over the short remaining distance, an uphill gradient of approximately 7.8% is introduced. Although gradients of up to 8% are permitted under TD 9/93, TD 22/06 limits gradients on motorway connector roads to 6% therefore a Departure from Standard TD 22/06 will be required.

Stopping Sight Distance

Over the existing diverge arrangement, the SSD provision matches the existing scenario. Therefore, the SSD is initially a minimum of 70m, limited by the width of the offside raised verge on the structure. This provision requires a Departure from Standard for the 85kph mainline Design Speed. As the vertical alignment continues downhill, SSD increases to a minimum of 160m, the Desirable Minimum for the selected Design Speed. The location of the piers to the Dargan Bridge on the nearside verge limit SSD on approach to the left hand curve under the bridge progressively to 50m, the minimum SSD allowed by TD 9/93 and Three Steps below Desirable Minimum, over a 50m distance underneath the Dargan Bridge. This provision requires a Departure from Standard. Beyond the Dargan Bridge, SSD increases to 120m over a short distance before being limited to at the beginning of the underpass structure to 90m, One Step below Desirable Minimum. As the link straightens in plan in the underpass, SSD increases to a minimum of 120m, which is carried through to the merge with Link A.

Transitions and Superelevation

Transitions have been provided in general accordance with TD 9/93 however, the departure transition from the curve with 200m horizontal radius is 65.6m, below the required 69.3m. A Departure from Standard will be required for this provision.

Superelevation on the link has been limited to 5%.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at seven locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at ten locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.2.5 ***Link E (York Street (South) to York Street (North))***

The alignment of Link E in Option C is identical to its counterpart in Option A, as described in **Section 5.2.3.2.5**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.2.6 ***Link F (York Street to M2)***

The alignment of Link F in Option C is identical to its counterpart in Option A, as described in **Section 5.2.3.2.6**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.2.7 ***Link G (Westlink to York Street)***

The alignment of Link G in Option C is identical to its counterpart in Option A, as described in **Section 5.2.3.2.7**.

5.2.5.2.8 ***Link H (Corporation Street to Westlink)***

The alignment of Link H in Option C is identical to its counterpart in Option A, as described in **Section 5.2.3.2.8**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.2.9 ***Link I (Dock Street to M3)***

The alignment of Link I in Option C is identical to its counterpart in Option A, as described in **Section 5.2.3.2.9**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.2.10 ***Link J (M3 to York Street)***

Master String Location

The master string for Link J is situated on the offside edge of lane 1, commencing on the tip of diverge nose on Link D and terminating at a signalised junction with Link E. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The diverge nose detail is formed by a left hand curve of 75m radius, Five Steps below Desirable Minimum, over the first 10m of the nose, opening out to a larger 360m radius, the Desirable Minimum for a 70kph Design Speed. The proposed 75m radius will require a Departure from Standard. The left hand curve transitions subsequently to a right hand curve of 1020m radius, in excess of the Desirable Minimum, beyond the back of the diverge nose. A left hand curve of 720m radius, in excess of the Desirable Minimum, is introduced, connecting into a straight on approach to the junction with Link E.

Vertical Alignment

The vertical alignment commences with a downhill gradient of approximately 5%, matching the vertical alignment on the adjacent Link D. This gradient connects to a sag curve with a K value of 9, Two Steps below Absolute Minimum which is continued beyond the back of the nose to a position in advance of the junction with Link E, where a 4% uphill gradient is introduced and carried through to the end of the alignment.

Stopping Sight Distance

The Desirable Minimum Stopping Sight Distances for the respective Design Speeds are provided over the entire length of the alignment.

Transitions and Superelevation

Transitions have been provided in accordance with TD 9/93.

Superelevation on the link has been limited to 5%.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD meets the requirements of paragraph 1.24 of TD 9/93 and therefore no Departures from Standard are required.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at two locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table C.1** in **Appendix D**.

5.2.5.3 *Cross-Sections*

5.2.5.3.1 ***Link A (M2 to Westlink)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.1**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.2 ***Link B (Westlink to M2)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.2**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.3 ***Link C (Westlink to M3)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.3**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.4 ***Link D (M3 to Westlink)***

Based on the projected traffic flows and the purpose of the link as an interchange link connector road from an Urban Motorway, the link would be classified as IL2B in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a two lane interchange link with urban hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 2.75m wide hard shoulder
- 2 no. 3.65m wide traffic lanes
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 3.3m wide hard shoulder
- 2 no. 3.65m wide traffic lanes, reducing to a single 3.65m traffic lane in accordance with TD 22/06 on approach to the back of the merge nose with Link A
- 1 no. 300mm (minimum) wide offside hardstrip, widening as lane 2 is reduced on approach to the merge nose in accordance with TD 22/06
- nearside paved verges with a typical width of 2m (minimum of 1.1m at Dargan Bridge)
- offside paved verge with a typical width of 1.5m (minimum of 1.1m at Dargan Bridge).

Given the limitations on the southbound capacity of the Westlink, it is only possible to provide a single lane gain and therefore the number of traffic lanes on the new underpass below York Street must be reduced to one, albeit with sufficient minimum paved width of 10.6m to allow for future maintenance. The proposed provision will require a Departure from Standard.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.5 ***Link E (York Street (South) to York Street (North)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.5**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.6 ***Link F (York Street to M2)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.6**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.7 ***Link G (Westlink to York Street)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.7**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.8 ***Link H (Corporation Street to Westlink)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.8**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.9 ***Link I (Dock Street to M3)***

The cross-section provision on the link is the same as its counterpart in Option A, as outlined in **Section 5.2.3.3.9**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.3.10 ***Link J (M3 to York Street)***

Based on the projected traffic flows and the purpose of the link as a slip road connector road from an Urban All-Purpose Road, the link would be classified as DG1D in accordance with Table 3/1a of Design Standard TD22/06, This requires the provision of a single lane slip road with hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 1 no. 3.7m wide traffic lane
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. nearside hardstrip of 200mm (minimum) width, widening out to a 3.95m hard shoulder at its widest point beyond the back of the diverge nose, reducing back to a 1m hardstrip to allow development of an additional 3.65m wide lane beyond back of nose
- 1 no. 3.65m (minimum) wide traffic lane , opening to three lanes on approach to the junction with York Street (Link E)
- 1 no. 300mm (minimum) wide offside hardstrip
- nearside paved verge with a minimum width of 1.05m
- offside paved verge with a minimum width of 2m.

The proposed provision maintains a minimum paved width of 7.3m past the pinch point at the back of the diverge nose however, a Departure from Standard will be required.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table C.2** in **Appendix D**.

5.2.5.4 *Junction Layouts*

5.2.5.4.1 ***Grade Separation Provision***

The proposed layout is a full interchange as movements between the three mainlines are grade separated.

5.2.5.4.2 ***M2 Foreshore Diverge (Link A)***

The junction layout of the diverge from the M2 foreshore is identical to its counterpart in Option A as described in **Section 5.2.3.4.2**.

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.3 ***Corporation Street/Westlink Merge (Links A/H)***

The junction layout of the diverge from the M2 foreshore is identical to its counterpart in Option A as described in **Section 5.2.3.4.3**.

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.4 ***Merge from M3 (Link D)***

Merge Type

Based on the projected traffic flows on the Link A mainline and the merging flows from York Street, with reference to Figure 2/3AP of TD 22/06, a type F lane gain with ghost island merge to Figure 2/4.4 of TD 22/06 would appear to be the preferred provision. However, ghost island merges are not permitted on urban roads in accordance with paragraph 2.28 of TD 22/06. Accordingly, it is proposed to provide a type E single lane gain merge layout to Figure 2/4.3 of TD 22/06, with a 2 lane urban merge detail to Figure 2/4.2 of TD 22/06 used to reduce the two lanes on the off-slip in advance of the merge nose. It is considered that a Departure from Standard is not required for this under provision.

Merge Layout

With regard to the details for the merge layout onto the mainline, the required 40m long nose with a minimum nose ratio of 1:12 has been provided. However, with regard to the geometric details of the 2 lane urban merge on the slip road, it is not possible to fully meet all the geometric requirements set out in TD 22/06.

With reference to the requirements of paragraph 2.34 of TD 22/06, a near straight is provided upstream of the back of the merge nose, which exceeds the nose length and is therefore compliant with standards. However, with reference to Table 4/3 of TD 22/06, the slip road lane reduction taper used is developed at a ratio of 1:25 c.f. the preferred minimum of 1:40, thereby requiring a Departure from Standard. The end of the taper is positioned 50m upstream of the back of the merge nose as per the requirements of TD 22/06.

Spacing to Adjacent Junctions

With regard to the requirements of paragraph 4.30 of TD 22/06 in relation to the spacing of successive merges or diverges on a connector road or mainline within an interchange, it is noted that the distance between the tip of the merge nose from Link H and that of Link D is approximately 370m. This exceeds the 262.5m minimum requirement for the 70kph Design Speed.

Weaving Sections

The provision of the merge from the M3 creates a weaving section in conjunction with the downstream Clifton Street diverge. The assessment of this weaving section is included in the assessment of the Clifton Street diverge arrangement reported in **Section 5.2.5.4.5**.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.5 ***Diverge to Clifton Street (Link A)***

Diverge Type

The merge/diverge type is the same as its counterpart in Option A, as described in **Section 5.2.3.4.5**. Therefore a single lane drop is provided in lieu of the type A taper diverge with three downstream mainline lanes required by TD 22/06. This provision will require a Departure from Standard.

Diverge Layout

The diverge to Clifton Street has been designed with the same geometry as its counterpart in Option A and so a number of Departures from Standard will be required.

Spacing to Adjacent Junctions

The diverge creates a weaving section, the assessment of which subsequently follows.

Weaving Sections

Identified Weaving Sections

A weaving section between the merge from the M3 (Link D) and the proposed lane drop to Clifton Street is proposed for Option C.

Calculation of Weaving Flows

In the absence of projected weaving flows derived from origin/destination surveys, an approximation of weaving flows was made using projected traffic flows.

Calculation of Actual Weaving Length

In the absence of calculated weaving flows, an approximation was made of the Desirable Minimum weaving length using projected traffic flows and Figure 4/14 of TD 22/06. This approximation indentified that the Desirable Minimum weaving length would be of the order of 350m. In contrast, the Absolute Minimum weaving length for the length is approximately 170m, using Figure 4/14. It is not possible to provide a 400m (350m Desirable Minimum weaving length plus 50m “d” distance) weaving length within the weaving section.

In contrast to Options A, B and D, the positioning of the M3 to Westlink merge in Option C provides a total 290m weaving length (170m Absolute Minimum weaving length plus and additional 70m plus 50m “d” distance) between opposing merge/diverge noses. This represents the maximum weaving length possible within the site constraints and offers Option C a potential operational advantage over the other options. It should be noted, however, that the increased provision is still likely to fall short of the anticipated Desirable Minimum length of 350m. Therefore a Departure from Standard is still anticipated, in a similar manner to the other options, although difference in the required and actual provision is reduced.

It is important to note that if selected as the Preferred Option, the junction layout will be subject to a Road Safety Audit in accordance with Design Standard HD 19/03. As part of this process, the appointed Auditor makes recommendations for the design in the interests of road user safety. Recommendations may therefore be made by the Auditor in relation to the weaving length provided and appropriate mitigation measures.

Calculation of Number of Lanes on Weaving Section

Using the actual weaving length provided, the next step in the design of the weaving section would be to identify the number of lanes required. As stated previously, estimated weaving flows are not available, so an approximation was made using projected traffic flows on the links, subject to a number of assumptions. This approximation would suggest that five lanes should be provided over the weaving section to facilitate weaving movements over the proposed weaving length.

SSD on Diverge Arrangement

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 160m downstream of the back of the diverge nose is met.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.6 ***Merge from Clifton Street (Link B)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.6**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.7 ***Diverge to York Street (Links B/G)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.7**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.8 ***M2 Merge (Link B)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.8**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.9 ***Westlink/M3 Diverge (Links B/C)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.9**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as Table C.4.

5.2.5.4.10 ***At-grade Junctions on York Street (Link E)***

The layouts of the various junctions are identical to their counterparts in Option A as described in **Section 5.2.3.4.10**. Where specific Departures from Standard TD 41/95 or TD 42/95 or TD 50/04 have been identified, these are included in **Appendix D** as **Table C.4**.

It is noted that the approach gradient for Link J to the signalised junction with York Street is 4%, in excess of the 2% maximum required to create a suitable dwell area for stationary vehicles. A Departure from Standard will be required for this provision.

5.2.5.4.11 ***At-grade Junction at Galway House (Link F)***

The layout of the junction is identical to its counterpart in Option A as described in **Section 5.2.3.4.11**. Where specific Departures from Standard TD 41/95 or TD 42/95 or TD 50/04 have been identified, these are included in **Appendix D** as **Table C.4**.

5.2.5.4.12 ***M2 Merge (Link F)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.12**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.13 ***Westlink/York Street Signalised Junction (Links G/E)***

The junction is identical to its counterpart in Option A as described in **Section 5.2.3.4.13**. Where specific Departures from Standard have been identified, these are included in **Appendix D** as **Table C.4**.

5.2.5.4.14 ***Corporation Street to Westlink Ghost Island Junction***

The junction is identical to its counterpart in Option A as described in **Section 5.2.3.4.14**. Where specific Departures from Standard have been identified, these are included in **Appendix D** as **Table C.4**.

5.2.5.4.15 ***Dock Street to M3 Merge (Links I/C)***

The junction layout is identical to its counterpart in Option A as described in **Section 5.2.3.4.15**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table C.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table C.4**.

5.2.5.4.16 ***M3 to York Street Diverge (Link J)***

Diverge Type

Based on the projected traffic flows on the Link D mainline and the diverging flows to York Street, with reference to Figure 2/5AP of TD 22/06, a type A taper diverge to Figure 2/6.1 of TD 22/06 is required. However, a single lane drop has been provided, which will require a Departure from Standard.

Diverge Layout

The lane drop layout should be set out in accordance with the geometric requirements of Table 4/4 of TD 22/06 for an urban road with a speed limit of 50mph or less, comprising:

- a 40m long nose with a minimum nose ratio of 1:12
- a minimum 1000m radius on the edge line at the tip of the diverge nose.

Within the space available under the Dargan Bridge, the required 40m nose has been provided at the minimum ratio however, the required radius on the edge line cannot be provided and has been limited to a radius of 75m. This will require a Departure from

Standard. The required near straight of 40m length beyond the back of the diverge nose has not been provided in accordance with the requirements of paragraph 2.46 of TD 22/06, therefore requiring a Departure from Standard.

Spacing to Adjacent Junctions

The distance between the tip of the diverge nose for the interchange link, on the Lagan Bridge, and the tip of the diverge nose to York Street is 240m, below the 262.5m minimum requirement for the selected 70kph Design Speed on the connector road. Therefore a Departure from TD 22/06 will be required.

The spacing between the tip of the diverge nose to York Street and the back of the merge nose with Link A is approximately 285m, exceeding the 262.5m minimum requirement for the selected Design Speed.

Weaving Sections

No new weaving sections are created by the junction.

SSD on Diverge Arrangement

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 120m downstream of the back of the diverge are met.

Access Arrangements

In order to maintain access to lands at Shipbuoy Street/ Nile Street, it is proposed to construct a new access road located underneath the Lagan Bridge and Dargan Bridge that ties into the truncated sections of carriageway on Nelson Street. The access road will be aligned around the piers of the Lagan Bridge and connect to Corporation Street at the existing entrance to the Roads Service Corporation Street car parks. These existing car parks will be closed to provide the necessary land for the access.

In order to maintain access to existing properties on Nelson Street, it is proposed to convert the remaining section of Nelson Street, south of the junction with Link J, to two-way operation. It is proposed to reduce the number of southbound lanes to two at the junction with Link J, opening to three on approach to the junction with Dunbar Link. Two lanes would then be provided in the opposing direction, facilitated with works to the existing junction on Dunbar Link to provide a right-turning facility and to ease the corner radius for the eastbound movement on Great Patrick Street. It is not proposed to provide physical separation between the flows. Access onto Link J is not proposed, in the interests of road user safety at the diverge and accordingly, Nelson Street will be stopped up with a turning head at its northern extent. Therefore, the existing left-turn from Link J onto Nelson Street will not be maintained, with an alternative route via Great George's Street, North Queen Street, Frederick Street and Great Patrick Street.

5.2.6 *Assessment of Option D*

5.2.6.1 *Design Speeds*

In Option D, links to and from the three mainlines are considered interchange links, as defined by paragraph 1.16 of TD 22/06.

Option D can be considered an extension of Option B, with grade separation of the Westlink to M2 movement via an interchange link in an elevated corridor using an overbridge above York Street and Dock Street. This approach would be similar to the proposed elevation of the M2 to Westlink link. With the proposed horizontal and vertical alignment, the Westlink to M3 movement would not be grade separated, with a slip road provided to York Street where the existing junction layout would be retained. Given its similarity to Option B, the same principles with regard to speed limits and Design Speeds have been applied to the connector roads in the option.

Table 5.2.4 summarises the selected Design Speeds for the various links in Option D. These Design Speeds and the proposed locations of speed limits have been illustrated on **Drawing S105296-R-SK-D-002**.

TABLE 5.2.4: OPTION D SPEED LIMITS AND DESIGN SPEEDS

Link	From	To	Relevant Mainline and Design Speed	Road Classification	Design Speed	Speed Limit
A	M2	Westlink	M2 Rural 120 kph	Interchange Link	85 kph	50 mph
B	Westlink	M2	Westlink Urban 85 kph	Interchange Link	85 kph	50 mph
C	Westlink	M3	Westlink Urban 85 kph	Slip Road	60 kph	50 mph
D	M3	Westlink	M3 Urban 85 kph	Interchange Link	70 kph	50 mph
E	York Street (South)	York Street (North)	York Street Urban 60 kph	Single Carriageway	60 kph	30 mph
F	York Street	M2	M2 Rural 120 kph	Slip Road	70 kph	30 mph / National
G	Westlink	York Street	Westlink Urban 85 kph	Slip Road	60 kph	40 mph / 30 mph
H	Nelson Street	Westlink	Westlink Urban 85 kph	Slip Road	60 kph	30 mph / 40 mph
I	Dock Street	M3	M3 Urban 85 kph	Slip Road	60 kph	30mph / 50 mph
J	M3	York Street	M3 Urban 85 kph	Slip Road	60 kph	50 mph / 30 mph

5.2.6.2 *Alignments*

5.2.6.2.1 ***Link A (M2 to Westlink)***

The alignment of Link A in Option D is identical to its counterpart in Option B, as described in **Section 5.2.4.2.1**.

5.2.6.2.2 ***Link B (Westlink to M2)***

Master String Location

The master string for Link B is situated on the offside edge of lane 2, commencing on the Westlink at the back of the Clifton Street merge nose and terminating at the tip of the proposed merge nose onto the M2 foreshore. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

Link B commences with a right hand curve of 351.65m in radius to match the existing cross-section at Clifton Street. This is slightly below the Desirable Minimum value of 360m for the 70kph Design Speed and will require a Departure from Standard given its location on the merge arrangement. East of North Queen Street Bridge, the alignment reverses into a short left hand curve of 510m radius, exceeding the Desirable Minimum requirement. The radius on the curve is subsequently tightened to 255m, Two Steps below Desirable Minimum, which is maintained over the majority of the proposed overbridge. On approach to the new structure at Dock Street, the alignment straightens and transitions into a left hand curve of 1055m radius to form the merge nose with the M2.

Vertical Alignment

The vertical alignment commences with a short (35m) grade of 2% to tie in with the existing road level before transitioning to a crest curve with a K value of 30, One Step below Desirable Minimum value. This crest curve continues over the North Queen Street Bridge, where a sag curve with a K value of 20, the Absolute Minimum, is introduced. On approach to the abutment for the proposed overbridge, a crest curve with a K value of 30, One Step below Desirable Minimum is introduced and continued on the overbridge, with the high point of the curve located to the west of the Dargan Bridge. At the tangent point between the sag and crest curves, the instantaneous gradient is approximately 6%. Beyond the Dargan Bridge, a straight gradient of 6% is introduced and maintained through to the approach to Dock Street Bridge. At this point a sag curve with a K value of 20 is used and maintained into the merge nose. This K value is Two Steps below Absolute Minimum for the higher mainline design speed of 120kph and will require a Departure from Standard. In the merge nose, a short (25m) crest curve with a K value of 20, Four Steps below Desirable Minimum for a 120kph Design Speed is proposed that will require a Departure from Standard. Beyond the crest curve, a sag curve with a K value of approximately 180, exceeding the Absolute Minimum, is used to tie in with the mainline vertical profile.

Stopping Sight Distance

At the start of the alignment, SSD is limited to 70m in lane 2 by the width of the underpass section, Three Steps below Desirable Minimum for the 85kph Design Speed. This provision will require a Departure from Standard. As the alignment passes over North Queen Street Bridge, the SSD increases to 160m for a short distance before reducing again to 120m on approach to the diverge arrangement for Link C. Over the diverge, SSD increases to 160m, with a progressive reduction to 90m, Two Steps below Desirable Minimum which is maintained on the uphill gradient on the overbridge, limited by the width of the nearside verge. As the alignment straightens beyond the Dargan Bridge, SSD increases to a minimum of 120m, One Step below Desirable Minimum through to the approach to the new structure at Dock Street, where the SSD reduces to 90m at the back of the merge nose, limited by the nearside verge width. The proposed verge width is the maximum possible within the extent of land ownership and the reduced provision requires a Departure from Standard as it is Four Steps below Desirable Minimum for the mainline 120kph Design Speed. As the alignment straightens, the SSD provided increases to 120, Three Steps below Desirable Minimum, which also requires a Departure from Standard.

Transitions and Superelevation

Transitions have been provided in general accordance with TD 9/93. However, two Departures from Standard will be required for provided transition lengths at two locations. The first is located at the connection between the two left hand curves of 510m and 255m radius respectively, where a 41m long transition is used. The second is located at the start of the final curve element of 1055m, where a 41m transition is provided onto the curve from the preceding straight element.

Superelevation of up to 7% has typically been provided on the link based on the radii of selected horizontal curves. It is noted that there is scope to further reduce this to 5%, based on the presence of at-grade junctions, in accordance with TD 9/93, however, the superelevation proposes represents the worst-case scenario. Opportunities to reduce the superelevation where favourable will be explored at detailed design stage following selection of a Preferred Option.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at twelve locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at sixteen locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table D.1** in **Appendix D**.

5.2.6.2.3 ***Link C (Westlink to M3)***

The alignment of Link C in Option D is that of the existing York Link, with revisions to the junction layout with the Westlink, York Street and Nelson Street.

5.2.6.2.4 ***Link D (M3 to Westlink)***

The alignment of Link D in Option D is identical to its counterpart in Option B, as described in **Section 5.2.4.2.4**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table D.1** in **Appendix D**.

5.2.6.2.5 ***Link E (York Street (South) to York Street (North)***

The alignment of Link E in Option D is that of the existing York Street, with revisions to the junction layout with York Link.

5.2.6.2.6 ***Link F (York Street to M2)***

Master String Location

The master string for Link F is situated on the nearside edge of lane 1, commencing on York Street at the diverge from York Street to York Link and terminating at the tip of the proposed merge nose onto the M2 foreshore. All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The horizontal alignment reflects that of the existing on-slip to the M2 from York Street. Accordingly, the alignment commences with a left hand curve of 2880m radius on York Street, matching the existing alignment that reverses into a right hand curve of 115m radius. This radius is continued to a position west of the Dargan Bridge. This radius is Three Steps below Desirable Minimum for the 60kph Design Speed. On approach to the Dargan Bridge, a left hand curve of 98m radius is introduced that is maintained beyond the bridge. This radius is also Three Steps below Desirable Minimum for the selected Design Speed. At a point east of the bridge, the alignment transitions to a straight that forms the merge arrangement onto the M2 foreshore, with a short left hand curve of 360m radius used to smooth the merge alignment. This radius is Three Steps below Desirable Minimum for the higher 120kph Design Speed. Matching the existing alignment of the foreshore, a left hand curve of approximately 595m radius is introduced at the tip of the merge nose and is continued to the tip of the merge nose with Link B. This radius is Three Steps below Desirable Minimum for the higher 120kph Design Speed.

Vertical Alignment

The vertical alignment also reflects that of the existing on-slip to the M2 from York Street. The alignment commences with a large crest curve with a K value of 182, exceeding the Desirable Minimum requirement. The crest curve continues to a point west of the Dargan Bridge, where a sag curve with a K value of 13 is used to match the alignment of the slip road under the bridge. The proposed K value meets the Absolute Minimum requirement. To the east of the bridge, a crest curve with a K value of 10, One Step below Desirable Minimum, is introduced and is continued beyond the back of the merge nose. As the Design Speed increases to 120kph beyond the back of the merge nose, the proposed K value is subsequently Five Steps below Desirable Minimum and requires a Departure from Standard. The crest curve connects into a sag curve with a K value of 13 that forms the merge nose onto the M2 foreshore. This K value is Three Steps below Absolute Minimum for the higher Design Speed of 120kph in effect from the back of the merge nose and requires a Departure from Standard. A crest curve with a K value of 17 is subsequently used to reflect the existing vertical alignment between the tip of the merge nose and the merge from Link B. For the 120kph Design Speed, this provision will also require a Departure from Standard.

Stopping Sight Distance

The SSD on the alignment is initially 90m, the Desirable Minimum for the Design Speed of 60kph. As the alignment passes under the Dargan Bridge, the piers form an obstruction that progressively reduces SSD to a minimum of 50m under the bridge. Beyond the Dargan Bridge, the SSD increases to 160m that is maintained into the back of the merge nose. Over the merge arrangement, the vertical alignment and reduced cross-section of the M2 foreshore limits SSD to 120m and a minimum 90m, both instances requiring Departures from Standard for the higher 120kph Design Speed. On approach to the merge from Link B, the SSD increases to 215m, One Step below Desirable Minimum for the mainline Design Speed.

Transitions and Superelevation

Transitions have been provided in general accordance with TD 9/93. However, substandard transitions lengths have been provided at three locations along the link to match the existing alignment of the slip road. The first is located at the start of the alignment on York Street, where a transition has not been used for the horizontal curve of 115m radius. The second is located close to the priority junction with the southbound lane on York Street, where another curve-to-curve connection is proposed without transitions. The third location is at the connection to the existing curved element forming the back of nose, where a transition has not been used. All instances will require a Departure from Standard.

Superelevation has not been applied to the link in accordance with TD 9/93, to match existing crossfall on the slip road. A maximum of 2.5% crossfall has been applied at four locations along the alignment and will require Departures from Standard.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at eleven locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at eleven locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table D.1** in **Appendix D**.

5.2.6.2.7 *Link G (Westlink to York Street)*

Master String Location

The master string for Link G is situated on the offside edge of lane 2, commencing on the Westlink at the back of the York Street diverge nose and terminating at the junction with York Street (Link E). All horizontal and vertical radii reported in the assessment of the link are relative to this master string.

Horizontal Alignment

The horizontal alignment commences with a right hand curve of 360m radius forming the diverge nose, with a reverse left hand curve with a radius of 400m introduced at the back of the diverge nose. The proposed 360m radius is One Step below Desirable Minimum for the 85kph Design Speed to the back of the nose, with the proposed 400m radius in excess of the reduced Desirable Minimum for the 70kph Design Speed from the back of the nose. The left hand curve subsequently transitions to a straight alignment on approach to the junction with Link E.

Vertical Alignment

The vertical alignment commences with a sag curve on the diverge nose with a K value of 20, the Absolute Minimum for the mainline Design Speed. Near the end of the diverge nose, a crest curve with a K value of 17 is introduced that is Two Steps below the 85kph Desirable Minimum, or One Step below the 70kph Desirable Minimum. The crest curve is maintained approximately halfway along the alignment beyond the back of the nose, with an instantaneous downhill gradient of approximately 7% at its end. The proposed gradient, on an all-purpose single carriageway link, is above the Desirable Maximum of 6%, but below the 8% threshold for a Departure from Standard. A sag curve with a K value of 20 is introduced to reduce the gradient on approach to the junction with Link E to approximately 2%

Stopping Sight Distance

Over the diverge nose, SSD is limited to 90m by the proposed vertical curvature, increasing to 160m on the downhill gradient, in excess of the Desirable Minimum. On approach to the junction, the SSD reduces to 120m, in excess of the Desirable Minimum.

Transitions and Superelevation

Superelevation has been limited to 5% on the link.

Combination Departures

The proposed combination of horizontal alignment, vertical alignment and SSD will fall below the requirements of paragraph 1.24 of TD 9/93 at two locations along the alignment and require Departures from Standard.

Reduced SSD and/or K Value over Junction Approaches

The combination of substandard SSD and/or K values over the identified approaches to junctions, including merge and diverge arrangements, will fall below the requirements of paragraph 1.26 of TD 9/93 at two locations and require Departures from Standard.

Summary Departures from Standard TD 9/93

A summary of required Departures from Standard TD 9/93 for the link is included as **Table D.1** in **Appendix D**.

5.2.6.2.8 ***Link H (Nelson Street to Westlink)***

The alignment of Link H in Option D is identical to its counterpart in Option B, as described in **Section 5.2.4.2.8**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table D.1** in **Appendix D**.

5.2.6.2.9 ***Link I (Dock Street to M3)***

The alignment of Link I in Option D is that of the existing Nelson Street, with revisions to the junction layout with York Link.

5.2.6.2.10 ***Link J (M3 to York Street)***

The alignment of Link J in Option D is identical to its counterpart in Option B, as described in **Section 5.2.4.2.10**. A summary of required Departures from Standard TD 9/93 for the link is included as **Table D.1** in **Appendix D**.

5.2.6.3 *Cross-Sections*

5.2.6.3.1 ***Link A (M2 to Westlink)***

The cross-section provision on the link is the same as its counterpart in Option B, as outlined in **Section 5.2.4.3.1**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table D.2** in **Appendix D**.

5.2.6.3.2 ***Link B (Westlink to M2)***

Based on the projected traffic flows and the purpose of the link as an interchange link connector road to a Rural Motorway, the link would be classified as IL2A in accordance with Table 3/1b of Design Standard TD22/06, This requires the provision of a two lane interchange link with urban hard shoulder.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 3.3m wide hard shoulder
- 2 no. 3.65m wide traffic lanes
- 1 no. 1m wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The proposed cross-section on the link comprises, in summary:

- 1 no. 3.3m wide hard shoulder
- 2 no. 3.65m wide traffic lanes, with 3 no. 3m wide lanes between Clifton Street and York Street
- 1 no. 300mm wide offside hardstrip
- nearside paved verges with a typical width of 2m (minimum of 600mm past pinch point at diverge to York Street)
- offside paved verge with a typical width of 1m.

The proposed provision will require a Departure from Standard.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table D.2** in **Appendix D**.

5.2.6.3.3 ***Link C (Westlink to M3)***

The cross-section on the link matches that of the existing Westlink to M3 diverge on approach to York Street and that of York Link. Therefore, a minimum of 2 no. 2.65m wide lanes are provided through the revised junction arrangements at York Street (Link E) and Nelson Street (Link I). An additional lane is provided on the offside on approach to the junction with Nelson Street to act as a right-turn filter lane into the access proposed for the lands at Shipbuoy Street and Nile Street. Existing paved verges will be maintained at their present width.

5.2.6.3.4 ***Link D (M3 to Westlink)***

The cross-section provision on the link is the same as its counterpart in Option D, as outlined in **Section 5.2.4.3.4**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table D.2** in **Appendix D**.

5.2.6.3.5 ***Link E (York Street (South) to York Street (North))***

The cross-section on the link matches that of the existing York Street. Therefore, a minimum of 5 no. 3.65m wide lanes are provided through the revised junction arrangements at Great George's Street and York Link. Existing paved verges will be maintained at their present width.

5.2.6.3.6 ***Link F (York Street to M2)***

The cross-section on the link matches that of the existing York Street, for the start of the link and that of the existing slip road from Westlink to the M2, for the remainder of the link. The existing on-slip has sufficient width for 3 no. 3.65m lanes, but a maximum of two lanes can only be permitted, given downstream arrangements at the junction with the foreshore. Therefore the link will be reduced to 2 no. 3,65m wide lanes using wide lining and hatching, with the existing paved width retained. Existing verges will be maintained at their present width. On approach to Dock Street, the existing carriageway will be narrowed to accommodate the new overbridge structure for Link B. A single 3.65m lane and a 3.3m hard shoulder are provided in the narrower arrangement.

5.2.6.3.7 ***Link G (Westlink to York Street)***

Based on the projected traffic flows and the purpose of the link as an slip road connector road from an Urban Motorway, the link would be classified as DG2F in accordance with Table 3/1a of Design Standard TD22/06, This requires the provision of a two lane slip road with hardstrips.

With reference to Design Standard TD 27/05, the required cross-section is therefore:

- 1 no. 1m wide nearside hardstrip
- 2 no. 3.65m wide traffic lanes
- 1 no. 300mm wide offside hardstrip
- minimum 2m wide verges where communications ducting and chambers are provided.

The alignment of the Westlink to M2 overbridge limits the width available for the link within the existing land ownership. A pinch point is thereby created at the back of the diverge nose, where the existing retaining wall at the back of residential properties is located approximately 6.75m from the master string for the alignment. Accordingly, the proposed cross-section on the link comprises, in summary:

- 1 no. nearside hardstrip, of minimum width 300mm, widening to a 2m hard shoulder over the pinch point at the diverge nose
- 1 no. 3.7m wide traffic lane, flaring out to provide two lanes for the Weslink to M3 onward movement and a single lane for connection to York Street (North) and return to M2
- 1 no. 300mm wide offside hardstrip
- nearside 1.05m wide paved verge
- offside 600mm wide paved verge.

The proposed provision will require a Departure from Standard.

A summary of required Departures from Standard TD 27/05 for the link is included as **Table D.2** in **Appendix D**.

5.2.6.3.8 ***Link H (Nelson Street to Westlink)***

The cross-section provision on the link is the same as its counterpart in Option B, as outlined in **Section 5.2.4.3.8**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table D.2** in **Appendix D**.

5.2.6.3.9 ***Link I (Dock Street to M3)***

The cross-section on the link matches that of the existing Nelson Street on approach to the junction with York Link. Therefore, the two existing citybound lanes on Nelson Street of 3.65m width are maintained from the junction with Dock Street to the junction with York Link. The remaining three lanes on Nelson Street that presently provide the connection between the M2 off-slip and the Westlink will be perforated and abandoned under the proposals.

5.2.6.3.10 ***Link J (M3 to York Street)***

The cross-section provision on the link is the same as its counterpart in Option B, as outlined in **Section 5.2.4.3.10**. A summary of required Departures from Standard TD 27/05 for the link is included as **Table D.2** in **Appendix D**.

5.2.6.4 *Junction Layouts*

5.2.6.4.1 ***M2 Foreshore Diverge (Link A)***

The junction layout is identical to its counterpart in Option B as described in **Section 5.2.4.4.2**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table D.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table D.4**.

5.2.6.4.2 ***Nelson Street/Westlink Merge (Links A/H)***

The junction layout is identical to its counterpart in Option B as described in **Section 5.2.4.4.3**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table D.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table D.4**.

5.2.6.4.3 ***Merge from M3 (Links A/D)***

The junction layout is identical to its counterpart in Option B as described in **Section 5.2.4.4.4**. A summary of required Departures from Standard TD 22/06 for the junction is included as Table D.3 in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as Table D.4.

5.2.6.4.4 ***Diverge to Clifton Street (Link A)***

The junction layout is identical to its counterpart in Option B as described in **Section 5.2.4.4.5**. A summary of required Departures from Standard TD 22/06 for the junction is included as Table D.3 in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as Table D.4.

5.2.6.4.5 ***Merge from Clifton Street (Link B)***

For Options, A, B and C, an Absolute Minimum weaving length was established using Figure 4/14 for the proposed 70kph Design Speed of 170m (total length between noses = 220m) and the proposed 85kph Design Speed of 245m (total length between noses = 295m). For the off-slip from Westlink to Clifton Street in all options, it is not possible to provide the full Absolute

Minimum weaving length, with a substandard 170m length (total length between noses of 220m) proposed.

For Option D, the vertical alignment of Link B requires the diverge nose for Link G to be moved further west along the alignment, immediately east of the North Queen Street Bridge. If the Clifton Street on-slip was retained, there would be a total distance between the noses of only 155m, just over half of the required 295m distance. Given the considerable (c. 53%) difference between the provision and the minimum standard, in contrast to the difference between the provision and the minimum standard on the adjacent carriageway (c. 34%), it is proposed to close the Clifton Street on-slip in Option D and convert the present lane gain to an auxiliary lane drop at a parallel diverge. The closure of the merge from Clifton Street thereby removes the weaving section.

The existing on-slip would be closed to vehicles at Clifton Street, but could potentially remain in place as an access road to the Westlink for emergency vehicles under blue light conditions only. All other vehicles in the area intending to join the Westlink northbound carriageway would be required to use Frederick Street and York Street instead. The traffic and economic performance of the Option, as reported in **Section 7**, reflects the redistribution of traffic onto the new routes and the resultant costs of delays to road users.

5.2.6.4.6 ***Diverge to York Street (Links B/G)***

Diverge Type

With regard to the layout of the diverge from Westlink to York Street (Link G), based on the projected traffic flows on the Link B mainline and the diverging flows to York Street, with reference to Figure 2/3AP of TD 22/06, a type D ghost island diverge with lane drop is required. However, a parallel diverge to type B (Option 2) to Figure 2/6.1 of TD 22/06 can only be provided within the constraints of the existing Westlink canyon section (which precludes a lane gain). Therefore a Departure from Standard is required.

Diverge Layout

The parallel diverge should be set out in accordance with the geometric requirements of Table 4/4 of TD 22/06 for an urban road with a speed limit of 50mph or less, comprising:

- 75m long exit taper
- auxiliary lane of 100m minimum length
- 40m long nose with a minimum nose ratio of 1:12
- a minimum 1000m radius on the edge line at the start and end of the exit taper
- a minimum 1000m radius on the edge line at the tip of the diverge nose.

The required near straight of 40m length beyond the back of the diverge nose has been provided in accordance with the requirements of paragraph 2.46 of TD 22/06.

In the proposed layout, it is not possible to provide a 1000m radius on the edge line at the end of the exit taper, with a radius of 250m proposed, requiring a Departure from Standard. Similarly, the proposed radius on the edge line at the tip of the diverge nose is 500m, requiring an additional Departure from Standard. All other elements in the diverge layout have been provided in accordance with the above requirements.

Spacing to Adjacent Junctions

The provision of the diverge creates successive diverge arrangements between the northbound diverge from Westlink to Clifton Street and the proposed diverge to York Street. For the proposed Design Speed of 85kph, the minimum spacing between the tips of the diverge noses is 300m. The proposed total distance between the successive diverge noses is 485m, exceeding the required length.

Weaving Sections

As noted in **Section 5.2.6.4.5**, the closure of the merge from Clifton Street means that a weaving section does not exist in this option, in contrast to Options A, B and C.

SSD on Diverge Arrangement

With regard to the provisions for SSD over the diverge arrangement under TD 22/06, the requirement for unobstructed SSD to a point 160m downstream of the back of the diverge nose cannot be met, requiring a Departure from Standard. The same requirement for a 90m SSD 70m downstream of the back of the nose is however met.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table D.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table D.4**.

5.2.6.4.7 ***M2 Merge (Link B)***

Merge Type

Based on the projected traffic flows on the M2 mainline and the merging flows from Link B, with reference to Figure 2/3MW of TD 22/06, a type G 2 lane gain with ghost island merge layout to Figure 2/4.5 of TD 22/06 would appear to be the preferred provision. However, ghost island merges are not permitted on urban roads in accordance with paragraph 2.28 of TD 22/06. Accordingly, it is proposed to provide a type E double lane gain merge layout similar to that shown in Figure 2/4.3 of TD 22/06. A Departure from Standard is not considered necessary for this provision.

Merge Layout

With the retention of the national speed limits on the M2 mainline northbound carriageway, its classification remains that of a rural motorway, i.e. a motorway not subject to a speed limit, as defined in TD 22/06. Therefore, with reference to Table 4/4 of TD 22/06, the layout should reflect that of a rural motorway within an interchange, comprising a 75m long hose with a minimum nose ratio of 1:25. The proposed merge arrangement has been designed to provide a longer nose length of 100m with a nose ratio of 1:25. This provision will require a Departure from Standard.

The required 75m long near straight on approach to the back of the merge nose has been provided in accordance with the requirements of paragraph 2.34 of TD 22/06.

Spacing to Adjacent Junctions

The spacing of the merge nose relative to the merge nose from Link F is reported under **Section 5.2.6.4.11**.

Weaving Sections

The alignment of the link is such that the merge from Link B is positioned approximately 195m north of the present merge from York Street. Therefore the same weaving section between York Street and Fortwilliam is maintained with a slightly reduced weaving length of approximately 1.8km. A Departure from Standard will be required for the reduction below 2km, the Desirable Minimum weaving length for a Rural Motorway, in accordance with paragraph 4.35 of TD 22/06.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table D.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table D.4**.

5.2.6.4.8 ***Westlink/M3 Diverge (Links B/C)***

It is not possible, for Option D, to provide a grade separated connection between Westlink and the M3. Therefore all M3 bound traffic will be required to exit the Westlink at the diverge to York Street (Link G) and continue along York Link via two signalised junctions before joining the existing M3 on-slip.

5.2.6.4.9 ***At-grade Junctions on York Street (Link E)***

The design of the at-grade junctions on Link E has taken cognisance of the relevant requirements of TD 42/95 and TD 41/95, in relation to the design of priority junctions and the requirements of TD 50/04, relevant to signal controlled junctions. The proposed junction arrangements on York Street, at the junction with Link J and at the access to Cityside Retail Park / Yorkgate Business Park are similar to their counterparts in Option B. To reflect the revised Westlink to York Street (Link G) alignment, the existing traffic islands on York Street at the junction with York Link will be modified as necessary.

5.2.6.4.10 ***At-grade Junction at Galway House (Link F)***

The existing at-grade junction at Galway House onto Link F is maintained with minimal changes.

5.2.6.4.11 ***M2 Merge (Link F)***

Merge Type

Based on the projected traffic flows on the M2 mainline and the merging flows from Link F, with reference to Figure 2/3MW of TD 22/06, a type F 2 lane gain with ghost island merge layout to Figure 2/4.4 of TD 22/06 would appear to be the preferred provision. However, this cannot be provided due to the constraint formed by the width of the existing M2 foreshore. Of the five lanes into which to merge on the M2 foreshore, two are allocated to the M2/M3 mainline, leaving three for the merging flows from York Street and Westlink. In contrast to Options A, B and C, the merging flow from York Street is positioned between the merging flows from Westlink and the mainline M2/M3 flows. The merging flow from Westlink is considered the higher priority, given its strategic importance and so it is proposed to allocate the movement the two nearside running lanes on the carriageway. Whilst this provides the movement with the maximum capacity possible, there may be potential operational difficulties as it will require all traffic in lane 1 intending to travel to the M2 or M5 to weave into lane 2 ahead of the downstream lane drop to Fortwilliam.

With the allocation of the two nearside lanes to the Westlink movement, it is proposed to provide a type E single lane gain merge layout for the York Street movement similar to that shown in Figure 2/4.3 of TD 22/06. It is not possible, given the vertical alignments of the links, to provide a ghost island major merge arrangement between them to maximise capacity.

Merge Layout

With regard to the merge onto the M2 motorway, the existing nose detail is maintained, i.e. a 115m long nose with a nose ratio of 1:40, compliant with standards.

Spacing to Adjacent Junctions

The merge creates successive merge arrangements between the merge from York Street (Link F) and the merge from the Westlink (Link B). For the proposed Design Speed of 120kph, the minimum spacing between the tips of the merge noses is 450m. The proposed total distance between the successive diverge noses is 195m, below the required length. A Departure from Standard will accordingly be required.

Weaving Sections

The alignment of the link is such that the merge from Link B matches the current position of the merge from York Street. Therefore the same weaving section between York Street and Fortwilliam is maintained with the same weaving length of approximately 2km. No Departures from Standard are considered necessary for maintaining the existing provision.

SSD on Merge Arrangement

The requirements for SSD on approach to the merge arrangement on both the mainline and connector road have been considered in their respective alignment SSD assessments, with Departures from Standard TD 9/93 identified where necessary.

Summary Departures from Standard

A summary of required Departures from Standard TD 22/06 for the junction is included as **Table D.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table D.4**.

5.2.6.4.12 ***Westlink/York Street Signalised Junction (Links G/E)***

The existing approach to York Street from Westlink will be changed to reflect the revised alignment and cross-section of the link from Westlink to York Street (Link G). To that end, the existing lanes designated for M3 will be realigned north, to a position where the existing traffic island between M2 and M3 destinations is situated. The existing traffic island will accordingly be removed to make way for the realigned carriageway, with amendments to traffic islands on York Street and York Link to reflect the new alignment.

5.2.6.4.13 ***Nelson Street to Westlink Signalised Junction***

The junction layout is identical to its counterpart in Option B as described in **Section 5.2.4.4.13**. In a similar manner to Option B, it is proposed to implement two-way running on Garmoyle Street and Whitla Street to provide access to the Westlink. The operational impacts of the loss of southbound capacity on Whitla Street and Garmoyle Street will be reflected in the traffic and economic performance of the option, as reported in **Section 7** of this report.

5.2.6.4.14 ***Dock Street to M3 Signalised Junction (Links I/C)***

In this option, the existing signalised junction between Nelson Street and York Link is maintained, with modification made to the junction to facilitate access to lands at Shipbuoy Street and Nile Street. To provide access, it is proposed to introduce an additional one-way access road with a split entrance layout, making use of what would be redundant carriageways under the Lagan Bridge. The access lane would have an alignment approximately along the alignment of the existing Shipbuoy Street, exiting onto what is presently the bus lane on York Link, which in turn exits onto the right turn filter lane from York Street onto York Link. With the introduction of grade separation, an additional link is required to allow non-motorway traffic to exit from Shipbuoy Street and continue towards the City Centre. A connection onto York Street is considered unsuitable given the frequency of existing junctions along its length and so a new link road between York Link and Corporation Street is proposed. This new link road would comprise a single lane (paved width = 3.97m) exiting the junction with York Link and Nelson Street that would open out to two lanes on approach to the existing junction with Corporation Street opposite the entrance to Clarendon Dock. It is proposed to introduce traffic signal control at this junction as part of the proposed works to regulate traffic movements.

5.2.6.4.15 ***M3 to York Street Diverge (Link J)***

The junction layout is identical to its counterpart in Option B as described in **Section 5.2.4.4.16**. A summary of required Departures from Standard TD 22/06 for the junction is included as **Table D.3** in **Appendix D**. Where specific Departures from Standard TD 41/95 or TD 42/95 have been identified, these are also included in **Appendix D** as **Table D.4**.

In order to maintain access to existing properties on Nelson Street, it is proposed to convert the remaining section of Nelson Street, south of the junction with Link J, to two-way operation in the same manner as for Option B. The same arrangements on Nelson Street and Great Patrick Street/Dunbar Link will be carried over to Option D, as detailed in **Section 5.2.4.4.16**.

5.2.7 *Road Safety Audits*

Key to the development of a road scheme is the completion of Road Safety Audits in accordance with HD 19/03 of the DMRB at various milestones in the process. The purpose of road safety audits is to identify potential road safety problems that may affect any users of the road to eliminate or mitigate those problems. The process extends beyond the design and construction period to include accident monitoring during the scheme's subsequent operation.

Road Safety Audits at key stages in the development of a scheme;

- Stage 1 Road Safety Audit at completion of preliminary design
  - typically an audit of the specimen design developed by Roads Service prior to publication of draft orders
- Stage 2 Road Safety Audit at completion of detailed design
  - typically an audit of the appointed Design and Build Contractor's design (which may or may not match the specimen design)
- Stage 3 Road Safety Audit at completion of construction
  - typically an audit of the scheme immediately prior to, or immediately after, opening of the scheme

- Stage 4 Road Safety Audits
  - comprising two separate audits carried out at both 12 months and 36 months after opening using collected accident data.

Audits are carried out by an Audit Team independent of the design team and whose skills, experience and training have been reviewed and approved by Roads Service. The findings from the audits comprise a series of recommendations that are delivered directly to Roads Service independently of the design team. Generally, Roads Service will instruct the modification of the scheme design to take account of recommendations made, but in scenarios where this is not possible, Roads Service may prepare an Exception Report for submission to their Divisional Roads Manager.

Under HD 19/03, there is the facility to additionally undertake Interim Road Safety Audit reports at any point between the set milestones to identify road safety problems and recommendations. Such audits are undertaken at the request of Roads Service and are carried out to a commensurate level of detail to identify problems and make recommendations.

Following selection of a Preferred Option, the design team will commence the preliminary design of the junction layout in sufficient detail to inform the statutory procedures carried out in parallel. Once the specimen design is sufficiently complete, a Stage 1 Road Safety Audit will be carried out in accordance with HD 19/03.

5.2.8 *Non-Motorised User Audits*

The DMRB recognises the importance of provision for non-motorised users in the development of road schemes and requires the completion of Non-Motorised User (NMU) Audits at various milestones in the process. Non-Motorised User Audits are carried out in accordance with HD 42/05 of the DMRB, comprising the preparation of:

- a Non-Motorised User (NMU) Context Report at the earliest possible stage in the design
  - preferably where scheme objectives are defined
  - prior to preliminary design
- NMU Audit Reports, specified by Roads Service following approval of the NMU Context Report, typically during the following stages
  - preliminary design
  - detailed design
  - completion of construction.

NMU Audits are completed by an NMU Audit Leader who may be a member of the design team with appropriate training, skills and experience to consider the implications of the schemes for NMU accessibility, safety, comfort and convenience. It should be noted that NMU Audits do not duplicate Road Safety Audits.

The NMU Context Report provides a summary of all available information relevant to existing and potential NMU patterns of use by NMUs during the design life of a scheme. The report must also set out the opportunities and objectives to improve conditions for NMUs. The report is submitted to Roads Service for approval, in particular of the objectives for NMUs. If Roads Service does not accept the report or the proposed scheme objectives, the NMU Context Report is revised accordingly and resubmitted. It should be noted that if the NMU Context Report identifies no issues and no objectives for NMUs, further NMU Audit Reports are not required.

Where NMU Audits are required, NMU Audit Reports are prepared to report on how the identified objectives are being satisfied, or not, by the design. Where the NMU Audit Team Leader considers that the objectives are not being met, an explanation must be given as to the reasons behind the identified failure. Issues identified should be listed with an action list developed to assist their resolution.

During the Stage 2 Scheme Assessment process, the NMU Context Report was prepared. The report draws together the NMU survey results from April 2010 and identifies a series of objectives for the future scheme.

5.3 Pavements

A detailed assessment of the construction and resultant residual life of the existing road pavements in the vicinity of the site has not been carried out on the basis that all options under consideration will require their removal to make way for the new interchange links and slip roads that are in new horizontal or vertical positions. This is especially true for the existing pavements on Westlink, York Street, York Link, Great George's Street and Nelson Street that comprise the existing junction.

With regard to the condition and residual life of the Westlink, M2 and M3 carriageways beyond the extent of the scheme at the tie-in positions, it should be noted that these are under the management of Highway Management (City) Limited as DBFO concessionaire under the terms of its DBFO Contract. Under the provisions of this contract, the concessionaire is required to regularly inspect and report upon the condition of the existing carriageways and programme remedial works as required to achieve a suitable residual design life upon hand back to Roads Service at the end of the 30 year contract period (2036).

5.4 Land Use

As part of the environmental assessment, an assessment has been made of the impact of each of the options on present land use, including demolition requirements and future development plans. The findings from this assessment are reported in **Section 6.6**.

5.5 Ground Engineering

5.5.1 *Introduction*

The proposed interchange will be situated in an area with poor ground conditions, with significant variance in the engineering properties of the underlying strata across the site. This is evidenced in the historical ground investigation information compiled from various sources as reported in the separate Preliminary Sources Study Report for the scheme.

All of the options considered as part of the Stage 2 assessment will require significant structures in the form of proposed:

- bridges
- underpasses
- retaining walls
- embankments.

The proposed approach to deal with each of these structural elements is detailed in **Sections 5.5.2 to 5.5.5**.

In order to carry out the detailed design of the various structures in the selected Preferred Option, it will be necessary to carry out additional ground investigations early within the DMRB

Stage 3 Scheme Assessment process. The proposed approach is explained in detail in the separately published Geotechnical Statement of Intent, but is summarised in **Section 5.5.7**.

5.5.2 *Geotechnical Assessment of Proposed Bridges*

All of the options propose the introduction of above ground bridge structures to provide grade separation between the various links. It is inevitable that the foundations to these bridges will be piled considering the thickness of the underlying compressible superficial deposits. The piles are expected to be either CFA or rotary bored piles (with temporary or permanent casings). Depending on the type and geometry of these structures pile groups may be subjected to combinations of vertical and horizontal loads generating compression, tension and bending on the piles. Subsequently, the diameter, length and number of piles can be determined depending on the design and access requirements. It is considered that the piles required for the largest bridge spans can be designed in such a manner so as to avoid the need for further ground improvement.

The construction of CFA or rotary bored piles is an established technique and is not considered to present a significant engineering difficulty to a competent contractor.

Aside from the bridge foundations, it is likely given the spans involved that specialist heavy lifting equipment will be required, particularly the crane(s) that would be required to lift in the larger spans for the M2 to Westlink bridge in Options B and D. Such equipment will require a stable working platform comprising a reinforced concrete slab supported on piles.

In summary, the significant engineering difficulties, from a ground engineering perspective, for the construction of the proposed bridges are:

- the provision of working space for piling equipment and labour teams
- the provision of a suitable working platforms for other heavy equipment e.g. pedestal cranes
- the constraints on piling operations in an urban environment due to noise and vibration levels
- the logistics involved in both removing spoil from the piling operations from the site and installing the permanent reinforced concrete piles

The above engineering difficulties will be reflected in the resultant rate of progress.

5.5.3 *Geotechnical Assessment of Proposed Underpasses*

5.5.3.1 *The M2 to Westlink Underpass*

5.5.3.1.1 *Development of Underpass Alignment Options*

The M2 to Westlink link in Options A and C is provided in an underpass underneath the Lagan and Dargan Bridges and carefully threaded between their existing substructures. In the development of the options ahead of the Stage 2 assessment process, two potential horizontal alignments variants for this underpass were identified which could be used within Options A and C.

The first horizontal alignment option would provide a 160m horizontal radius, some 3 Steps Below the Desirable Minimum set out in DMRB Design Standard TD 9/93, with a minimum lateral clearance to existing bridge pile caps of approximately 2.5m (measured from the trafficked face of the underpass wall to the nearest edge of the bridge pile cap). The second alternative alignment would provide an improved 180m horizontal radius, 2 Steps Below Desirable Minimum, at the cost of a reduced minimum clearance to the existing bridge pile caps of 2.0m (as measured in a similar manner). It should be noted that the 160m alignment has been adopted in the design of all Options at Stage 2 and represents the fallback position should the 180m alignment be deemed unfeasible at a future date.

5.5.3.1.2 ***Development and Evaluation of Proposed Underpass Structure***

As an improved horizontal radius has the potential to improve the benefits offered by the scheme, further assessment was undertaken to evaluate the feasibility of constructing the underpass based on the 180m horizontal radius, i.e. with a 2.0m minimum lateral clearance envelope from the existing bridge pile caps. The assessment team considered the ground conditions, the nature of the existing structures, the available techniques in industry, the buildability and practicalities of constructing a solution within such a confined area and the health and safety issues associated with such activities. The findings from this and subsequent assessments are detailed separately in **Section 5.5.6**.

5.5.3.1.3 ***Proposed Extent of Enclosure***

The proposed extent of enclosure on the underpass will be confirmed at detailed design stage and will be dependant on a number of factors, including the vertical alignment of the road links, arrangements for access to severed lands and the structural design of the underpass. Design Standard BD 78/99 of the DMRB entitled “Design of Road Tunnels” defines tunnels as a subsurface highway structure enclosed for a length of 150m, or more. Based on the projected traffic flows, should the link be enclosed for a length of 150m or more, it would be re-classified as a Category B tunnel and require additional mechanical and electrical infrastructure and an increased cross-section and headroom. As the required increased cross-section cannot be provided due to the constraints imposed by the existing bridge substructure and the overlying road links, it is necessary therefore to limit the extent of enclosure to a maximum of 150m, centred on the low point on the link below the Lagan Bridge.

5.5.3.2 *The Westlink to M2/M3 Underpass*

The Westlink to M2/M3 Underpass is proposed in Options A, B and C to provide grade separated links in depressed corridors under the proposed York Street Bridge and the Dargan Bridge.

When compared to the M2 to Westlink Underpass, the Westlink to M2/M3 underpass is not considered to provide as many significant engineering challenges, given that its alignment is not constrained to the same degree by the presence of existing substructure. Accordingly, there will be an opportunity for the designer and contractor to use conventional embedded wall construction techniques such as CFA or rotary bored secant walling to form the required supports for the underpass excavation.

In summary, the significant engineering challenges, from a ground engineering perspective, for the underpass are:

- the provision of working space for piling equipment and labour teams
- the constraints on piling operations in an urban environment due to noise and vibration levels
- the logistics involved in both removing spoil from the piles from the site and installing the permanent reinforced concrete piles
- the temporary support of the embedded retaining walls during the main underpass excavation
- the logistics involved in the removal, treatment and disposal from the main underpass excavation

- the construction of the propping slab and in-situ vehicle restraint system
- the control of groundwater ingress into the underpass structure
- the design of the structure to resist pressures imparted by the high groundwater level
- the design of the northern wall of the structure to act as an abutment for the proposed York Street Bridge.

It should be noted that whilst these challenges are significant, they reflect the challenges encountered in the development and construction of the nearby Grosvenor Road and Broadway underpasses on the Westlink, which were managed and overcome by the appointed contractor and their designer.

5.5.3.2.1 ***Proposed Extent of Enclosure***

The vertical alignment of the road links does not provide sufficient headroom to enable enclosure of this underpass.

5.5.3.3 *The M3 to Westlink Underpass*

The M3 to Westlink underpass features in Option C only and will be of a similar form to the Westlink to M2/M3 underpass. The cross-section of the underpass is not principally governed by the presence of existing substructure and so the designer and contractor will have options for the use of CFA and rotary bored secant walling rather than diaphragm walling.

In summary, the significant engineering challenges, from a ground engineering perspective, for the underpass are:

- the provision of working space for piling equipment and labour teams
- the constraints on piling operations in an urban environment due to noise and vibration levels
- the logistics involved in both removing spoil from the piles from the site and installing the permanent reinforced concrete piles
- the temporary support of the embedded retaining walls during the main underpass excavation
- the logistics involved in the removal, treatment and disposal from the main underpass excavation
- the construction of the propping slab and in-situ vehicle restraint system
- the control of groundwater ingress into the underpass structure
- the design of the structure to resist pressures imparted by the high groundwater level
- the design of the southern wall of the structure to act as an abutment for the proposed York Street Bridge.

5.5.3.3.1 ***Proposed Extent of Enclosure***

The vertical alignments of the road links are such that, without recourse to raising of levels on adjacent land, it is only possible to enclose a section of the underpass of approximately 48m in length, in advance of the crossing under York Street. The proposed structure is therefore not classified as a road tunnel in accordance with BD 78/99.

The proposed extent of enclosure on the underpass will be confirmed at detailed design stage and will be dependant on a number of factors, including the vertical alignment of the road links, arrangements for access to severed lands and the structural design of the underpass.

5.5.4 *Geotechnical Assessment of Proposed Retaining Walls*

In all options, the horizontal and vertical alignments of the various connector roads will require the provision of retaining walls so that they can be provided within the constraints of the site.

Given the poor ground conditions, it is likely that such retaining walls will take the form of an L or inverted T type structure, constructed from reinforced concrete and typically supported on piled foundations.

The placement of backfill to the proposed retaining walls, particularly the backfill to the retaining walls on Links A and F, have the potential to create an engineering challenge given the high compressibility of the underlying strata and the possibility that the fill may slump between the provided retaining walls. This challenge would be also experienced on any proposed embankments, with ground improvement measures to address this challenge discussed in **Section 5.5.5**.

5.5.5 *Geotechnical Assessment of Proposed Embankments*

5.5.5.1 *Overview*

The use of embankments is proposed at several locations in all of the options on approach to proposed bridge structures, where sufficient space permits in plan to accommodate their footprint. Given the poor ground conditions at the site, it is considered that the provision of embankments will present a significant engineering challenge that will require careful consideration during detailed design stage. This assessment is limited at this time due to the uncertainty in the ground conditions within the site, specifically along York Street. Based on available historical ground investigation information compiled for the Preliminary Sources Study Report, an apparent boundary exists along York Street between the extent of the Belfast Sleech and boulder clay. Should the embankments to the proposed York Street Bridge be found to be underlain by the Belfast Sleech rather than the boulder clay, its high compressibility will create issues with differential settlement unless a suitable ground improvement measure is employed.

Given the present uncertainty, the area along York Street has been targeted for future ground investigation during the DMRB Stage 3 assessment to further identify the extent of the Belfast Sleech within the area.

Should further investigation determine that the embankments are underlain by Belfast Sleech or other highly compressible material, there are a number of ground improvement measures considered viable within the constraints of the site, i.e.:

- Piled embankments
- Ground treatment.

A limited assessment of the advantages and disadvantages of these options is included in **Sections 5.5.5.2 and 5.5.5.3**.

5.5.5.2 *Piled Embankments*

Considering variation of the fill and/or wall heights above the compressible strata, the following options are available:

- a geo-grid reinforced platform
- a reinforced concrete slab supported embankment

A geo-grid reinforced platform supported embankment would require a minimum of 2.5m thick fill cover, which would limit its use on embankments within the proposed interchange. The alternative slab option would allow a wide range of traffic management arrangements (i.e. can accommodate varying fill heights) to be implemented since it provides a rigid cap on the piles and minimises the lateral load effects on the piles. However, the construction of a reinforced concrete slab over the proposed extent of the embankments, particularly on York Street, would create significant disruption during construction due to the number and complexity of traffic management arrangements required.

5.5.5.3 *Ground Treatment*

Ground treatment measures would be required to a depth of approximately 12m below the existing ground surface, to the bottom of the Belfast Sleech, and where present, any underlying peat deposits. Options for ground treatment include:

- Replacement / Displacement
  - where compressible soil depths do not exceed 4m, the existing strata could be replaced / displaced by 6A material, if under water, and by 1C or 6N material, if in dry conditions
  - given the depths of underlying unsuitable material, the limited working space and the network of services in the site, the extents over which replacement/displacement can be used could be severely limited
- Ground Modification
  - soil mixing (both shallow and deep) could be considered depending on the lithological variations (i.e. granular and cohesive nature and organic material contents) and environmental impact (i.e. in-situ mixing with lime and / or cement)
- Pre-Surcharging
  - allow time for consolidation settlement / surcharging of ground (potentially with vertical drains). It should be noted that use of surcharging would be dependent on traffic management constraints.

5.5.6 *Evaluation of the M2 to Westlink Underpass*

5.5.6.1 *Underpass Structure Evaluation Report*

A separate report has been prepared by URS for Roads Service that fully details the various activities carried out by URS to develop the underpass structure ahead of the DMRB Stage 2 Scheme Assessment. Given the level of detail in the report, a précis is presented as **Sections 5.5.6.2 to 5.5.6.3**.

5.5.6.2 *Review of Previous Assessment Work*

As part of the development of the options ahead of the Stage 2 assessment process, assumptions made during the DMRB Stage 1 Scheme Assessment regarding the structural cross-section required for the underpass structure were evaluated in greater detail.

As the underpass structure is present in one form or another in two of the four options being taken forward (i.e. Options A and C), it is imperative to the feasibility of the scheme as a whole that the cross-section proposed at this stage is viable. Whilst one solution would be the provision of an over-sized structural section; the need to locate the proposed road alignment between and adjacent to existing structures and within defined land takes means this is not a realistic option.

Additionally, as the proposed underpass structure would pass directly adjacent to the piled foundations for the existing road and rail bridges (Lagan and Dargan bridges respectively), potential long and short term effects on these existing structures due to construction of the proposed underpass would require to be considered.

5.5.6.3 *Initial Consideration of Potential for Clash with existing Lagan Bridge substructure*

As part of the Stage 2 works for the York Street Interchange project, consideration was given to potential interfaces between proposed scheme alignments and existing infrastructure. One such interface being considered is between the new M2 to Westlink underpass structure (which is common to Options A and C) and the existing foundations for the Lagan Bridge. The concern is that if the existing piles for the Lagan Bridge have not been installed within expected tolerances, there is the possibility of a clash between the existing piles and the proposed pile walls installed as part of a new underpass structure

To resolve these concerns, three possibilities were considered:

- Option 1. Investigative GI work, to try to determine the exact location of existing piles.
- Option 2. Non-intrusive GI work, to try to determine the exact location of existing piles.
- Option 3. Numerical back-analysis of existing piles, to determine pile capacities and outline potential remedial works required should a clash occur.

For Option 1, it was proposed to drill exploratory boreholes to find the existing piles. This was considered and rejected due to the high probability of missing the existing piles and not finding anything and the potential damage/loss of stability that could occur by boring through any of the existing piles at one or more locations.

For Option 2, a number of specialist GI contractors were approached to discuss the use of ground radar and other non-intrusive techniques. Due to ground conditions in the area, none of the specialists approached could guarantee that such works would produce meaningful results. This Option was therefore rejected.

For Option 3, it was proposed to assess the applied loads from the existing structure, followed by a back-analysis of the existing piles using MPILE software. This allowed the determination of the capacity of the existing piles and the consideration of remedial measure options, if found to be required.

After using MPILE, the maximum pile load generated by the modified structure was found to be greater than the structural pile capacity stated on the historic drawing. This confirms that remedial works will be required should a clash occur between the existing piles at the Lagan Bridge and any new underpass structure.

One possible remedial works solution would be the provision of additional 450mm diameter mini-piles for the existing Lagan Bridge. These additional mini-piles would be located adjacent to the existing pile where the clash occurred and structurally connected to the existing pile cap via an extension to the pile cap. This extension may be fastened to the existing pile cap via dowels or similar. As previously noted, preliminary analysis shows that loads induced in the additional mini piles noted above are within the likely capacity range for such a pile size. This option has therefore been identified for further development in the future.

5.5.6.4 *Development of the Underpass Structural Form*

As part of the investigative works into the feasibility and buildability of the proposed M2 to Westlink underpass, confidential informal consultations were conducted with a specialist groundworks contractor. These consultations built and expanded on those carried out as part of the DMRB Stage 1 Scheme Assessment works.

The specialist ground works contractor consulted has experience in the construction of underground structures in Belfast Sleech using diaphragm walls along with ground treatment works in other areas. It was considered that this knowledge of working with the local ground conditions would be invaluable in providing the assurances required to ensure that the proposed underpass cross-section was a 'can-do' solution. Due to this local knowledge it was considered that consultations with other specialist ground works contractors were not required at this point, as any ground information being provided was historical in nature, as well as lacking project specific details.

The following points and issues were discussed with the specialist groundworks contractor:

- the advantages and disadvantages of using secant piles or diaphragm walling
- site constraints and plant operating clearances required
- construction tolerances achievable
- clearance issues with existing structures / foundations
- site investigation works that would be required to confirm any assumptions made
- installation of temporary sheet piling or ground treatment works during construction to limit movement of adjacent ground
- estimated timescale for construction of diaphragm walls
- waterproofing and drainage options for underpass structure
- potential 'showstoppers' that should be considered
- whether the proposed cross-section appears to be a robust, 'can do' proposal to an experienced groundworks contractor.

The outcome of the above consultations was that, based on the information currently available, provision of 800mm thick diaphragm walls with a separate inner box structure appear to be the most practical and feasible 'can-do' solution for the proposed underpass structure. The proposed cross-section of the underpass at the pinch point underneath the Lagan Bridge, adjacent to Lagan Bridge pier B22, is shown on **Drawing S105296-S-02-02-01**.

5.5.6.5 *Buildability Assessment and Decisions Moving Forward*

Following specific consultations in relation to the proposed underpass structure, a buildability assessment of the options as a whole was undertaken in consultation with an appointed buildability advisor. The buildability advisor noted the efforts undertaken by the team in the development of the proposed structure and the investigation into measures to locate the existing piles, but considered that the residual risk would be unacceptably high for a tendering contractor.

Based on the advisor's findings, and following further discussions with Roads Service, it has been proposed that the design proceeds on the basis that the two foundations of the existing Lagan Bridge most at risk with the construction of the proposed underpass structure are underpinned prior to the commencement of the diaphragm wall construction. The detailed design of the proposed underpinning works will be developed in conjunction with the diaphragm wall design during the DMRB Stage 3 scheme assessment process and included as part of the works requirements. The inclusion of these works as a pre-emptive measure ensures that the risk associated with a pile clash during construction is effectively removed realised within the respective cost estimate.

The above recommendations have been discussed and agreed in outline principle with representatives of Roads Service during the DMRB Stage 2 scheme assessment process.

5.5.7 ***Recommendations for DMRB Stage 3 Scheme Assessment***

5.5.7.1 *Ground Investigation*

An intrusive Ground Investigation will require to be undertaken as part of the DMRB Stage 3 Scheme Assessment activities to investigate the foundation locations of the proposed elevated structures (i.e. bridges, reinforced concrete and earth retained structures) and or underpass buried structures. Combinations of intrusive and non-intrusive investigations will be considered to verify the as-built locations of the existing bridge foundations.

Based on the structures proposed, and the availability and quality of historical ground investigation information, it is considered that the ground investigation contract should include, as a minimum:

- cable percussive boreholes and follow-on rotary coring along the wall lines of the proposed underpasses and at grid lines for above ground structures to depths of up to 50m
- installation of water and gas standpipe piezometers and divers
- recovery of Class 1 samples in soft soils with piston sampling or thin walled sampling in stiffer clays
- specialist in-situ testing, of the form of either Self Boring Pressuremeter, High Pressure Dilatometer or Cone Pressuremeter
- Mostap or Shelby sampling (should Cone Pressuremeter testing be selected)
- excavation of trial pits, with follow-on in-situ testing and sampling

The future ground investigation data should then be used to model the ground conditions of the study area to enable evaluation of the impact of the ground conditions on the selected options. This will facilitate design development of the preferred option.

5.5.7.2 *Land Contamination Evaluations*

York Street is located near Belfast Harbour and other historic industrial locations, which are partially built over claimed and old industrial land. The fill materials (i.e. made ground) have been placed across the site over a very long period of industrial development, which was associated with construction and expansion of the harbour and road and rail network. It is therefore highly likely that land contamination will be encountered.

The intrusive investigations and contamination studies should be carried out as part of ground investigations and contaminated soils will be classified in accordance with the Specification for Highway Works. The appropriate measures should then be defined and implemented to eliminate the risk to the potential receptors.

5.5.7.3 *Further Development of the Underpass Structures*

Following completion of the additional Ground Investigation, the proposed M2 to Westlink structure should be reviewed in conjunction with the newly acquired information. This will inform the detailed design of the structure and the further design of the proposed underpinning works to the Lagan Bridge.

5.5.7.4 *Further Development of Embankment Structures*

The provision of additional information on the ground conditions at York Street will enable an assessment to be made on the ground improvement measures that will be required to determine the most viable solution.

5.6 Hydrogeology

In all Options, the introduction of additional structures both above and below existing ground level, are likely to impact upon the existing groundwater regime. The provision of underpasses is expected to have a more significant impact on groundwater flow paths than the provision of piled foundations for overbridges and retaining walls.

From a desktop study, it would appear that there are a number of industrial heritage sites in the vicinity of the proposed interchange. Given the extensive development of the area over time, it is expected that only legacy foundations remain at these sites. A full investigation of the existing groundwater regime will be included as part of the detailed Ground Investigation undertaken at the next assessment stage. This information will enable an assessment of the possible impacts of the proposed structure on the groundwater regime and the industrial heritage sites within the vicinity.

5.7 Hydrology and Drainage

5.7.1 *Introduction*

As described in **Section 2.1.4**, the location of the proposed York Street Interchange site and the existing convergence point of the strategic routes of the M2, M3 and A12 lies within the area influenced by the river and costal floodplain of the River Lagan and Belfast Lough. The route options under consideration to provide improvement to the linkages traverse land which is also subject to this influence while being extensively developed and predominantly impervious in nature. Currently the majority of the land is drained through a network of road gullies, drainage pipes and sewers to a large diameter combined sewer, the Low Level Sewer, which runs in a south to north direction beneath Corporation Street before outfalling into Duncrue Street Wastewater Treatment Works. The review of existing drainage infrastructure within the site area has revealed that apart from the Mile Water culvert and the Gamble Street combined sewer overflow which are at the northern and southern extremities of the site there are no other known separate drainage facilities owned by either Rivers Agency or Northern Ireland Water which would add to potential flooding sources but would also provide potential discharge outlet locations.

Collection of the surface water runoff from the proposed links associated with each of the route options is not expected to present any difficulty during the further design development stages. It will be achieved primarily through the use of road drainage gullies discharging to longitudinal collector pipes. At underpass or elevated structure locations and in scheme areas with unavoidable shallow longitudinal gradients, it is anticipated that combined kerb and drainage units discharging to carrier pipes will be utilised as the most appropriate drainage mechanism.

Due to the absence of a network of storm culverts or drainage waterways the disposal or discharge of surface water runoff which is generated from the proposed site will however present a number of challenges which will be resolved as part of the ongoing design process. These challenges include the identification of locations for appropriate drainage outfalls, ascertaining permitted rates and volumes of storm water discharge, achieving consent to discharge and obtaining agreement with the appropriate authorities to the acceptable permitted quality of the drainage water to be discharged.

Consultation is ongoing with Northern Ireland Water (NI Water) in seeking to achieve an agreed drainage strategy for the area of the York Street Interchange site. The scheme area currently drains to the local combined sewer network which then outfalls into the existing 2400mm diameter Low Level combined sewer in Corporation Street. The potential development of a separate drainage network to serve the built environment in the area would require a significant funding contribution from NI Water. An assessment of storm water discharge rates and volumes, resulting from the construction of the scheme options under consideration, has demonstrated that potential discharge rate and volume increases following construction of each of the proposed options would be minor. As a result the scheme drainage design solutions being progressed are centred around utilisation of the existing adjacent infrastructure.

Outline drainage design measures have been considered for each of the scheme option proposals and these are set out in **Sections 5.7.3 to 5.7.6**.

5.7.2 *Hydrology and Floodplain Impacts*

5.7.2.1 *Overview*

The potential impact of the scheme options under consideration on the existing coastal and river floodplain and the associated requirements of the Design Manual for Roads and Bridges HD45/09, Rivers Agency and the legislation governing their work have been considered and assessed from two standpoints i.e.

- impacts which the floodplain may have on the scheme options
- impacts which the scheme options may have on the floodplain and the current mechanisms and influences on flood progression.

Consultation on the various issues affecting the scheme options including meetings and correspondence is ongoing with Rivers Agency, Northern Ireland Environment Agency and NI Water.

It should be noted that significant existing infrastructure within the greater study area including parts of Belfast City Centre is currently within the designated coastal and river floodplain and is subject to flood risk. However the area is protected from regular flooding by existing flood protection measures which are in place along the river banks. The existing circumstances with respect to the floodplain and the potential impact of a flood event which breaches the existing protection, on the urban area of Belfast City Centre may create an opportunity for the development of a joint strategy between Roads Service and Rivers Agency. Such a forum could see the development of York Street Interchange being progressed so as to be a beneficial influence on the level of protection afforded to Belfast City Centre during a significant flood event.

5.7.2.2 *Existing floodplain impacts on the scheme options*

A general review of the current options suggests that Options A, B and C which have significant depressed elements built into them and will require the development of underpass structures would be at risk of becoming inundated with flood water should an extreme flood event occur which overtops the existing flood protection infrastructure. Preliminary preventative design investigations have been carried out to assess whether existing roads at locations adjacent to proposed on-ramps into underpasses could be raised to prevent such a situation arising. Further design investigations have also been carried out to assess whether proposed underpass walls could be raised above envisaged flood levels and thereby be utilised as flood protection walls. Such features could then act in conjunction with raised on-ramps to keep the underpasses free from flood inundation.

The investigative design works completed to date indicate that exclusion of direct flood waters emanating from the River Lagan and flowing above ground into the site area from the north and east is feasible for all of the options concerned.

Whilst it is anticipated that it will be possible to prevent flood water inundation of future underpass features it should be noted that for each of the options developed the remainder of the York Street Interchange site area with proposed finished levels below approximately 3.1 metres AOD could be directly affected by an extreme flood event which overtops the existing flood protection infrastructure. However it is anticipated that such an event will be notified in advance through the early warning procedures and alert systems which are currently being developed by Rivers Agency, Roads Service, Northern Ireland Environment Agency, Belfast City Council and other relevant bodies as part of the Belfast Flood Risk Management Plan.

5.7.2.3 *Impacts of the scheme options on the floodplain*

For all of the four options being assessed consideration has been given to the impact of elevated links, the decks of which would be constructed above the predicted levels of flooding, and other associated proposed road infrastructure with anticipated finished levels above 3.1 mAOD. The result of this review indicates that such features would remain free from the risk of flood inundation during flood events. However the potential impacts of higher level road infrastructure, any structural piers and any proposed flood protection walls, located within the extents of the floodplain still remain to be assessed. This assessment will consider how such features impact on the floodplain and the progression of a flood event through the site area. It is anticipated that this work will be undertaken as part of a detailed flood risk assessment to be carried out during the development and assessment of the preferred route alignment.

5.7.3 *Option A*

The nature of the proposed road link alignments associated with Option A will result in significant lengths of new carriageway being constructed considerably below existing ground levels within the area. This situation presents a challenge to the design of a drainage network which will meet the requirements of appropriate statutory orders and design standards.

The finished road levels of the proposed M2 to Westlink link (Link A), the Westlink to M2 link (Link B) and the Westlink to M3 link (Link C) would be below the ground levels of the surrounding area and its existing drainage networks and therefore would be constructed using underpasses. It is proposed that these underpasses would be drained by means of pumping storm water up to a level where it is able to establish a gravity connection with the existing drainage infrastructure. From an engineering and economical perspective an optimum location for a pumping station has been identified and this would be close to the M2 to Westlink link finished road level low point of approximately -6.6m AOD as shown on **Drawing S105296-D-SK-A-001**.

The proposed pumping station would be capable of ensuring that the project can comply with the core requirements of DMRB Volume 4 Section 2 HD 33/06 entitled “Surface and Sub-surface Drainage Systems for Highways”, together with various structural design standard requirements, and would discharge via a combination of pumping and gravity pipelines to the 2400mm diameter Low Level sewer in Corporation Street.

Where other road drainage outfalls are required for Option A, for example in the area of York Street, the associated outfall levels can be achieved through gravity drainage pipe connections into existing and proposed sewerage as shown in the drainage design drawings. This design approach seeks to minimise the catchment areas which would contribute storm water to the proposed storm water pumping arrangement thus minimising associated construction, maintenance and operational costs and minimising the number of alterations to the existing network.

North of Dock Street the revised carriageway arrangement would utilise the existing motorway drainage. This can be accommodated by a drainage connection from the relatively small area which would slope towards the M2 motorway from the new Dock Street overbridge that would form part of the proposed M2 to Westlink link (Link A).

5.7.4 *Option B*

The finished road levels of the proposed Westlink to M2 link (Link B) and the Westlink to M3 link (Link C) would be below the ground levels of the surrounding area and its existing drainage networks and would therefore be constructed using underpasses. It is proposed that these underpasses are drained by means of pumping storm water up to a level where it is able to establish a gravity connection with the existing drainage infrastructure, in a similar way to Option A.

However, the M2 to Westlink link (Link A) in Option B is proposed as an elevated structure and therefore the associated outfall levels can be achieved through gravity drainage pipe connections into existing and proposed sewerage. This would allow the total road drainage catchment area which would need to be drained to the pumping station to be reduced thus reducing associated construction, maintenance and operational costs and minimising the number of alterations to the existing network. It is anticipated that the optimum location of this pump station from an economical perspective would be in the area between York Street and Little York Street as shown on **Drawing S105296-D-SK-B-001**.

As with Option A, where other road drainage outfalls are required for Option B, for example in the area of York Street, the associated outfall levels can be achieved through gravity drainage pipe connections into existing and proposed sewerage as shown in the drainage design drawing.

North of Dock Street a significant extent of the proposed M2 to Westlink link (Link A) elevated structure would be drained towards the M2 motorway. It is unlikely that there would be sufficient spare capacity available within the existing motorway drainage to receive any significant additional drainage flows from the proposed scheme. Therefore it is currently envisaged that an additional pipeline would need to be constructed within the eastern motorway verge or hard shoulder which would outfall to the Mile Water Culvert at the northern end of the scheme.

5.7.5 *Option C*

The drainage design proposals for Option C are similar to those for Option A. The major difference between the two options is the fact that in Option C the M3 to Westlink link (Link D) is aligned below the proposed York Street over bridge in the form of an underpass. As a result the finished road levels would be below the ground levels of the surrounding area and its existing drainage networks. This link, together with a section of Great George's Street would need to be connected into the proposed pumping station. The larger overall catchment area (when compared with Option A) would result in greater design flow rates discharging to the pumping station and a pumping station of higher pumping capacity would be required to achieve the necessary discharge rates. This would inevitably result in increased associated maintenance, construction and operational costs for the pumping station.

The outline drainage design for Option C is set out on **Drawing S105296-D-SK-C-001**. Once again, as with Options A and B, it is proposed that where other road drainage outfall levels can be achieved through gravity drainage pipe connections into existing and proposed sewerage and in order to minimise the catchment area contributing storm water to the pumping station, connections to existing and proposed sewerage would be acceptable.

Again, it is currently proposed that in this scheme option the pumping station would discharge via a combination of pumping and gravity pipelines to the 2400mm diameter Low Level sewer in Corporation Street.

5.7.6 *Option D*

Due to the elevated nature of the proposed road links which are associated with Option D it is not anticipated that a pumping station would be required to facilitate drainage. Examination of the various design requirements show that outfall levels can be achieved through gravity drainage pipe connections into the existing and proposed sewerage.

Drawing S105296-D-SK-D-001 illustrates the proposed locations where storm water runoff which is generated by the scheme can be conveniently discharged based on the information currently available.

North of Dock Street a significant portion of the proposed M2 to Westlink link (Link A) and the Westlink to M2 link (Link B) elevated structures would be drained towards the M2 motorway. It is unlikely that there would be sufficient spare capacity available within the existing motorway drainage to receive significant additional drainage flows from the proposed scheme. Therefore it is currently envisaged that an additional pipeline would need to be constructed within the eastern and western motorway verges or hard shoulders which would outfall to the Mile Water Culvert at the northern end of the scheme.

5.8 Public Utilities

5.8.1 *Introduction*

Significant diversions of utilities infrastructure and mitigation measures would be required as a result of the construction of Options A to D. From information supplied by the utility providers it is evident that the majority of service utilities to be diverted are located in the four main areas of York Street, Nelson Street, Great George's Street and around York Link.

An assessment of the diversions which would be required has been carried out based on the data which has been received from the utility providers. No provision has been made for the possibility of preferred upgrades to existing infrastructure which may be requested by any of the utility providers. Further consultations will be carried out at Stage 3 with the affected utility providers to establish the utilities mitigation measures which will be necessary as a result of the construction of the preferred Option.

5.8.2 *Option A*

The construction of underpasses for the M2 to Westlink link (Link A), Westlink to M2 link (Link b) and Westlink to M3 link (Link C) associated with Option A would lead to existing services routes within York Street and Nelson Street being cut off. **Drawing S105296-S-SK-A-001** shows proposed services diversion corridors which are expected to be required to accommodate these severed services routes. Services Routes V, W and X have been proposed to accommodate the services within York Street which are expected to require diversion.

Section 1-1 in the drawing illustrates the proposed utilities infrastructure which is likely to require to be diverted within Services Routes W and X. This apparatus would need to be accommodated within the proposed York Street over bridge. There are 2 No 375mm diameter gravity combined sewers (CS) which it is anticipated would require to be diverted around the underpass structures and these have been accommodated within proposed Services Route V as shown in the design drawing. Alternatively, Services Routes V and Y could be used to house the required permanent (or indeed the temporary) utilities diversions which are shown within Services Routes W and X, but a significant services diversion corridor of total width greater than 5 metres is likely to be required in this case.

Services Route Y (the green corridor) has been provided as a services link between York Street and Dock Street. This can accommodate for example any services in Nelson Street which would be cut off by the proposed works. Section 2-2 shows the apparatus which is proposed to be installed in Services Route Y between York Street and Nelson Street. Section 3-3 refers to any apparatus which it is proposed would be diverted within Services Route Y, between Nelson Street and Dock Street.

In Corporation Street an on-slip is proposed which would provide access onto the M2 to Westlink link (Link A). This on-slip would cross the west footpath which contains services apparatus which is likely to require to be lowered, protected or diverted on the line of the existing services.

Services Route Z has been included in the utilities diversion proposals because of an existing 600mm diameter combined sewer which is shown to cross the Roads Service Depot car park between Nelson Street and Corporation Street. It is likely that the existing sewer would be severed by the construction of the proposed M2 to Westlink link (Link A).

Services would also need to be diverted around any proposed structural foundations which are required as part of Option A, e.g. in connection with the bridge structure over Dock Street which is proposed as part of the M2 to Westlink link (Link A).

5.8.3 *Option B*

In a similar way to Option A, the construction of underpasses for the Westlink to M2 link (Link B) and the Westlink to M3 link (Link C) would lead to existing services routes within York Street and Nelson Street being cut off. However, as the M2 to Westlink link (Link A) is proposed as an elevated structure there are variations (from Option A) associated with the proposed services diversion corridors required for Option B. The proposed services routes are illustrated on **Drawing S105296-S-SK-B-001**. York Street Services Routes W and X are similar to those shown for Option A.

Services Route V, which is proposed to accommodate 2 No 375mm diameter combined sewers, passes around the eastern side of the proposed underpasses as opposed to the western side of the underpasses as shown within the services diversion proposals for Option A. This is due to the Westlink retaining wall which is proposed between the elevated M2 to Westlink link (Link A), the Westlink to M2 (Link B) and the Westlink to M3 link (Link C). Alternatively, Services Routes V and Y could be used to house the permanent (or indeed the temporary) utilities diversions which are shown within Services Routes W and X, but a significant services diversion corridor of total width greater than 5 metres is likely to be required.

Services Route Y (the green corridor) has been included as a proposed services corridor between York Street and Dock Street. This can accommodate for example any services in Nelson Street which would be cut off by the proposed works. Section 2-2 shows the apparatus which, from review of existing utilities infrastructure records, would need to be accommodated within Services Route Y between York Street and Nelson Street. Section 3-3 refers to any apparatus which it is proposed would be diverted within Services Route Y, between Nelson Street and Dock Street.

Services Route Z (the peach corridor) along Great George's Street has been included in the utilities diversion proposals mainly because of the proposed elevated M3 to Westlink link (Link D). Due to the proposed locations of structural foundations and significant depths of embankment fill which are proposed between Nelson Street and the proposed Great George's

Street/York Street Junction, services diversions are proposed as shown on the drawing. Section 4-4 shows the expected nature of utilities apparatus which would require to be diverted. Additional services which have been included in the proposed utilities crossing Great George's Street at Nelson Street are also represented on the drawing. It is envisaged that only relatively short diversion lengths would be required for these additional services which cross at this location.

Services would also need to be diverted around any proposed structural foundations which are required as part of Option B e.g. in connection with the elevated M2 to Westlink link (Link A).

5.8.4 *Option C*

The proposed Services Routes for Option C involve a combination of those which are proposed for Options A and B. This information is set out on **Drawing No S105296-S-SK-C-001**. Similarly to Services Route V in Option A, York Street Services Route U passes around the west side of the proposed M3 to Westlink link, M2 to Westlink link, Westlink to M3 link and Westlink to M2 link underpasses.

Services Routes V and W are again similar to Services Routes W and X which are proposed as part of Options A and B.

Alternatively, Services Routes U, X and Z could be used to house the permanent (or indeed the temporary) utilities diversions which are shown within Services Routes V and W, but a significant services diversion corridor of total width greater than 5 metres is likely to be required.

Services Route X (the green corridor) is again provided as a services link between York Street and Dock Street. This can accommodate for example any services in Nelson Street which would be cut off by the proposed works. Section 2-2 shows the apparatus which is proposed to be installed between York Street and Nelson Street. Section 3-3 refers to any proposed apparatus to be diverted within the Services Route X, between Nelson Street and Dock Street.

In Corporation Street an on-slip is proposed which would provide access onto the M2 to Westlink link (Link A). This on-slip would cross the west footpath which contains services apparatus which is likely to require to be lowered, protected or diverted on line of the existing services.

Services Route Y has been included in the utilities diversion proposals because of an existing 600mm diameter combined sewer which is shown to cross the Roads Service Depot car park between Nelson Street and Corporation Street. It is likely that the existing sewer would be severed by the construction of the proposed M2 to Westlink link (Link A).

As is the case with Option A, services would also need to be diverted around any proposed structural foundations which are required as part of Option C.

Services Route G (the peach corridor) along Great George's Street has been included in the utilities diversion proposals mainly because of the proposed M3 to Westlink link (Link D) underpass. Due to the proposed locations of structural foundations and proposed changes in finished road alignment along the proposed Great George's Street, services diversions have been proposed. Section 4-4 shows the expected nature of the apparatus which would need to be diverted and additional services which have been included in the proposed utilities crossing Great George's Street at Nelson Street are also represented on the drawing. It is envisaged that only relatively short diversion lengths would be required for these additional services which cross at this location.

5.8.5 *Option D*

In a similar manner to each of the other Options, services would need to be diverted around any proposed structural foundations which are associated with Option D. Whilst this Option is likely to have the least overall impact on existing utilities apparatus, the anticipated number of localised diversions around pile caps and other structural elements is expected to be higher for Option D than any of the alternative options under consideration. This is due to the significant lengths of elevated structures and their foundations associated with this Option.

Services Route Z (the peach corridor) along Great George's Street has been included in the utilities diversion proposals mainly because of the proposed elevated M3 to Westlink link (Link D). Due to the proposed locations of structural foundations and significant depths of embankment fill which are proposed between Nelson Street and the proposed Great George's Street/York Street Junction, services diversions are proposed as shown on **Drawing No S105296-S-SK-D-001**. Sections 1-1 and 2-2 show the apparatus which would require to be diverted at these locations. It is envisaged that only relatively short diversion lengths would be required for existing utilities which cross Great George's Street at Nelson Street.

5.9 Structures

5.9.1 *Overview*

A number of structures are proposed that are common to one or more of the Options, albeit with small variation. A short summary of each of the proposed structures is included below that identifies potential structural forms and any significant engineering challenges that will require to be overcome.

5.9.2 *Underpasses*

The findings from the engineering assessment of the proposed underpass structures are included in **Section 5.5.3**.

5.9.3 *York Street Bridge*

A York Street Bridge is proposed for Options A, B and C in order to provide the necessary vertical clearance to the Westlink to M2 and M3 links (Links B and C).

At time of this assessment, it is proposed to provide a single structure with two spans of approximately 50m in length for Options A and C, as illustrated for Option C on **Drawing. S105296-ST-SK-G-001**. A single span structure, of approximately 50m in length is proposed for Option B as illustrated on **Drawing S105296-ST-SK-B-002**.

The structure will comprise a four lane carriageway, a minimum of 16.25m wide, with a 2m nearside footway and a 2m offside hardened verge, not intended for pedestrian usage.

In all options, the proposed superstructure comprises trapezoidal box girders supported in turn on piled foundations. The selection of steel box girders over precast concrete U-beams owes largely to the constraints on structural depth and the spans proposed.

The structure will be fairly complex, given the varying cross-section combined with a varying horizontal and vertical alignment. The use of steel box girders in this instance will require careful detailing of the joints between sections and the bearing arrangements. The use of steel sections over reinforced concrete sections will also have implications for long-term maintenance, which will need to be considered further in future assessments.

Whilst no issues have been identified at time of this assessment that would render the proposed design unfeasible, a number of issues will require further careful consideration at the next assessment stage, including:

- the structural form and span arrangements
- footway provision and treatment of hardened verges not intended for pedestrian use
- integration of services within the structure
- design and detailing of joints and bearing arrangements
- the location and form of the abutments.

5.9.4 *Dock Street Bridge*

A Dock Street Bridge is proposed for Options A and C for Link A between the M2 and Westlink. At time of this assessment, it is proposed to provide a structure with a span of approximately 65m in length for Options A and C, as illustrated for Option C on **Drawing S105296-ST-SK-G-002**. A steel trapezoidal ox girder structure on piled foundations is proposed. Whilst a single span is proposed at this time, an opportunity exists to revert to a two span structure, with a pier located in Dock Street. This could be provided with additional works Dock Street to divert services and construct the central pier and is only possible given the limited residual benefit of maintaining the Nelson Street bus lane, as Nelson Street south of Dock Street will only provide a connection to the M3 motorway.

Additional structures will be required on either side of the span. There are a number of options for these structures, including the provision of embankments with retaining walls or low-level structures, similar in form to the main Dock Street Bridge. The type of structure will be confirmed following further detailed design after the selection of the Preferred Option. Whilst an embankment structure may provide fewer challenges to construct, the issues with traffic management and ground improvement may lead to a multi-span structure being provided in its place.

The proposed structure will require the modification of the existing M2 embankment, with a retaining wall proposed as a replacement measure.

Whilst no issues have been identified at time of this assessment that would render the proposed design unfeasible, a number of issues will require further careful consideration at the next assessment stage, including:

- the structural form and span arrangements
- integration of services within the structure
- design and detailing of joints and bearing arrangements
- the works to the existing M2 embankment
- the location and form of the abutments.

5.9.5 *M2 to Westlink Overbridge*

In Options B and D, the link between the M2 and Westlink (Link A) is provided via an overbridge elevated above the existing Lagan and Dargan bridges. A high level multi-span steel trapezoidal box girder structure on piled foundations is proposed, as illustrated on **Drawing S105296-ST-SK-G-004**. A steel section is proposed given the restriction on span/depth ratios created by the alignment above the Dargan Bridge. At its highest point, the finished road level on the bridge is approximately 21m above Ordnance Datum, some 18m above existing street level and approximately 8m above the existing Lagan and Dargan bridges. A separate structure, of similar form, will be required parallel to the main structure to provide the Nelson Street to Westlink link.

The main structure is approximately 575m in overall length, comprising ten spans of 30m minimum length. The largest span is approximately 90m and is centred about the high point of the bridge, above the Dargan Bridge. Approach spans to the central 90m span are also significant, with two 75m spans and three 60m spans. Given the spans, the box girders would be a minimum of 2.2m deep, with a constant structural depth through to assist the fabrication, construction and aesthetics. In order to maintain such a depth, a balance has to be reached between providing an efficient structural section and minimising an overly deep section at the end spans. For this reason, it is proposed that an inefficient section with thicker flanges will be provided at the maximum 90m span. Additionally, haunches may be provided local to this span. These measures will allow a larger span/depth ratio to be utilised, leading to a more balanced overall structural form being provided.

The adjacent ramp structure is approximately 185m in overall length, comprising a minimum of four spans, with the largest span approximately 65m. Careful consideration will need to be given at future assessment stages to the design and detailing of the connection between the main bridge and the ramp structure.

It should be noted that consultations with Roads Service's Engineering Policy Branch have confirmed that a Very High (H4a) containment parapet system will be required on the bridge over sections above the existing Dargan Bridge. This will have implications for both forward visibility and the aesthetic of the structure.

As part of the buildability assessment undertaken for all the options, as reported in **Section 5.10.1**, consultations were undertaken with a specialist bridge contractor. The purpose of these consultations was to examine the options available for the construction of the bridge. Whilst it was acknowledged that options existed to push-launch some sections of the structure, the specialist noted that, given the varying alignment geometry and cross-section, the simplest, and hence the most economical solution would be the use of craned sections.

In response to these findings, a preliminary load assessment was made to identify whether specialist lifting equipment would be required. Given the steel tonnages involved, it was concluded that a very large pedestal crane, with a lifting capacity of at least 2,000 tonnes, would be required. Based on these requirements, it would appear that a limited number of crane companies in the UK or Europe have such fleet capabilities. Following consultation with one of the identified crane companies, it is understood that the lead-in time for their crane, that is the time between placing the order and the crane arriving on site, is of the order of 18 months. For the successful contractor, the construction programme would be critical to the arrival of the crane as expected. Any failure to either secure the advance order, or failure by the crane operator in delivery, would have a major impact on the completion of the works.

A further complication with the use of such a large crane is the logistical operations involved in delivering the crane and its ancillary crane to site and positioning the crane when at site, to minimise the number of inter-site moves. The crane is likely to arrive by ship at the nearby Belfast Harbour and require transport in sections to the site, where it will take up to a week to assemble using a slave crane. The size of the crane components will require the use of abnormal load arrangements with Roads Service and the Police and may require temporary closures along the route and removal of street furniture. Once at the site, **Drawing S105296-ST-SK-G-005** illustrates a number of locations where the proposed crane could be positioned for maximum effectiveness during construction of the various spans. The working area required by such cranes is quite large and given the constraints at the site, providing the working areas for its operation will create further challenges for traffic management during the construction period. It should be noted that the weight of the crane will require the prior construction of suitable working platforms at each of the identified working areas.

In addition, challenges with the logistics of beam delivery and erection will require careful planning by the successful contractor to overcome. URS has experience with similar operations in its involvement on the M74 motorway extension, a scheme that draws parallels with the proposed interchange. In the M74 scheme, a similar elevated bridge structure was constructed near Glasgow's city centre using a combination of craned and push-launched solutions. In order to deliver the box girder sections to site, the contractor arranged for sections to be delivered to site in halves, reducing the size and weight of transported sections. These sections were then spliced on site in both the longitudinal and transverse section before being craned into an elevated launch position for subsequent push launching. It is considered that a similar strategy could be utilised for this scheme by the successful contractor. Given the loads involved, all other works including the forming of the bridge deck and a

Once the box girder sections are ready for erection, the next logistical challenge would be the management of road and rail possessions to allow lifting operations to commence. This will require careful co-ordination with Roads Service, Translink and the Police. Splice joints will be required to join the girders along the bridge, which will careful consideration in relation to their placement (to allow for the temporary and permanent loading scenarios) and require the construction of temporary bridge supports on suitable platforms. Positioning these temporary supports and constructing the associated load transfer platforms will also create challenges for traffic management arrangements.

Whilst no issues have been identified at time of this assessment that would render the proposed design unfeasible, a number of issues will require further careful consideration at the next assessment stage, including:

- the structural form and span arrangements of the main structure
- the structural form, span arrangements and connection of the ramp structure
- the development of craning plans in consultation with specialist crane companies
- the logistics of delivering, using and removing the proposed crane
- the logistics of delivering and assembling the proposed box girders
- the siting, construction and removal of temporary bridge supports
- the logistics of erecting the proposed box girders
- the construction of the remainder of the bridge superstructure at height.

5.9.6 *M3 to Westlink Overbridge*

Options B and D proposed the construction of a new bridge above York Street to provide a grade separated link between the M3 and the Westlink. To maintain a consistent appearance with the adjacent M2 to Westlink overbridge, a multi-span trapezoidal box girder structure is proposed, supported on piled foundations. A general arrangement for the structure is shown on **Drawing S105296-ST-SK-G-003**. The largest span proposed is across York Street and will be a minimum of 37.5m in length. The proposed structure is likely to be founded on a raised embankment to the west, which could potentially form part of the abutment for the adjacent M2 to Westlink overbridge. The bridge would tie in with a new embankment structure to the east.

The structure is situated on a section of varying horizontal and vertical alignment on the link, which will require careful structural design and detailing at later stages of assessment.

However, no issues have been identified at time of this assessment that would render the proposed design unfeasible or particularly challenging from an engineering perspective.

5.9.7 ***Westlink to M2 Overbridge***

In Option D, a grade separated Westlink to M2 (Link B) movement is provided using an overbridge structure that spans over York Street, the Dargan Bridge and the underlying slip road from York Street to the M2.

A similar form and method of construction is proposed for this structure as for the M2 to Westlink overbridge, as described in **Section 5.9.5**. This form comprises a steel box girder superstructure, supported on intermediate piers with piled foundations. The skew angle of the bridge relative to the underlying York Street and Dargan Bridge gives rise to a maximum span of 75m above York Street, with a side span of 60m above the existing Dargan Bridge.

In order to support the bridge, special consideration has been given to support arrangements for the spans over York Street. In an ideal scenario, the alignment of York Street and specifically, the alignments of York Link and the slip road to the M2, would be changed to open up areas of land where piers could be directly located underneath the structure. However, in order to minimise the disruption on York Street, it is proposed to retain the present alignment of the links in their present form. To support the bridge, it is proposed to use goalpost type piers, with large frames positioned such that the column members are located in traffic islands. This will impact upon the appearance of the structure when viewed from street level.

Another challenge with the construction of this bridge is the proximity of the structure to Galway House, which will constrain the available space for craning operations.

5.9.8 ***Widening of Existing Dock Street Bridge***

5.9.8.1 *Widening Works on Northbound Carriageway*

The existing Dock Street Bridge will be widened in Options A and C on the western side (northbound carriageway) to accommodate the revised slip road from York Street to a maximum of approximately 10m to the west of the existing structure. A typical section through the widening is shown as Section 14 on **Drawing S105296-R-SK-A-203**.

As noted in **Section 2.1.2.4**, the existing bridge was widened on the western side in 1991 using post-tensioned connectors. Proposed widening could therefore take a number of forms, including:

- widening of the structure using the same or similar methods
- widen the structure using a separate, but adjoined, structure
- widen the structure with a completely separate structure.

A review of the advantages and disadvantages of the various forms was undertaken, as summarised in **Table 4.8.1** below:

TABLE 4.8.1: COMPARISON OF WIDENING OPTIONS FOR DOCK STREET BRIDGE

Widening Option	Advantages	Disadvantages
Same or similar method of widening	No differential movement likely between existing and proposed deck slabs. Aesthetically matches existing structure.	Likely to be design and construction issued when dealing with post-tensioned components. Previous design may not have sufficient capacity for current design loads.
Separate but adjoined structure	No differential movement likely between existing and proposed deck slabs. Potentially simpler construction as modification to the existing structure should be minimal.	May be aesthetically different from the existing structure.
Completely separate structure	Potentially simpler construction as modification to existing structure should be minimal.	Likely differential movement between existing and proposed deck slabs. May be aesthetically different from existing structure.

Of the aforementioned options, on the basis of the review it was considered that the provision of a separate, but adjoined structure would be the optimum solution. Potential differential movement between the existing and new decks could be controlled to avoid damage to the road surface carried under live and thermal loads, combined with minimal modification works to the existing structure.

There are a number of ways in which the two structures could be joined together. These include:

- an integral connection along interface between proposed and existing structures
- joining at deck and at abutments and piers
- joining at the deck only.

Of the above options, joining the proposed and existing structures at deck level would only control differential movement between the decks without applying undue additional forces onto the foundations. This is an important consideration as the existing structure supports the deck on discrete columns carrying a crosshead, in effect, a “skeleton” type pier. The new piers will also have to be designed for impact loading from the adjacent road. By separating the existing and proposed substructure and foundations, the load path from such an impact is simplified.

It is noted from a review of the Preliminary Sources Study Report that underlying peat deposits can be expected to the west of the structure. Due to the likely settlement issues if pad foundations were used, piled foundations for the new structure are proposed. This would reflect the foundation type used for the previous widening of the structure in 1991.

In Option D, however, the new Westlink to M2 overbridge structure would require such space between the existing Dock Street Bridge and the existing Dock Street Rail Bridge that the existing road bridge would require to be partially demolished. With reference to Section 12 on **Drawing S105296-R-SK-D-202**, the existing bridge would require to be reduced in width by approximately 2.5m, approximately the width of the existing hard shoulder. A new raised verge and parapet upstand would be required to accompany the partial demolition of the structure.

The biggest engineering challenge for the successful contractor will be the completion of the works, particularly those involved in Option D, within an extremely constrained site. The northern abutment of the structure can only be readily accessed from the M2 motorway above, which will require the delivery and placement of equipment and materials using hard shoulder and lane closures on the M2. The adjacent existing structures will also form a restriction on the height of equipment and plant that can be delivered to the location from the underlying Dock Street. Given the proximity to the existing railway line, the contractor will be required to comply with the specific requirements of Translink as necessary.

5.9.8.2 *Remedial Works to Existing Structure*

The existing bridge is included within the DBFO Package 1 Contract and in accordance with the terms of the contract, it is the responsibility of Highway Management (City) Limited as the DBFO Company to undertake any remedial works necessary to provide the required residual life upon handback to Roads Service at the end of the thirty year concession period. Any remedial works required in accordance with the terms of the DBFO Contract are financed by the DBFO Company. However, the proposed widening works by Roads Service will require integration with the existing structure. In accordance with current European design standards, any existing structural elements affected by works to integrate the new structure are required to achieve the same residual design life as the new structure. At time of assessment, a residual design life for these elements has not been confirmed and accordingly, a full assessment of these works has not been completed.

To provide some indication of works that may be required, the available Principal Inspection Report for the bridge carried out by Highway Management Maintenance (HMM) dated November 2007 was reviewed. The report found the structure to be in good condition, with no major structural defects. A condition factor of 1.0 was considered appropriate in the report for the numerical assessment of the bridge. Some minor defects were observed which were noted to require some future remedial works. These defects were assigned a priority ranking for repair based on a five point scale as set out in the DBFO Contract, such that defects with a priority of 0 require no further action whilst defects with a priority of 4 are considered serious or highly serious with repair recommended within a maximum of 26 weeks.

The following defects on the structure were assigned a priority of 3 such that they are deemed significant and could become serious enough to affect the integrity of the structure. Repairs are recommended as soon as possible within a 26 week period:

- the pot hole in the transverse asphaltic plug joint within the southbound carriageway and cracking in the joint.

The following defects on the structure were assigned a priority of 2 such that they are deemed minor that are likely to get worse and become more expensive to repair within 6 years. Repairs are recommended as soon as possible within a maximum period of 52 weeks:

- various instances of sealant de-bonding from the vertical joints at the abutments, in particular at the north west joint
- the spalled concrete to the underside of the eastern parapet upstand due to low cover to reinforcement.

At time of assessment, it is unknown if the DBFO Company have completed any of the above recommended works. As some time has passed since the last principal inspection report, it is accordingly proposed to defer an assessment on the remedial works required to the existing structure until further consultation has been undertaken with the DBFO Company at detailed design stage.

5.9.9 *Widening of Existing North Queen Street Bridge*

5.9.9.1 *Widening Works to Southbound carriageway*

North Queen Street Bridge will require widening by approximately 5m in all of the options on the southern side to accommodate the wider southbound carriageway on the Westlink. A number of potential options for widening the structure were considered with particular regard to the issue of differential settlement between the widening works and the existing structure, in a similar manner to Dock Street Bridge as detailed in **Section 5.9.8**. For similar reasons, it is proposed to provide a separate, but adjoined, structure. It is anticipated that the form of such a structure would closely match that of the existing, with the articulation of the proposed structure matching the existing structure as closely as possible to avoid differential movements at deck and road level. In order to achieve this match, it is noted that additional construction works will be required at the south-east wingwall and that the backfill to the south-west and south-east wingwalls will require to be raised.

It is expected that the proposed and existing structures would be joined at deck level only, with the new structure supported on separate piled foundations.

In all options, all existing memorials to the victims of the McGurk's Bar terrorist attack will require removal and relocation to accommodate the widened bridge wingwall. The sensitivities surrounding such works are noted and it is suggested that these works are carried out in consultation with the victims groups, community representatives and the DBFO Company.

The access available to the structure during the widening works is likely to present the most significant issue for the appointed contractor, in particular the access available to the western abutment. The footway is approximately 1m higher than the adjacent North Queen Street at the eastern abutment, which will create difficulties for plant access from below. The alternative is access from the Westlink, but this will require lane closures and the provision of narrow lanes to accommodate, both on the mainline and the off-slip to Clifton Street.

5.9.9.2 *Remedial Works to Existing Structure*

The existing bridge is included within the DBFO Package 1 Contract and in accordance with the terms of the contract, it is the responsibility of Highway Management (City) Limited as the DBFO Company to undertake any remedial works necessary to provide the required residual life upon handback to Roads Service at the end of the thirty year concession period. Any remedial works required in accordance with the terms of the DBFO Contract are financed by the DBFO Company. However, the proposed widening works by Roads Service will require integration with the existing structure. In accordance with current European design standards, any existing structural elements affected by works to integrate the new structure are required to achieve the same residual design life as the new structure. At time of assessment, a residual design life for these elements has not been confirmed and accordingly, a full assessment of these works has not been completed.

To provide some indication of works that may be required, the available Principal Inspection Report for the bridge carried out by Highway Management Maintenance (HMM) dated November 2007 was reviewed. The report found the structure to be in good condition, with no major structural defects. A condition factor of 1.0 was considered appropriate in the report for the numerical assessment of the bridge. Some minor defects were observed which were noted to require some future remedial works. These defects were assigned a priority ranking for repair based on a five point scale as set out in the DBFO Contract, such that defects with a priority of 0 require no further action whilst defects with a priority of 4 are considered serious or highly serious and require repair within a maximum of 26 weeks.

Numerous defects were determined to be insignificant and assigned a priority of 1, with no remedial works recommended. The following defects on the structure were assigned a priority of 2 such that they are deemed minor that are likely to get worse and become more expensive to repair within 6 years. Repairs are required as soon as possible within a maximum period of 52 weeks:

- a damaged section of vehicle restraint system on the eastbound carriageway.

At time of assessment, it is unknown if the DBFO Company have completed any of the above recommended works. In any event, the section of barrier in question is to be replaced and upgraded as part of the works described in **Section 5.9.9.1**. As some time has passed since the last principal inspection of the bridge, it is accordingly proposed to defer an assessment on the remedial works required to the existing structure until further consultation has been undertaken with the DBFO Company at detailed design stage.

5.9.9.3 *Works on Northbound Carriageway*

A survey of existing lane widths on the northbound carriageway confirms that they are substandard, with lane widths of 2.85m (lane 1), 2.75m (lane 2) and 3.0m (lane 3). Full 3.65m lane widths could be provided along with a hard shoulder if the structure is widened by approximately 6m on the northern side. However, as only 400mm is required to provide lane widths of 3m per lane, the absolute minimum under Chapter 8 of the Traffic Signs Manual, a proposal was considered to relocate the kerbline and reduce the raised verge width from 2.5m to 2.1m in all options. This would provide a widening of the lanes to the absolute minimum within the existing cross-section, albeit through a reduction of the raised verge width. The remaining verge width would still be in excess of the 2m minimum requirement for motorway communications cabling.

When assessing the feasibility of relocating the kerbline, a number of issues were considered. As the carriageway is superelevated, falling to the central reserve, drainage systems are not present at the nearside kerbline and therefore considered to be unaffected.

Services are known to exist in the nearside raised verge, in the form of longitudinal motorway communications cables and street lighting cables. These services may require minor relocation to accommodate the change in the kerbline and will require protection during such works.

A vehicle restraint system is currently provided on the raised verge, in the form of a single sided steel safety barrier providing protection to lighting columns on approach to and departure from the bridge. An existing P2 parapet is provided on the structure. The safety barrier continues along the bridge, presumably due to the short distance between the sections of need on either side of the bridge. In response to the reduction in the width of the raised verge, it is proposed to remove the existing P2 parapet system and replace it with a contemporary N2 normal containment parapet. By inspection, it would appear feasible to upgrade the parapet with minimal additional works. However, the relocation of the kerbline will require the relocation of the safety barrier by a corresponding distance, or replacement of the road lighting columns with passively safe columns such that the need for the barrier is removed. Both of these options appear feasible in principle but will require further consideration at detailed design stage.

5.9.10 ***Retaining Walls***

5.9.10.1 *Widening of Existing Retaining Wall at Clifton Street Off-Slip*

A section of the existing retaining wall to the nearside of the off-slip to Clifton Street from the southbound Westlink carriageway will require demolition and replacement with a similar structure as part of the widening works to the North Queen Street Bridge.

Whilst the works appear feasible, there are a number of issues that will require further consideration at detailed design stage. These include:

- the required retained height following detailed topographical survey
- the ground conditions that can be expected following further Ground Investigation(s)
- access and egress arrangements for the contractor
- the extent of land made available to the contractor
- proposed temporary works
- interaction with the adjacent retaining wall to the North Queen Street Police station.

5.9.10.2 *Replacement of Little George's Street Retaining Wall*

In all Options, a slip road is provided between the Westlink and York Street. The alignment of the Westlink to M2 link requires a slip road alignment that is closer and higher to the existing residential properties at Little George's Street. This is necessary to provide a tie in with the raised York Street alignment. To remain within the existing land boundary, it is proposed to raise the existing retaining wall to accommodate the additional retained height.

Drawing S105296-R-SK-G-077 illustrates the difference in height between the existing wall and the proposed replacement wall for Options A, B and C. The drawing illustrates a typical change in top of wall level of 0.8m, with a maximum change of 1.6m where the slip road is closest to the existing wall at the diverge arrangement. On the immediate approach to the junction with York Street, the existing boundary wall will be removed and replaced with a new retaining wall with a retained height of approximately 4m.

For Option D, the slip road from Westlink to York Street is significantly higher and closer to the existing land boundary along the section of wall adjacent to the diverge arrangement. Therefore a higher retaining wall is required, with a top of wall level approximately equal to eave heights on the adjacent properties. **Drawing S105296-R-SK-G-078** illustrates the maximum level difference of 5m between the top of the existing wall and the proposed replacement wall for Option D.

An outline assessment of the existing wall capacity was carried out and revealed that the base slab of the retaining wall would have insufficient structural capacity to resist the increase bending forces applied to it. As the controlling reinforcement is on the underside of the slab, there is no simple way to reinforce the section.

As the load effects in the base slab are governed by the distribution of bearing pressure across the slab, various options were considered that could limit the amount of additional lateral load being applied to the wall. These options included:

- use of ground anchors to carry and reduce lateral loads
- use of a reinforced earth structure built on top of the existing wall
- installation of a secondary wall system, such as sheet piling, behind the existing wall.

Following consultations with geotechnical specialists and considering the site constraints, it was concluded that the most effective long term solution would be to isolate and replace the existing wall with a new retaining wall structure. It is proposed that the new retaining wall is installed behind the existing wall, with the existing wall removed.

The construction of the replacement wall proposed will present significant engineering challenges for the appointed contractor, given the physical constraints at the location. In order to replace the wall, it will be necessary to construct a suitable piling platform to either install temporary sheet piling or a permanent bored wall, if the contractor's preferred retaining solution, behind the existing wall. Such a platform will require to be constructed from the higher Westlink side through lowering of the existing embankment alongside the wall. This will require temporary relocation of the existing motorway communications and street lighting services and part of the existing carriageway, to facilitate access for labour, plant and materials. This will require significant traffic management measures on the Westlink to provide a sufficiently large working area. The progress of piling operations would be constrained by statutory requirements in relation to noise and vibration impacts at the adjacent residential properties. Following completion of this aspect of the works, access will be necessary to construct the base slab of the wall and portions of wall above existing ground level. This will require access to both the higher and lower sides of the wall, using temporary possession of the existing rear gardens to the properties. The works area in the gardens will require to be fenced off from the residential properties, with two access/egress points proposed at North Queen Street and the existing green area at Henry Place. The rate of progress of works within the gardens will be constrained by the restrictions on plant size and hours of operation. Given the extent of the works area, and their expected duration, the works in the rear gardens will create significant disruption to the use of the properties for the affected landowners which will require careful consideration and consultation at detailed design stage.

As the works to replace the Little George's Street present significant engineering challenges, it is proposed to develop measures to remove the need to replace the existing wall, or mitigate the extent of works involved as part of the detailed design activities.

5.9.10.3 *Replacement of Great George's Street Retaining Wall*

In all options, the southbound carriageway on the Westlink is widened from North Queen Street Bridge to the Clifton Street off-slip. This will require removal and replacement of the existing retaining wing wall to the bridge, along with the existing retaining wall at Great George's Street that supports the Westlink embankment. Whilst the replacement works are required, in the majority, to reflect the widened road, the extent of the replacement works varies for each option. For Options A and C, the extent of wall to be replaced is limited to the extent of the widening works near North Queen Street bridge. For Options B and D, the raised level of the M2 to Westlink link relative to existing levels increases the overburden on the entire length of the existing retaining wall.

An outline assessment of the existing wall capacity was carried out for the proposed embankment level in Options B and D. This assessment revealed that the toe slab of the existing wall has insufficient structural capacity to resist the additional bending forces that would be applied to it. Accordingly replacement of the wall with a new retaining structure has been deemed the most effective long-term solution.

Following consultations with geotechnical specialists and considering the site constraints, it was concluded that the most effective long term solution would be to isolate and replace the existing wall with a new retaining wall structure.

The replacement of the wall gives rise to the same engineering challenge anticipated for the works to the Little George's Street retaining wall, i.e. the provision of access and working space for the works. In order to provide temporary support to the embankment during the replacement works, it will be necessary to prepare a suitable piling platform on the Westlink side of the retaining wall. This will require temporary lowering of the existing embankment adjacent to the retaining wall which will require significant traffic management on the Westlink to provide access and egress points.

Access will be required to the toe of the existing retaining wall at Great George's Street to complete the construction of the new base slab for the retaining wall. In contrast to the works to the Little George's Street retaining wall, there is space available within the existing street to facilitate the works. However, services located within Great George's Street will require prior relocation and temporary traffic management arrangements will need to be in place to facilitate access from York Street for residents in Thomas Street, Lancaster Street, Portland Place and Fisher's Court.

5.9.10.4 *Construction of Retaining Wall at Cityside Retail Park*

A new retaining wall is required to support the raised York Street alignment in Options A, B and C from the junction with Westlink to a position south of the existing left in-left out access to Cityside Retail Park.

The new wall will support a maximum retaining height of approximately 4m, reducing to a retained height of 1m at its northern extent.

A reinforced concrete "L" retaining structure is proposed that would be supported on piled foundations, based on available information in relation to the foreseeable ground conditions.

The most significant challenges in relation to the construction of the wall are the relocation of affected underlying services in the York Street footway and the provision of working space using temporary traffic management arrangements for both motorised and non-motorised users.

5.9.10.5 *Modification of the Existing Gantry on the M2 On-slip*

An existing signal gantry spans the on-slip to the M2 motorway from York Street and the joining M3 motorway at a position near to the tip of the merge nose on the northbound foreshore carriageway. This gantry is supported on reinforced concrete plinths in the central reserve and the nearside verge and spans approximately 25m. The northbound carriageway on the M2 is widened as part of the works to provide the grade separated York Street to M2 link. The position of the present gantry is considered suitable for the new layout but will require modification for the widened carriageway. Accordingly, it is proposed to remove and replace the western plinth with a plinth in the nearside verge of the widened carriageway, whilst retaining the existing gantry plinth in the central reserve. This approach has been taken to minimise works in the central reserve.

The existing gantry truss of 25m in length will require removal and replacement with a wider truss of approximately 37m in length. It may be possible to reuse the existing supports, but this would require confirmation at detailed design stage. A new plinth would be required in the nearside verge, supported on a piled foundation.

From a review of the available systems and the works involved, no engineering challenges have been identified at this time that would present significant difficulties to the appointed contractor.

5.9.10.6 *Construction of Concrete Step Barrier and Retaining Wall in Westlink Central Reserve*

In all options, the works provide an opportunity to replace the existing Vertical Concrete Barrier (VCB) on the Westlink within the extent of the scheme with a Concrete Step Barrier

(CSB) system. This has advantages for the safety of road users as a CSB system has a reduced Impact Severity Level (ISL) of Class B, compared to an ISL of Class C for standard VCB systems. The proposed replacement of the VCB with CSB would be in keeping with the requirements of DMRB TD 19/06 that require all new vehicle restraint systems to have an ISL not greater than Class B, unless otherwise agreed with the Overseeing Organisation.

A CSB system is constructed in-situ using special slipform paving equipment. Concrete is extruded through a paving mould and reinforced longitudinally as the paver advances. Following an assessment of the CSB systems approved by the UK Highways Agency, it is proposed to use a Variable Profile Concrete Step Barrier (VCSB) system given the level difference between the carriageways. The standard profile CSB barrier system can accommodate level differences of up to 300mm between carriageways with no change in containment performance class or working width class. For level differences between carriageways greater than 300mm, VCSB can be used, but will require a Departure from Standard as the containment performance class would be reduced. The mould used in a VCSB system has moving sides that allow the height of the wall section to vary such that the finished height of the barrier remains a minimum of 900mm above carriageway level on both traffic faces.

The works involved in replacement of the existing section of VCB appear feasible without significant engineering challenges. In order to construct the barrier, traffic will need to be diverted away from the central reserve, which will require careful planning of traffic management operations by the appointed contractor.

5.10 Construction

5.10.1 *Introduction*

To inform the economic assessment of delays through roadworks, a series of major traffic management phases have been developed to enable the construction of the works within the confines of the site. It is not possible to identify all major and minor traffic management phases at this time until further detailed design has been completed. These plans have been developed on the basis of an assumed requirement to maintain all existing traffic movements through the works during the period of 6am to 10pm, Monday to Saturday and the period of 11am to 10pm on Sundays. Outside of these periods, lane and full closures (limited or otherwise) will normally be considered permissible.

It is recognised that full closures may be required within these periods for specific works activities. Where such full closures are considered necessary, their extent and likely duration have been highlighted.

With regard to the construction of overbridges above the Dargan Bridge, it has been assumed that possessions of the railway track will only be permissible for the period of 12am to 5.30am, Monday to Friday, the periods of 12am to 6am and 11pm to 12am on Saturday and the period of 12am to 8.30am on Sundays. This reflects the present programme of rail services on the Dargan Bridge. Discrete operations that require longer possessions may be required subject to the agreement of Translink and with the provision of a bus substitution service.

In the following description of the various phases for each option, reference is made to the link naming convention set out in Section 3 of this report and the engineering drawings included in **Volume 3**.

5.10.2 ***Option A***

5.10.2.1 *Phase 1*

The first phase of traffic management is shown on **Drawing S105296-R-SK-A-301**. The temporary traffic management comprises the introduction of lane and hard shoulder closures to facilitate site clearance works and establishment of site offices and compounds.

Given that working space is severely limited, the team proposes the adoption of the lesser 0.5m safety clearance with narrow lanes in accordance with the exceptional provisions of paragraph D3.2.10 of Chapter 8 of the Traffic Signs Manual. In accordance with these provisions, a blanket 30mph limit and the permanent demarcation of the safety zone is required on the Westlink.

On the Westlink, a lane closure will be introduced on the northbound carriageway to allow the removal of existing vegetation on the embankment at the back of Little George's Street. It is proposed that the on-slip from Clifton Street be closed to permit access to the works zone.

On the M2, a hard shoulder closure will be introduced to permit site clearance works on the adjacent embankments. To accompany these site clearance works, the southbound bus lane on Nelson Street will require closure so that northbound traffic from Dock Street can be temporarily realigned.

5.10.2.2 *Phase 2*

The second phase of traffic management is shown on **Drawing S105296-R-SK-A-302**. During this phase all major service diversions shall be undertaken. In addition to the permanent diversions, additional temporary diversions shall be required to maintain the existing level of service.

A trenchless solution shall be required to install services across the Westlink with lane closures to facilitate excavation of catch/launch pits. One concern is the feasibility of such a solution along the verge of the northbound carriageway of the Westlink due to the presence of a concrete slab and piled foundations for the existing VRS either side of the gantry (see **Drawing S105296-R-SK-G-073**). Other road crossings at York Street and York Link could be facilitated with night closures.

Closure of the bus lane on Nelson Street north of Dock Street will be required to carry out NIE diversion works. On Dock Street, a footway closure will be required as a minimum to install services.

On York Street southbound traffic will no longer have access to the M2 and a temporary opening the central traffic island must constructed to allow for U-turns. This closure will facilitate relocation of the NIE substation.

5.10.2.3 *Phase 3*

The third phase of traffic management is shown on **Drawing S105296-R-SK-A-303**. A hard shoulder closure on the M2 southbound along with a lane closure on Nelson Street north of Dock Street shall allow construction on the retaining walls and the New Dock Street overbridge to commence. A temporary connection from Corporation Street is required to allow Nelson Street south of Dock Street to be closed. This will allow construction of the bridge abutment. The majority of the piled walls and underpass structure on Link A shall be constructed. Realignment of M2 to Westlink and Westlink to M3 traffic will be required. A low headroom diaphragm walling rig would be required to construct the underpass walls under the existing M3 structure. Further piling can also commence at this stage for Link C.

A lane closure on the Westlink will permit piling of a new retaining wall on the northern side of the Westlink.

A lane closure on Dock Street and on the M2 foreshore northbound would allow widening of the existing Dock Street Bridge and construction of retaining walls for Link F.

5.10.2.4 *Phase 4*

The fourth phase of traffic management is shown on **Drawing S105296-R-SK-A-304**. Following completion of the roof slab on Link A traffic from M2 and Dock Street can be reinstated to the original alignment. At this stage works adjacent to the southbound carriageway of the Westlink can commence including construction of replacement retaining walls and widening of North Queen Street Bridge.

Realignment of the Westlink for northbound traffic shall provide working area to allow construction of the new retaining walls and further piling on Link C. Upon completion of the retaining walls fill can be placed to bring Link G up to finished level.

During this phase, it is proposed to realign York Street to facilitate construction of the abutments and piers for the York Street overbridge. The north abutment will need to be constructed in two halves to allow access to be maintained.

On Corporation Street the existing bus lane will be closed to allow widening to be undertaken.

5.10.2.5 *Phase 5*

The fifth phase of traffic management is shown on **Drawing S105296-R-SK-A-305**. During this phase, York Street traffic shall be split around the works area with traffic wishing to continue north along York Street using a temporary alignment constructed to the west of the York Street bridge structure. This alignment will need to be constructed on a temporary embankment to tie in with the final levels on Link G. The remainder of the northern abutment on York Street overbridge would now be constructed. This new arrangement combined with a lane closure on the M2 on-slip shall allow the retaining wall to the east of the northern abutment of the York Street overbridge to be constructed.

The southern approach of York Street needs to be raised to finished level so that the overbridge can be opened to traffic when completed. The levels across the existing junction need to be raised a maximum of 1.6m. It is anticipated that this work could be carried out over a weekend closure. All services and drainage would need to be laid through the junction at this time.

5.10.2.6 *Phase 6*

The sixth phase of traffic management is shown on **Drawing S105296-R-SK-A-306**. Upon completion of Link G, traffic from the Westlink heading for York Street or the M2 will be able to use this route. M3 traffic would still pass through the raised York Street junction south of the York Street structure. During this phase the York Street overbridge would be completed.

5.10.2.7 *Phase 7*

The seventh phase of traffic management is shown on **Drawing S105296-R-SK-A-307**. The York Street overbridge will now be open to traffic allowing the temporary alignment to be removed. In order to commence excavation of the underpasses for Links B and C, the direct link between the Westlink and M3 will need to be closed and this traffic will be diverted via York Street and Dock Street. Excavation of the underpass on Link A shall also be undertaken at this stage. Realigning the southbound carriageway of the Westlink to follow the new kerbline shall allow works on the central median wall and VCSB to be completed.

Construction of the VCSB may need to be completed with overnight lane closures due to restricted working space on the northbound carriageway.

5.10.2.8 *Phase 8*

The eighth phase of traffic management is shown on **Drawing S105296-R-SK-A-308**. The underpasses for Links B and C shall be opened. Traffic using Link C to the M3 will be controlled at the junction with Nelson Street. At this stage, work to complete the York Street to M2 on-slip can be undertaken. These works are relatively minor mainly involving road markings to prevent traffic exiting the Westlink onto York Street from continuing straight onto the M2.

Construction of Link A underpass would be completed during this phase.

Work to convert Nelson Street to 2-way traffic and amendments to the junction on Dunbar Link could be completed with lane closures.

5.10.2.9 *Phase 9*

The ninth phase of traffic management is shown on **Drawing S105296-R-SK-A-309**. The Link A underpass would now be open to traffic including the link from Corporation Street. In order to construct Link I from Dock Street to M3, the existing link via Nelson Street shall be closed and traffic will be diverted via the existing network.

Work to construct the access to DSD land adjacent to Nelson Street will be completed during this phase.

5.10.2.10 *Phase 10*

Phase 10 shown on **Drawing S105296-R-SK-A-310** illustrates the completion of outstanding works with the scheme fully opened for public use.

5.10.3 ***Option B***

5.10.3.1 *Phase 1*

The first phase of traffic management is shown on **Drawing S105296-R-SK-B-301**.

The temporary traffic management comprises the introduction of lane and hard shoulder closures to facilitate site clearance works and establishment of site offices and compounds.

Given that working space is severely limited, the team proposes the adoption of the lesser 0.5m safety clearance with narrow lanes in accordance with the exceptional provisions of paragraph D3.2.10 of Chapter 8 of the Traffic Signs Manual. In accordance with these provisions, a blanket 30mph limit and the permanent demarcation of the safety zone is required on the Westlink.

On the Westlink, a lane closure will be introduced on the northbound carriageway to allow the removal of existing vegetation on the embankment at the back of Little George's Street. It is proposed that the on-slip from Clifton Street be closed to permit access to the works zone.

On the M2, a hard shoulder closure will be introduced to permit site clearance works on the adjacent embankments. To accompany these site clearance works, the southbound bus lane on Nelson Street will require closure so that northbound traffic from Dock Street can be temporarily realigned.

5.10.3.2 *Phase 2*

The second phase of traffic management is shown on **Drawing S105296-R-SK-B-302**. During this phase all major service diversions shall be undertaken.

Road crossings at York Street and York Link could be facilitated with night closures including works required in the centre of York Street.

Closure of the bus lane on Nelson Street north of Dock Street will be required to carry out NIE diversion works.

On York Street southbound traffic will no longer have access to the M2 and a temporary opening the central traffic island will be constructed to allow for U-turns. This closure will facilitate relocation of the NIE substation.

5.10.3.3 *Phase 3*

The third phase of traffic management is shown on **Drawing S105296-R-SK-B-303**.

Garmoyle Street shall be converted to accommodate two-way traffic. Lane closures will be required to undertake these works which include construction of a central separation island. Once completed the new bus lane on Nelson Street shall remain closed.

In order to construct the pier of the M2 to Westlink overbridge at the junction of Dock Street and Nelson Street, a lane closure is required on Nelson Street. Realignment of Nelson Street and the M2 off-slip at Nelson Street can be facilitated by the removal of the existing central reserve. This will allow piers at gridline E and F to be constructed.

A lane closure on the Westlink will permit piling of a new retaining wall on the northern side of the Westlink.

A lane closure on Dock Street and on the northbound carriageway of the M2 foreshore would allow widening of the existing Dock Street Bridge and construction of retaining walls on Link F.

5.10.3.4 *Phase 4*

The fourth phase of traffic management is shown on **Drawing S105296-R-SK-B-304**.

Realignment of the Westlink for northbound traffic shall provide working area to allow construction of the new retaining wall at the rear of the houses north of the Westlink. Piling of walls the underpass walls on Link C can also be completed at this stage. Upon completion of the retaining walls fill can be placed to bring Link G up to finished level.

At this stage works adjacent to the southbound carriageway of the Westlink can commence including construction of replacement retaining walls and widening of North Queen Street Bridge.

During this phase, it is proposed to realign York Street to facilitate construction of the abutments for York Street overbridge. The north abutment will need to be constructed in two halves to allow access to be maintained to York Street.

The remaining piers and abutment at the southern end of the M2 to Westlink overbridge can also be constructed during this phase.

During this phase the bridge beams for the M2 to Westlink overbridge shall be erected. Overnight closures would be required to facilitate erection of beams over live carriageways.

A hard shoulder closure on the M2 and the closure of Nelson Street north of Dock Street would allow for the remaining piers and abutment of the M2 to Westlink overbridge to be constructed. At this stage construction of the retaining walls would also be undertaken.

5.10.3.5 *Phase 5*

The fifth phase of traffic management is shown on **Drawing S105296-R-SK-B-305**.

During this phase, York Street traffic shall be split around the works area with traffic wishing to continue north along York Street using a temporary alignment constructed to the west of the York Street bridge structure. This alignment will need to be constructed on a temporary embankment to tie in with the final levels on Link G. The remainder of the northern abutment on York Street overbridge would now be constructed. This new arrangement combined with a lane closure on the M2 on-slip shall allow the retaining wall to the east of the northern abutment of the York Street overbridge to be constructed.

The southern approach of York Street needs to be raised to finished level so that the structure can be opened to traffic when completed. The levels across the existing junction need to be raised by approximately 1.0m. It is anticipated that this work could be carried out over a weekend closure. All services and drainage would need to be laid through the junction at this time. Offline the approach embankment to the structure would be constructed It is likely that this embankment would need to be piled.

Work to complete Link G would be undertaken during this phase. In order to tie-in the temporary realignment of York Street, north of the overbridge, a weekend closure may be required.

5.10.3.6 *Phase 6*

The sixth phase of traffic management is shown on **Drawing S105296-R-SK-B-306**. Upon completion of Link G, traffic from the Westlink heading for York Street or the M2 will be able to use this link. M3 traffic would still pass through the raised York Street junction south of the York Street structure. During this phase the York Street overbridge would be completed.

Work to the junction on Dunbar Link could be completed at this stage with lane closures.

5.10.3.7 *Phase 7*

The seventh phase of traffic management is shown on **Drawing S105296-R-SK-B-307**.

Traffic from the M2 and M3 heading for the Westlink would be diverted onto a temporary road across York Street and onto the northbound side of the existing Westlink. Traffic signals will be required to control the merging of the M2 and M3 traffic and also at the junction with York Street. This would enable construction of Link D and J from the M3. Upon completion of these works a weekend closure would be required to complete tie in works.

At this stage the embankment on the southbound carriageway of the Westlink would be constructed and all works to the M2 to Westlink overbridge completed.

The direct link from Westlink to M3 will be lost and M3 traffic will be diverted via York Street and Dock Street.

5.10.3.8 *Phase 8*

The eighth phase of traffic management is shown on **Drawing S105296-R-SK-B-308**.

The M2 to Westlink overbridge shall be opened to traffic. At the southern end of the overbridge traffic will be moved into the hard shoulder and lane one. Temporary traffic signals may be required to allow traffic from the M3 to merge. At this point traffic will run on the hard shoulder and lane gain, allowing construction of the remainder of the median wall and placement of the remainder of fill where the temporary alignment had been located in phase 7. The central VCSB would also be constructed at this stage. Overnight lane closures may be required due to limited working area on the northbound carriageway.

At this stage Links B and C shall be excavated and completed with M3 traffic still diverted via York Street and Dock Street.

Nelson Street south of the new M3 to Westlink link shall be converted for two way traffic at this stage.

5.10.3.9 *Phase 9*

The ninth phase of traffic management is shown on **Drawing S105296-R-SK-B-309.**

In order to construct Link I from Dock Street to M3, the existing link via Nelson Street shall be closed and traffic will be diverted via the existing network.

Work to construct the access to DSD land adjacent to Nelson Street will be completed during this phase and the realigned bus lane on Nelson Street north of Dock Street would also be constructed.

All other links will be completed by this stage.

5.10.3.10 *Phase 10*

Phase 10 shown on **Drawing S105296-R-SK-B-310** illustrates the completion of outstanding works with the scheme fully opened for public use.

5.10.4 ***Option C***

5.10.4.1 *Phase 1*

The first phase of traffic management is shown on **Drawing S105296-R-SK-C-301**. The temporary traffic management comprises the introduction of lane and hard shoulder closures to facilitate site clearance works and establishment of site offices and compounds.

Given that working space is severely limited, the team proposes the adoption of the lesser 0.5m safety clearance with narrow lanes in accordance with the exceptional provisions of paragraph D3.2.10 of Chapter 8 of the Traffic Signs Manual. In accordance with these provisions, a blanket 30mph limit and the permanent demarcation of the safety zone is required on the Westlink.

On the Westlink, a lane closure will be introduced on the northbound carriageway to allow the removal of existing vegetation on the embankment at the back of Little George’s Street. It is proposed that the on-slip from Clifton Street be closed to permit access to the works zone.

On the M2, a hard shoulder closure will be introduced to permit site clearance works on the adjacent embankments. To accompany these site clearance works, the southbound bus lane on Nelson Street will require closure so that northbound traffic from Dock Street can be temporarily realigned.

5.10.4.2 *Phase 2*

The second phase of traffic management is shown on **Drawing S105296-R-SK-C-302**. During this phase all major service diversions shall be undertaken. In addition to the permanent diversions, additional temporary diversions shall be required to maintain the existing level of service.

A trenchless solution shall be required to install services across the Westlink with lane closures to facilitate excavation of catch/launch pits. One concern is the feasibility of such a solution along the verge of the northbound carriageway of the Westlink due to the presence of a concrete slab and piled foundations for the existing VRS either side of the gantry (see **Drawing S105296-R-SK-G-073**). Other road crossings at York Street and York Link could be facilitated with night closures.

Closure of the bus lane on Nelson Street north of Dock Street will be required to carry out NIE diversion works. On Dock Street, a footway closure will be required as a minimum to install services.

On York Street southbound traffic will no longer have access to the M2 and a temporary opening the central traffic island must constructed to allow for U-turns. This closure will facilitate relocation of the NIE substation.

5.10.4.3 *Phase 3*

The third phase of traffic management is shown on **Drawing S105296-R-SK-C-303**. A hard shoulder closure on the M2 southbound along with a lane closure on Nelson Street north of Dock Street shall allow construction on the retaining walls and the New Dock Street overbridge to commence. A temporary connection from Corporation Street is required to allow Nelson Street south of Dock Street to be closed. This will allow construction of the bridge abutment. The piled walls and underpass structure on Link A can be constructed as this stage. Realignment of M2 to Westlink and Westlink to M3 traffic will be required. A low headroom diaphragm walling rig would be required to construct the underpass walls under the existing M3 structure. Further piling can also commence at this stage for Link C.

A lane closure on the Westlink will permit piling of a new retaining wall on the northern side of the Westlink.

A lane closure on Dock Street and on the M2 foreshore northbound would allow widening of the existing Dock Street Bridge and construction of retaining walls for Link F.

5.10.4.4 *Phase 4*

The fourth phase of traffic management is shown on **Drawing S105296-R-SK-C-304**. Following completion of the roof slab on Link A, traffic from M2 and Dock Street can be reinstated to the original alignment. Realignment of the Westlink (for southbound traffic) shall enable the new retaining walls to be constructed and widening of the existing North Queen Street Bridge.

Realignment of the Westlink for northbound traffic shall provide working area to allow construction of the new retaining walls and further piling on Link C. Upon completion of the retaining walls fill can be placed to bring Link G up to finished level.

At this stage works adjacent to the southbound carriageway of the Westlink can commence including construction of replacement retaining walls and widening of North Queen Street Bridge.

During this phase, it is proposed to realign York Street to facilitate construction of the abutments and piers for the York Street overbridge. The north abutment will need to be constructed in two halves to allow access to be maintained. The northbound carriageway of the Westlink may have to be reduced to two lanes to allow construction of the southern abutment.

On Corporation Street the existing bus lane will need to be closed to allow widening to be undertaken.

5.10.4.5 *Phase 5*

The fifth phase of traffic management is shown on **Drawing S105296-R-SK-C-305**.

During this phase, York Street traffic shall be split around the works area with traffic continuing north along York Street using a temporary alignment constructed to the west of the York Street bridge structure. This alignment will need to be constructed on a temporary embankment to tie in with the final levels on Link G. The remainder of the northern abutment on York Street overbridge would now be constructed. This new arrangement combined with a lane closure on the M2 on-slip shall allow the retaining wall to the east of the northern abutment of the York Street overbridge to be constructed.

The southern approach of York Street needs to be raised to finished level so that the structure can be opened to traffic when completed. The levels across the existing junction need to be raised a maximum of 1.7m. Consideration would need to be given to how this junction would be raised e.g. staged construction over weekends. All services and drainage would need to be laid through the junction at this time.

5.10.4.6 *Phase 6*

The sixth phase of traffic management is shown on **Drawing S105296-R-SK-C-306**. Upon completion of Link G, traffic from the Westlink heading for York Street or the M2 will be able to use this route. M3 traffic would still pass through the raised York Street junction south of the York Street overbridge. During this phase the York Street overbridge would be completed.

5.10.4.7 *Phase 7*

The seventh phase of traffic management is shown on **Drawing S105296-R-SK-C-307**. The York Street Overbridge will now be open to traffic allowing the temporary alignment to be removed. In order to commence excavation of the underpasses for Links B and C, the direct link between the Westlink and M3 will need to be closed and this traffic will be diverted via York Street and Dock Street. Excavation of the underpass on Link A shall also be undertaken at this stage.

In order to construct Links D and J, it will be necessary to divert traffic on Nelson Street onto a temporary alignment. This will affect M2 and M3 traffic wishing to make the movement to the Westlink. With Great George Street closed, traffic will be diverted along Nelson Street, Great Patrick Street, York Street and back onto the Westlink.

Realigning the southbound carriageway of the Westlink to follow the new kerb line shall allow works on the central median wall and VCSB to be completed. Construction of the VCSB may need to be completed with overnight lane closures due to restricted working space on the northbound carriageway.

5.10.4.8 *Phase 8*

The eighth phase of traffic management is shown on **Drawing S105296-R-SK-C-308**. The underpasses for Links B and C shall be opened. This shall enable works to be completed on the York Street to M2 on-slip. These works are relatively minor mainly involving road markings to prevent traffic exiting the Westlink onto York Street from continuing straight onto the M2.

Link A would also be open at this stage including the link from Corporation Street.

In order to tie in Links D and J to the M3 off-slip, a weekend closure would be required to lower the levels by up to 700mm.

Works to convert Nelson Street to 2-way traffic and amendments to the junction on Dunbar Link could be completed with lane closures.

5.10.4.9 *Phase 9*

The ninth phase of traffic management is shown on **Drawing S105296-R-SK-C-309**. In order to construct Link I from Dock Street to M3, the existing link via Nelson Street shall be closed and traffic wishing to make this movement shall have to be diverted via the existing network.

Work to complete the access to DSD land adjacent to Nelson Street will be completed during this phase.

5.10.4.10 *Phase 10*

Phase 10 shown on **Drawing S105296-R-SK-C-310** illustrates the completion of outstanding works with the scheme fully opened for public use.

5.10.5 ***Option D***

5.10.5.1 *Phase 1*

The first phase of traffic management is shown on **Drawing S105296-R-SK-D-301**.

The temporary traffic management comprises the introduction of lane and hard shoulder closures to facilitate site clearance works and establishment of site offices and compounds.

Given that working space is severely limited, the team proposes the adoption of the lesser 0.5m safety clearance with narrow lanes in accordance with the exceptional provisions of paragraph D3.2.10 of Chapter 8 of the Traffic Signs Manual. In accordance with these provisions, a blanket 30mph limit and the permanent demarcation of the safety zone is required on the Westlink.

On the Westlink, a lane closure will be introduced on the northbound carriageway to allow the removal of existing vegetation on the embankment at the back of Little George's Street. It is proposed that the on-slip from Clifton Street be closed to permit access to the works zone.

On the M2, a hard shoulder closure will be introduced to permit site clearance works on the adjacent embankments. To accompany these site clearance works, the southbound bus lane on Nelson Street will require closure so that northbound traffic from Dock Street can be temporarily realigned.

5.10.5.2 *Phase 2*

The second phase of traffic management is shown on **Drawing S105296-R-SK-D-302**. During this phase service diversions shall be undertaken.

Road crossings at Dock Street and York Street could be facilitated with night closures. Closure of the bus lane on Nelson Street north of Dock Street will be required to carry out NIE diversion works. A lane closure may also be required on Great George Street.

Existing services in the footways along York Street may need to be lowered or protected in order to accommodate temporary realignments during the construction of the works.

5.10.5.3 *Phase 3*

The third phase of traffic management is shown on **Drawing S105296-R-SK-D-303**.

Garmoyle Street shall be converted to accommodate two-way traffic. Lane closures will be required to undertake these works which include construction of a central separation island. Once completed the new bus lane on Nelson Street shall remain closed.

In order to construct the pier on gridline I of the M2 to Westlink overbridge at the junction of Dock Street and Nelson Street, a lane closure is required on Nelson Street. Realignment of Nelson Street and the M2 off-slip at Nelson Street can be facilitated by the removal of the existing central reserve. This will allow piers at gridline E and F to be constructed. Localised realignment of York Street may be required to construct the piers at gridline C.

A lane closure on the Westlink will permit piling of a new retaining wall on the northern side of the Westlink. At this stage works adjacent to the southbound carriageway of the Westlink can commence including construction of replacement retaining walls and widening of North Queen Street Bridge.

When the piers are completed for the M2 to Westlink Overbridge, the bridge beams may be erected. Overnight closures will be required to lift beams over live carriageways.

A lane closure on Dock Street and on the M2 foreshore northbound would allow works to be carried out to tie the Westlink to M2 overbridge at the M2. These works involve demolition of part of the existing structure. Construction of piers from gridline E to I can be constructed at this stage.

5.10.5.4 *Phase 4*

The fourth phase of traffic management is shown on **Drawing S105296-R-SK-D-304**.

A hard shoulder closure on the M2 and the closure of Nelson Street north of Dock Street would allow construction of the remaining piers and abutment on the Westlink to M2 overbridge.

Traffic from the M2 and M3 heading for the Westlink would be diverted onto a temporary road across York Street and onto the northbound side of the existing Westlink. Traffic signals will be required to control the merging of the M2 and M3 traffic and also at the junction with York Street. This would enable construction of Link D and J from the M3. Upon completion of these works a weekend closure would be required to complete tie in works.

At this stage the embankment on the southbound carriageway of the Westlink would be constructed and all works to the M2 to Westlink overbridge completed.

The central median VCSB could be constructed on the Westlink although overnight lane closures may be required due to limited working space on the northbound carriageway.

5.10.5.5 *Phase 5*

The fifth phase of traffic management is shown on **Drawing S105296-R-SK-D-305**.

The M2 to Westlink overbridge shall be opened to traffic. At the southern end of the overbridge traffic will be moved into the hard shoulder and lane one. Temporary traffic signals may be required to allow traffic from the M3 to merge. At this point, traffic will run on the hard shoulder and lane gain, allowing construction of the remainder of the median barrier and placement of the remainder of fill where the temporary alignment had been located in phase 4.

In order to construct the remainder of the Westlink to M2 overbridge, all Westlink traffic will be diverted down the off-slip to York Street (Link G). Due to restricted width at the nosing of this off-slip, the raised verge should not be constructed to allow two 3m running lanes to use the off-slip. A temporary alignment for Westlink to M3 traffic between piers on gridline C and D will be required.

Work to construct the access along Shipbuoy Street and Little York Street can be completed at this stage along with the new link to Corporation Street. Works to convert Nelson Street to two way traffic and alterations to the junction at Dunbar Link would be completed using lane closures.

5.10.5.6 *Phase 6*

Phase 6 shown on **Drawing S105296-R-SK-D-306** illustrates the completion of outstanding works with the scheme fully opened for public use.

5.11 Buildability Assessment

5.11.1 *Introduction*

A buildability advisor was engaged to undertake a buildability assessment of the four Options to include:

- the review of engineering drawings to identify potential show-stoppers
- the identification of key construction issues and possible mitigation measures
- the review of TTM phasing drawings (to inform QUADRO modelling)
- the development and issue of feasible construction programmes
- the identification of value engineering opportunities
- the identification of key residual risks with regard to construction
- assisting the project team to summarise the overall assessment findings.

The appointed buildability advisor reviewed the information available and met with the project team on site to gain a further appreciation of the constraints experienced at the location. The advisor reported back to the project management team to confirm the presence of ‘showstoppers’, if any, and specific aspects of the work which represent key construction issues requiring further assessment at detailed design stage.

This response is summarised for each option in **Sections 5.11.2 to 5.11.5**.

5.11.2 *Option A*

5.11.2.1 *Potential Showstoppers*

The buildability advisor considered that there are no engineering challenges within the construction of Option A which cannot be overcome with good detailed design and planning.

5.11.2.2 *Key Construction Issues*

5.11.2.2.1 ***Underpass Construction***

The key activity is the construction of the M2 to Westlink underpass given the plant required, the slow rate of progress and the risk associated with a clash with the existing substructure. Based on the project team's investigations into the proposed underpass structure and the proposed method to deal with an errant pile, the works are considered feasible with careful site management and monitoring of the existing structures. An issue noted by the buildability advisor was the potential for a clash between the existing substructure and the diaphragm wall, based on the construction tolerances involved in both processes. Following the buildability workshop, the structures and geotechnics teams have reviewed the permissible tolerances for the construction of CFA piling and diaphragm walling, using the current version of Series 1600 of the Specification for Highway Works.

Further to the buildability assessment, the project team has researched the availability and lead-in times for the required low-headroom diaphragm wall rig (also known as a compact or mini cutter). It would appear that several established worldwide ground contractors can provide such equipment and have experience of its use in similar scenarios. From discussions with one of these groundworks contractors, it is noted that lead-in times are of the order of 3 months compared to the 18 months lead-in time for the 2,000t crane required for Options B and D.

5.11.2.2.2 ***Service Diversions***

The advisor highlighted the proposed and temporary service diversion work as a key construction issue that requires significantly more investigation and consultation with the utility companies.

Whilst the proposed permanent service diversions appear feasible, the advisor noted these works are often underestimated in their programming, given the level of co-ordination required between the contractor and the utility companies.

The advisor also identified that the temporary diversion of services during the works was a key construction issue which will require consideration at detailed design stage. The location of a number of services in the middle of the York Street/ Great George's Street junction adds further complication to maintaining services during construction. A service tunnel or bridge across the existing Westlink may be required and this should be confirmed with the utility companies.

It was noted that the proposed diversion of the twin 375mm diameter sewers running along York Street could be avoided if it can be confirmed that the service could be severed on either side of the bridge.

A suggestion offered by the advisor to remove/mitigate the risks associated with the service diversions was the use of an advance works contracts for the service diversions. However, it was recognised that this would be dependent on the form of contract used and could potentially limit a contractor's ability to programme their works in a more advantageous manner.

5.11.2.2.3 ***Ground Treatment***

The advisor noted the poor ground conditions at the site and the limited opportunity for the reuse of spoil as fill. Since nearly all spoil will be tipped off site, the advisor noted that the traffic disruption caused by temporary traffic management arrangements would increase travel times to and from the tip site for haulage vehicles, which would effectively dictate the rate of progress.

An issue raised by the advisor was the likely form of ground treatment, particularly for the support of embankments at York Street where considerable overburden will be added. The buildability advisor noted that this overburden could be reduced through the use of lightweight fill aggregates or expanded polystyrene blocks.

From a review of available ground investigation data, it would appear that the underlying Belfast Sleech and peat layers extend to a point somewhere between the Dargan Bridge and the Westlink. However, the team has insufficient information at this time to establish if it extends under York Street. Should these soft layers extend under York Street considerable ground treatment works will be required to support the embankment overburden. These treatment works may take the form of excavate and replace or ground improvement measures such as the use of lime/cement columns or controlled modulus columns (CMC).

Upon review, our structures and geotechnics teams consider that excavate and replace would only be appropriate at the site to a depth of 3m, whereas treatment depths are expected to be up to 12m. This leaves ground improvement as the most likely option for treatment, with the structures and geotechnics teams favouring lime/cement columns at this time.

In order to place the lime/cement columns, service diversions would require prior completion. Additional temporary traffic management arrangements (most likely additional off-peak full road closures) would also be required to provide sufficient working space to complete the operation.

Given the uncertainty surrounding the extent of the ground conditions at York Street, the project team's approach in the first instance will be to obtain additional ground investigation at the location at detailed design stage.

5.11.2.2.4 ***Construction Phasing and Duration***

The advisor considered that the outline temporary traffic management arrangements proposed by the team appear feasible at this time, but will ultimately be dictated by the contractor's requirements for working space and access. The most difficult operations within the proposed traffic management arrangements are considered to be the works to construct the underpasses and increasing the levels on York Street/Great George's Street on the approaches to the new overbridge whilst maintaining traffic flow through the existing junction. The advisor considers that this will take several consecutive weekend closures given the complexity of the operation. The suggested use of lightweight fills, or expanded polystyrene blocks, could assist this operation and merits further investigation.

Based on the outline temporary traffic managements arrangements proposed by the team, and the complexity of the works, the advisor considered that the works could take up to 36 months to complete.

5.11.3 ***Option B***

5.11.3.1 *Potential Showstoppers*

The buildability advisor considered that there are no engineering challenges within the construction of Option B which cannot be overcome with good detailed design and planning.

5.11.3.2 *Key Construction Activities*

5.11.3.2.1 ***Overbridge Construction***

The key activity is the construction of the M2 to Westlink bridge. Having looked at the proposed structural form (its geometry and the spans involved) the buildability advisor agreed with the project team that craning appears to be the most economical solution at this time. However, in order to lift the 90m main span a specialist pedestal crane (minimum 2,000t) would be required. There are only a limited number of cranes of this size available in Europe, most notably the 2,000t pedestal crane used recently for the M74 Auchenshuggle Bridge in Glasgow. Through subsequent discussions with parties involved in this contract, it is understood that the crane has a lead-in time of approximately 18 months. The buildability advisor highlighted the reliance on such a crane as the key construction issue with Option B and suggested further consideration of other techniques or span arrangements (including the use of additional temporary supports) to mitigate this.

The advisor considered that the area of land to the east side of this bridge provides sufficient working space to set up on-site splicing, such that the box girders can be factory fabricated and transported by road using heavy load transporters. This technique draws parallels from the recent M74 scheme in Glasgow, where the box girders for the Port Eglinton Viaduct were fabricated in halves under factory conditions and longitudinally welded once transported to site.

Following the buildability advisor's comments, the team consulted further with a bridge construction specialist to provide an additional insight into the issues surrounding the use of craned sections and potential ways to overcome them.

The specialist indicated that bridges to be built over existing transport infrastructure generally utilise pre-fabrication so that the main structural members can be erected during short road closures or railway possessions. The lengths of girders required for longer spans can be too long to transport to site in one piece so assembly into erection lengths is often required in situ.

The two possible erection methods are:

- launching a fully assembled length of steelwork, possibly with a section of deck slab pre-cast on to it, from one end
- the traditional method of erecting the steelwork by crane followed by construction of the deck slab.

5.11.3.2.2 ***Launching Considerations***

The specialist indicated that where erection by crane is possible this is usually the most economic method. Launching is generally reserved for situations where access into the spans is very limited or construction activities over live traffic must be minimised. For long viaducts a combination of these methods is often adopted.

Launching is generally considered suitable when the following conditions are met:

- the superstructure is straight or has constant horizontal curvature
- the superstructure has constant vertical alignment
- the superstructure has constant width
- the superstructure has a constant soffit profile.

Whilst the above conditions are the accepted convention, the specialist noted that it is not impossible to launch bridges where the above conditions are not met. However, having launch supports that must move transversely or be introduced/removed results in additional complexity into the equipment, temporary works and launch operations. Varying curvature or girder spacing can require a significant total transverse shift of the support position with the added complication that it must be adjusted continuously as the launch progresses. This is to be avoided if possible.

As noted above constant vertical curvature of the soffit is preferable but not essential. Even if the finished soffit profile is specified as a vertical curve of constant radius the steelwork must be fabricated to a shape that allows for the deflections of the spans in the finished condition. During the launch this shallow wave profile passes over supports generally at fixed levels. Depending on the position/longitudinal spacing of the supports this results in flexing of the steelwork to sit down on the supports or span between them. Varying the curvature of the finished soffit magnifies this effect and may result in overstress.

A solution is to vary the levels of the supports at intervals during the launch, and, depending on the height range needed, this can increase the complexity of the temporary works and equipment.

Haunched girders also pose particular problems. In general for a superstructure with a variety of spans, the haunches will not pass over the launch support all at the same time so very large changes in individual support levels are required to avoid overloading or tipping. Climbing supports are possible but complicated and expensive.

With regard to Option B and with particular attention to the M2 to Westlink structure, given the limited opportunity to change the geometry of the horizontal alignment, the specialist considered that 240m of the overall 575m (between gridlines C and F) had potential for launching using the areas of land between gridlines F and I for an assembly area (a 2-stage incremental launch would likely be required). However, in order to launch this section additional supports that move transversely and be introduced/removed would likely be required to overcome the geometry issues. At the same time the change in cross-sectional width between spans C to E and E to F would also likely require a significantly more complex construction process that would be reflected in significantly higher costs.

The specialist identified that if a launch erection method is to be used the detailed design process for a steel box girder/concrete composite superstructure must take account of this. The factors to consider include:

- bending moment at the root of the maximum cantilever
- web buckling over the launch support bearings
- the effect of precamber, tolerances and plan curvature on the support reactions during the launch
- forces in the vertical bracing between the boxes
- the distribution of steel and concrete dead loads in the finished structure.

Where part of the superstructure is launched the sequence and splice positions for erection of the rest by crane needs to be considered in the build-up of dead load stresses. The specialist further noted that whilst some of the above matters can be considered by the designer others require input from the contractor who is going to perform the launch.

5.11.3.2.3 ***Lifting Considerations***

As stated previously the specialist identified that lifting by crane is usually the most economic erection method for bridge steelwork even when this requires a very large crane. Viaducts are typically erected span by span starting from one or both abutments. The first lift would project beyond the first pier and each subsequent lift would be a full span, temporarily hung off the end of the previous one until completion of the permanent joint and projecting beyond the next pier.

For longer spans temporary intermediate trestles might be considered to reduce crane size, provided there are no ground obstructions. When the viaduct has one central longer span, erection may proceed from both abutments leaving a span girder as the final closure lift. If there are more than one of these long spans it may be necessary to erect the girder sections over the piers first, followed by infill span girders. Temporary trestles may be needed in this case.

The specialist noted that when considering the bridge spans envisaged in Option B, erection of the steel box girders would require a large crane. Preliminary sizing of the steelwork should be carried out to determine likely lift weights. Lift radii are determined by the availability of suitable areas to position the crane, and where the steelwork can be assembled into the erection lengths.

When checking suitable areas within the site it is important to consider:

- the assembly (in the horizontal position) of the main boom
- the ground conditions under the outriggers
- the swept path of super-lift (counterweight)
- access and egress to and from the site.

Catalogues of cranes are available that give charts of lift capacity against radius for various boom, jib and super-lift combinations. These can be used for an initial check of feasibility.

Both mobilisation and daily hire costs of a large crane are high, and the largest cranes are few in number. Careful planning of their use is therefore the key to economic erection. The number of mobilisations and moves should be kept to a minimum and all the pieces to be erected at each position must be assembled and ready so that the crane is not standing idle. The largest cranes must be booked well in advance.

During erection by crane the key issues are strength and stability of the steelwork during lifting, immediately after releasing the crane and during subsequent casting of the composite deck slab.

For long spans where crane capacity dictates lifting single girders the stability of the first one against lateral torsional buckling upon release of the crane needs careful consideration. In this regard box girders have an advantage over plate girders, but are likely to be heavier.

The advisor noted that careful consideration will need to be given to the proposed erection sequence and practical positions for air-splices, which can lead to complications in the erection. Such complications include level pre-sets to induce points of contraflexure at the air-splices and vertical jacking to induce the finished stress distribution assumed by the designer.

The specialist noted that for a long span bridge the erection method must be considered in the design. For example if the 90m road/rail span is to be lifted in by crane the positions of the air-splices for the closure span girders should be determined from crane studies. From a design point of view there is no real constraint on these positions. All that is needed is for the steelwork self-weight stresses to be determined from a stage-by-stage analysis that models the erection sequence instead of a simple continuous beam model.

5.11.3.2.4 ***Recommended Further Studies at Detailed Design Stage***

The specialist recommended that further studies should be undertaken to further examine the proposed craned solution at detailed design, including:

- the preliminary sizing of the steelwork.
- the identification of suitable areas on the site for ground assembly, trestles and cranes
- the completion of a tentative crane study using typical crane load/radius charts
- consultations with a steelwork contractor and/or one of the main crane hire companies.

Similarly, the following further studies were recommended to further examine a launched erection method at detailed design stage:

- reviewing the feasibility of crane erection
- determining the maximum length of structure that be assembled for launching within the site constraints
- reviewing the horizontal alignment to see if superstructure curvature and width changes can be moved off the likely launch section
- preliminary sizing of the steelwork, including the likely critical launch stages, to determine launch weights and reactions for equipment and temporary works cost estimating.
- consultations with appropriate authorities to determine constraints.

5.11.3.2.5 ***Service Diversions***

Given that much of the option reflects Option A, with the presence of the Westlink to M2/M3 underpass and a raised York Street alignment, the buildability advisor noted that the same issues with regard to services on Option A would equally apply to Option B.

5.11.3.2.6 ***Ground Treatment***

Whilst the removal of the M2 to Westlink underpass in Option B reduces the overall volume of unsuitable material to be disposed, the same issue of haulage to the disposal site noted for Option A applies to Option B.

As the York Street bridge is also included in Option B, the same issue of suitable ground treatment for Option A applies to Option B.

5.11.3.2.7 ***Construction Phasing and Duration***

The buildability advisor considered that the outline temporary traffic management arrangements proposed by the team appear feasible at this time. The advisor noted that the key issues would be increasing the levels on York Street/Great George's Street on the approaches to the new overbridge and the M3 to Westlink bridge, which would require several weekend closures to complete. Furthermore, the possessions required to lift in the sections of structure above the existing bridges will dictate construction progress for these elements of work, subject to availability of the required crane.

Based on the outline temporary traffic management arrangements proposed by the team, and the complexity of the works, the advisor considered that the works could take up to 36 months to complete.

5.11.4 *Option C*

5.11.4.1 *Potential Showstoppers*

The buildability advisor considered that there are no engineering challenges within the construction of Option C which cannot be overcome with good detailed design and planning.

5.11.4.2 *Key Construction Issues*

5.11.4.2.1 ***Service Diversions***

As the layout of Option C is similar to Option A, the issues with regard to service diversions in Option A can be considered to apply to Option C. A further complication is the requirement to divert services along Great George's Street, which will increase the complexity and duration of these operations.

5.11.4.2.2 ***Ground Treatment***

As the layout of Option C is similar to Option A, the issues with regard to suitable ground treatment for Option A apply equally to Option C. With the additional underpass in Option C, the increased volume of excavated material makes the option particularly sensitive to the issue of haul journey times described previously.

5.11.4.2.3 ***Construction Phasing and Duration***

The advisor considered that the outline temporary traffic management arrangements proposed by the team appear feasible at this time, but will ultimately be dictated by the contractor's requirements for working space and access. The most difficult operations within the proposed traffic management arrangements are considered to be the works to construct the underpasses and increasing the levels on York Street/Great George's Street on the approaches to the new overbridge whilst maintaining traffic flow through the existing junction. A further issue is the required lowering of the M3 to Westlink link under the Dargan Bridge on the existing off-slip whilst maintaining traffic movements. The advisor considers that these tie-in operations will take several consecutive weekend closures given their complexity. The suggested use of lightweight fills, or expanded polystyrene blocks, could assist the tie-in operations on York Street and merits further investigation.

Based on the outline temporary traffic management arrangements proposed by the team, and the complexity of the works, the advisor considered that the works could take up to 36 months to complete.

5.11.5 *Option D*

5.11.5.1 *Potential Showstoppers*

The buildability advisor considered that there are no engineering challenges within the construction of Option D which cannot be overcome with good detailed design and planning.

5.11.5.2 *Key Construction Issues*

5.11.5.2.1 ***Bridge Construction***

The issues with regard to lifting and launching of the M2 to Westlink bridge in Option B will apply to both the overbridge structures between the M2 and Westlink in Option D.

5.11.5.2.2 ***Service Diversions***

The limited numbers of service diversions required in Option D, compared to the other options, present no construction issues that cannot be overcome through careful planning and liaison with the relevant authorities.

5.11.5.2.3 ***Ground Treatment***

The provision of embankment structures in Option D require careful consideration of ground treatment measures to deal with the additional overburden on underlying strata, in a similar manner to Option A. Placing the required fill on the Westlink east of North Queen Street was highlighted as a particularly difficult operation that would require careful planning, with particular regard to temporary support during placement and compaction.

5.11.5.2.4 ***Construction Phasing and Duration***

The advisor considered that the outline temporary traffic management arrangements proposed by the team appear feasible at this time. The reduced number of traffic management layouts is considered by the advisor to offer a potential reduction in the overall construction duration.

Based on the outline temporary traffic managements arrangements proposed by the team, and the reduced works and risks from staying above existing ground level, the advisor considered that the works could take up to 30 months to complete.

5.12 Anticipated Departures from Standard

5.12.1 *Road Geometry*

A broad assessment of the key Departures from Standards TD 9/93, 27/05 and 22/06 has been undertaken for each of the options under assessment. A number of additional Departures from other Standards (TD 41/95, TD 42/95 and TD 50/04) have been identified relevant to the geometry of the proposed priority junctions and signal controlled junctions. Relaxations from Standard have not been identified at this time. This assessment has been carried out to a level of detail commensurate with their level of development. It is expected that the overall number of Departures for the Preferred Option selected will increase following more detailed design development.

The Departures for each option identified have been scheduled relative to the respective Standards and included in **Appendix D**. A summary for each option is presented in **Tables 5.12.1 to 5.12.4**.

TABLE 5.12.1: SUMMARY OF ROAD GEOMETRY DEPARTURES FROM STANDARD OPTION A

		No. of Departures per Link									
Standard	**Element**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
TD 9/93	Horizontal Radius (Hr)	0	0	1	1	0	0	0	0	0	0
	K Value	0	1	0	0	0	1	0	0	0	0
	Stopping Sight Distance (SSD)	0	1	0	0	0	2	0	0	0	0
	Combination of Hr/K /SSD	4	7	4	0	1	11	1	0	0	2
	Substandard K and/or SSD on approach to junction	6	13	5	2	4	11	3	2	2	2
	Superelevation	0	0	0	0	0	0	0	0	0	0
	Transition Lengths	0	0	1	0	0	1	1	0	0	1
	Sub-Total	***10***	***22***	***11***	***3***	***5***	***26***	***5***	***2***	***2***	***5***
	Sub-Total(for Option)	***91***									
TD 27/05	Cross-Section	1	1	1	1	0	1	1	1	1	0
TD 22/06	Grade Separated Junction Design	12	7	5	0	0	3	0	0	3	0
TD 41/95	Direct Access Design	0	0	0	0	1	0	0	0	0	0
TD 42/95	Priority Junction Design	0	0	0	0	0	1	0	0	0	0
	Total (per Link)	**23**	**30**	**17**	**4**	**6**	**31**	**6**	**3**	**6**	**5**
	Total (for Option)	**131**									

TABLE 5.12.2: SUMMARY OF ROAD GEOMETRY DEPARTURES FROM STANDARD OPTION B

		No. of Departures per Link									
Standard	**Element**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
TD 9/93	Horizontal Radius (Hr)	0	0	1	0	0	0	0	0	0	0
	K Value	0	1	0	0	0	1	0	0	0	0
	Stopping Sight Distance (SSD)	1	1	0	2	0	2	0	0	0	0
	Combination of Hr/K /SSD	7	7	4	12	1	11	1	1	0	1
	Substandard K and/or SSD on approach to junction	11	13	5	18	4	11	3	2	2	1
	Superelevation	0	0	0	0	0	0	0	0	0	0
	Transition Lengths	0	0	1	1	0	1	1	0	0	0
	Sub-Total	***19***	***22***	***11***	***33***	***5***	***26***	***5***	***3***	***2***	***2***
	Sub-Total(for Option)	***128***									
TD 27/05	Cross-Section	1	1	1	1	0	1	1	1	1	1
TD 22/06	Grade Separated Junction Design	13	7	5	2	0	2	0	0	3	1
TD 41/95	Direct Access Design	0	0	0	0	1	0	0	0	0	0
TD 42/95	Priority Junction Design	0	0	0	0	0	1	0	0	0	0
	Total (per Link)	**33**	**30**	**17**	**36**	**6**	**30**	**6**	**4**	**6**	**4**
	Total (for Option)	**172**									

TABLE 5.12.3 SUMMARY OF ROAD GEOMETRY DEPARTURES FROM STANDARD OPTION C

		No. of Departures per Link									
Standard	**Element**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
TD 9/93	Horizontal Radius (Hr)	0	0	1	0	0	0	0	0	0	1
	K Value	0	1	0	0	0	1	0	0	0	0
	Stopping Sight Distance (SSD)	0	1	0	2	0	2	0	0	0	0
	Combination of Hr/K /SSD	4	7	4	7	1	11	1	0	0	0
	Substandard K and/or SSD on approach to junction	6	13	5	10	4	11	3	2	2	2
	Superelevation	0	0	0	0	0	0	0	0	0	0
	Transition Lengths	0	0	1	1	0	1	1	0	0	0
	Sub-Total	***10***	***22***	***11***	***20***	***5***	***26***	***5***	***2***	***2***	***3***
	Sub-Total(for Option)	***106***									
TD 27/05	Cross-Section	1	1	1	1	0	1	1	1	1	1
TD 22/06	Grade Separated Junction Design	12	7	5	3	0	2	0	0	3	1
TD 41/95	Direct Access Design	0	0	0	0	1	0	0	0	0	0
TD 42/95	Priority Junction Design	0	0	0	0	0	1	0	0	0	1
	Total (per Link)	**23**	**30**	**17**	**24**	**6**	**30**	**6**	**3**	**6**	**6**
	Total (for Option)	**151**									

TABLE 5.12.4: SUMMARY OF ROAD GEOMETRY DEPARTURES FROM STANDARD OPTION D

		No. of Departures per Link									
Standard	**Element**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
TD 9/93	Horizontal Radius (Hr)	0	0	0	0	0	0	0	0	0	0
	K Value	0	2	0	0	0	3	0	0	0	0
	Stopping Sight Distance (SSD)	1	3	0	2	0	2	0	0	0	0
	Combination of Hr/K /SSD	7	12	0	12	0	11	2	1	0	1
	Substandard K and/or SSD on approach to junction	11	16	0	18	0	11	2	2	0	1
	Superelevation	0	0	0	0	0	4	1	0	0	0
	Transition Lengths	0	2	0	1	0	3	2	0	0	0
	Sub-Total	***19***	***35***	***0***	***33***	***0***	***34***	***7***	***3***	***0***	***2***
	Sub-Total(for Option)	***133***									
TD 27/05	Cross-Section	1	1	0	1	0	0	1	1	0	1
TD 22/06	Grade Separated Junction Design	13	4	0	2	0	2	0	0	0	1
TD 41/95	Direct Access Design	0	0	0	0	1	0	0	0	0	0
TD 42/95	Priority Junction Design	0	0	0	0	0	0	0	0	0	0
	Total (per Link)	**33**	**40**	**0**	**36**	**1**	**36**	**8**	**4**	**0**	**4**
	Total (for Option)	**162**									

In order of the number of Departures required, the options can be ranked, from highest to lowest, in the following order:

- Option B
- Option D
- Option C
- Option A.

5.12.2 ***Drainage***

Figures 2.1.7 to 2.1.8 inclusive show that each of the scheme options has an impact of some nature on the River Lagan estuarine and coastal floodplain as recognised and defined by DARD Rivers Agency in their Strategic Flood Mapping. Preliminary drainage assessment and design work has been undertaken on the project in relation to the potential effects which the scheme may have on the existing floodplain and correspondingly the potential effects that the existing floodplain may have on the proposed scheme. The outcome of this work to date suggests that all of the currently proposed future scheme options under consideration fail to comply with the requirements of HD 45/09 paragraph 2.37.

A Departure from Standard is therefore likely to be required.

HD 45/09 Road Drainage and the Water Environment within Volume 11 Section 3 of DMRB, paragraph 2.37 requires that;

'*Transport infrastructure in the functional floodplain must be designed and constructed to:*

i) remain operational and safe for users in times of flood;

ii) result in no net loss of floodplain storage;

iii) not impede water flows; and

iv) not increase flood risk elsewhere.'

Further assessment and design development will be undertaken to mitigate the impacts at subsequent design stages. However because of the proximity of the River Lagan and Belfast Lough it is not anticipated that full compliance with the requirements of paragraph 2.37 is possible. It should be noted that it may be possible to comply with part i) of HD 45/09, however achieving this is likely to preclude compliance with part ii). Further design and assessment works and consultation with relevant third parties will be carried out to establish whether parts iii) and iv) can and will be achieved.

5.12.3 ***Structures***

No Departures from Standard for the structures are envisaged at this time.

6 ENVIRONMENTAL ASSESSMENT

6.1 Introduction

This section provides an Environmental Assessment of the preferred options identified from the Stage 1 'Preliminary Options Report' published in March 2009. As noted in **Section 1.1**, URS has been commissioned by DRD Roads Service to:

- undertake a DMRB Stage 2 Scheme Assessment of these options
- prepare a DMRB Technical Directive (TD) 37/93 Stage 2 Scheme Assessment Report (the "Preferred Options Report").

The environmental assessment process has been undertaken, managed and compiled by URS and this section of the Stage 2 Scheme Assessment Report prepared in accordance with the guidelines detailed in DMRB Volume 11, which sets out the methods to be used and the level of detail required when assessing the environmental aspects under consideration. Assessment of major road schemes can be summed up in the following three stages:

- **Stage 1 Assessment** – identification of the environmental, engineering, economic and traffic advantages, disadvantages and constraints associated with broadly defined improvement strategies. This concludes in the selection of a number of potential routes or scheme options.
- **Stage 2 Assessment (current stage)** – identification of the factors to be taken into account in choosing alternative routes or improvement schemes and to identify the environmental, engineering, economic and traffic advantages and constraints associated with those routes or schemes. This concludes in the selection of a preferred route or scheme option.
- **Stage 3 Assessment** – clear identification of the advantages and disadvantages, environmental, engineering, economic and traffic terms of the preferred route or scheme option. A particular requirement at this stage is an assessment of the significant environmental effects of the project, in accordance with the requirements of Part V of The Roads (Northern Ireland) Order 1993 as substituted by the Roads (Environmental Impact Assessment) Regulations (Northern Ireland) 1999 and amended by The Roads (Environmental Impact Assessment) Regulations (Northern Ireland) 2007, implementing EC Directive 85/337/EEC as amended by Council Directive 97/11/EC and 2003/35/EC.

6.1.1 *Design Manual for Roads and Bridges*

Volume 11 of DMRB provides the methodology for the environmental assessment of the options under consideration. The relevant sections from DMRB applied to the assessment are described below and referenced in each of the technical Sub-Sections within **Section 6** of this report. DMRB is occasionally updated to take account of changes in policy and best practice. Where applicable, changes have been fully incorporated into the assessment methodology.

6.1.1.1 *Stage 2 Environmental Impact Assessment*

In August 2008, DMRB Volume 11, Section 1, Part 1 (Aims and Objectives of Environmental Assessment (HA 200/08)) amended the 'Stage 1, 2 & 3' approach to EIA, to instead ensure that the level of environmental assessment undertaken is appropriate to the project, irrespective of what stage in the design process the project is at. The overall objective is to define the depth of assessment necessary to enable informed decision making at as early a stage of the project as possible. It necessitates a 'fit-for-purpose' assessment method and relies on four 'Assessment Levels' as detailed below:

- Scoping

- Simple
- Detailed
- Mitigation/enhancement and monitoring.

For ease of reference, this report has retained the term ‘Stage 2 Environmental Assessment’. Although this document may refer to both assessment methods, the outcome of the assessment has not been affected.

6.1.1.2 *Revision to Environmental Assessment Sub-Structure*

Current guidance in DMRB Volume 11, Section 2, Part 6 HD48/08, Chapter 1, and Interim Advice Note (IAN 125/09), recommends that the topics of ‘Disruption due to Construction’ and ‘Policies and Plans’ are reported under their respective technical Sub-Sections. Therefore, this approach has been adopted within the structure of this Report. Relevant predicted construction impacts and subsequent mitigation is reported in each technical Sub-Section (**6.2 – 6.11**). In a similar vein, relevant polices & plans are discussed under ‘Regulatory/Policy Framework’ within each technical Sub-Section.

With reference to DMRB Volume 11, Section 1, Part 1, Chapter 1, the structure of DMRB Volume 11 is currently being revised and alterations made to the DMRB Environmental Assessment Techniques. This Report embraces the new assessment methodology included in revised sections of DMRB Volume 11, and continues to use extant assessment methodology (where appropriate), included in still to be revised sections of DMRB Volume 11.

Table 6.1.1 identifies the revised IAN 125/09 section structure and the section structure for this report, with the corresponding Sub-Sections and location of particular assessment information. This divergence in structure has not affected the outcome of the Environmental Assessment.

TABLE 6.1.1: COMPARISONS OF REVISED IAN 125/09 SECTION STRUCTURE AND SECTION STRUCTURE FOR THIS REPORT

Suggested Sub-Section Structure (IAN 125/09 Format)	York Street Interchange Environmental Assessment Sub-Section Structure
Air Quality	Air Quality
Cultural Heritage	Cultural Heritage
Landscape	Landscape Effects
Nature Conservation	Ecology & Nature Conservation
Geology and Soils	Geology & Soils
Materials	Geology & Soils
Noise and Vibration	Noise and Vibration
Effects on all Travellers	Pedestrians, Cyclists, Equestrians& Community Effects; Vehicle Travellers
Community and Private Assets	Pedestrians, Cyclists, Equestrians & Community Effects; Land Use
Road Drainage and the Water Environment	Road Drainage & the Water Environment

Source: DMRB 11.1.1.1 (Table 1.1 Structure of DMRB Volume 11 Environmental Assessment)

It has been agreed with Roads Service that the assessment of ‘Disruption due to Construction’ and ‘Policies and Plans’ be incorporated into each of the technical sub-sections within Section 6 and not reported individually.

6.1.1.3 *Approach and Methods*

This Section has been prepared in accordance with DMRB, Volume 11 (Environmental Assessment). Details of the methodology used in the assessment of each environmental topic have been included in the individual Sub-Sections.

Each Sub-Section follows the same general format as follows:

- **Introduction**: a brief summary of what is considered/assessed in the Sub-Section;
- **Methodology**: describing the methodology that has been used in the assessment of the environmental topic;
- **Regulatory/Policy Framework**: short summary of legislation and planning policy pertinent to the assessment of the environmental topic;
- **Baseline Conditions**: a description of the existing environmental conditions against which the predicted environmental impacts have been assessed, including an assessment of value/sensitivity of environmental receptors/assets;
- **Predicted Impacts**: identification of predicted impacts resulting from the operation and construction of the options under consideration and assessment of impact magnitude;
- **Mitigation & Enhancement Measures**: recommendations for measures to avoid, offset or reduce the identified adverse impacts associated with any of the options under consideration;
- **Residual Impacts**: assessment of significance of effects after consideration of mitigation measures; and
- **Summary & Conclusions**: a summation of main effects associated with the options assessed.

6.1.1.4 *Assessment of Predicted Impacts and Residual Impacts (Significance of Effects)*

Predicted impacts associated with the options under consideration have been identified, magnitude of impact described, and an assessment of the level of significance for each effect determined, within the assessment of each environmental topic.

The determination of the significance of effects is a key stage in the EIA process. In general, impact significance has been defined using a combination of the Sensitivity (e.g. High, Medium or Low) of the environmental feature, and the Magnitude of impact (e.g. Major, Moderate, Minor or Negligible) where appropriate. The criteria for assessing Sensitivity and Magnitude level have been defined for each environmental topic in the appropriate sub-sections of Section 6. The overall significance of an impact, considering the relationship between sensitivity and the magnitude level, is also defined for each environmental topic.

6.1.1.4.1 ***Sensitivity (or Value)***

Sensitivity has generally been defined according to the relative value or importance of the feature, (i.e. whether it is of international, national, regional or local importance; by the sensitivity of the receptor in the case of the air quality and noise assessment; or by susceptibility or vulnerability to change in the case of landscape and visual aspects).

The typical criteria for assessing the sensitivity of an environmental receptor are described in **Table 6.1.2** below. It should be noted that there are variations in how sensitivity is assessed, depending on whether an existing framework for sensitivity exists. Moreover, not all of the environmental sensitivity and typical descriptions have necessarily been adopted, as not all features assessed within each Sub-Section would necessarily warrant the application of each sensitivity rating.

TABLE 6.1.2: ENVIRONMENTAL SENSITIVITY AND TYPICAL DESCRIPTIONS

Value (Sensitivity)	Typical descriptors
Very High	• Very high importance and rarity, international scale and very limited potential for substitution.
High	• High importance and rarity, national scale, and limited potential for substitution.
Medium	• High or medium importance and rarity, regional scale, limited potential for substitution.
Low (or Lower)	• Low or medium importance and rarity, local scale.
Negligible	• Very low importance and rarity, local scale.

Source: DMRB 11.2.5.2 (Table 2.1 Environmental Value (or Sensitivity) and Typical Descriptors)

6.1.1.4.2 ***Magnitude of Impact***

Typical descriptions and criteria for defining Magnitude of Impact are described in **Table 6.1.3** below.

TABLE 6.1.3: MAGNITUDE OF IMPACT AND TYPICAL DESCRIPTION

Magnitude of impact	Typical criteria descriptors
Major	• Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse). • Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial).
Moderate	• Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements (Adverse). • Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial).
Minor	• Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (Adverse). • Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial).
Negligible	• Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse). • Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial).
No change	• No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Source: DMRB 11.2.5.2 (Table 2.2 Magnitude of Impact and Typical Descriptors)

6.1.1.4.3 ***Assessing Significance***

With reference to DMRB Volume 11, Section 2, Part 5 HA205/08, Chapter 2 (Determining Significance of Environmental Effects), the approach to assigning significance of effect relies on reasoned argument, professional judgement and taking on board the advice and views of appropriate organisations. For some disciplines, predicted effects may be compared with quantitative thresholds and scales in determining significance. Assigning each effect to one of the five significance categories enables different topic issues to be placed upon the same scale, in order to assist the decision-making process. These five significance categories are set out in **Table 6.1.4** below.

TABLE 6.1.4: SIGNIFICANCE CATEGORIES

Significance category	Typical criteria descriptors
Very Large	Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
Large	These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
Moderate	These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.
Slight	These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Source: DMRB 11.2.5.2 (Table 2. 3 Descriptors of the Significance of Effect Categories)

With reference to DMRB 11.2.5.2, it is important to note that significance categories are required for positive (beneficial) as well as negative (adverse) effects. The five significance categories give rise to eight potential outcomes. Applying the formula, the greater the environmental sensitivity or value of the receptor or resource, and the greater the magnitude of impact, the more significant the effect. The consequences of a highly valued environmental resource suffering a major detrimental impact would be a very significant adverse effect. The typical significance categories are presented in **Table 6.1.5** below.

TABLE 6.1.5: EXAMPLE MATRIX FOR DETERMINING SIGNIFICANCE OF EFFECTS

SENSITIVITY						
	Very High	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Medium	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
	Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
	Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
		MAGNITUDE OF IMPACT (Degree of Change)				

With reference to DMRB 11.2.5.2, change can be either beneficial or adverse, and effects can also, therefore, be either beneficial or adverse. In some cases above, the significance is shown as being one of two alternatives. In these cases a single description should be decided upon, with reasoned professional judgement for that level of significance chosen.

The significance is assigned after consideration of the effectiveness of the design and committed mitigation measures, allowing for the positive contribution of all mitigation that is deliverable and committed.

DMRB Volume 11, Section 3 guidance for the environmental assessment techniques reported in the individual technical Sub-Sections of Section 6, provides advice on the significance criteria for individual topics. Where necessary, the description of the criteria has been adjusted to reflect the specific effects that a project may generate, but the overall criteria levels have not been adjusted. As noted earlier, the structure of DMRB Volume 11 is currently being revised and alterations made to the DMRB Environmental Assessment Techniques. This Report embraces the new assessment methodology included in revised sections of DMRB Volume 11, and continues to use extant assessment methodologies (where appropriate), included in still to be revised sections of DMRB Volume 11. For those assessment methodologies that have not been updated, DMRB does not describe how the significance of effects should be scaled. In these cases, professional judgement and awareness of the relative balance of importance between sensitivity and magnitude allows the overall significance of impact to be assessed.

As noted earlier, the environmental topics assessed in relation to the various scheme options are considered in the following Sub-Sections:

- 6.2 Air Quality
- 6.3 Cultural Heritage
- 6.4 Ecology & Nature Conservation
- 6.5 Landscape Effects
- 6.6 Land Use
- 6.7 Noise & Vibration
- 6.8 Pedestrian, Cyclist, Equestrian & Community Effects
- 6.9 Vehicle Travellers
- 6.10 Road Drainage & the Water Environment
- 6.11 Geology & Soils.

6.2 Air Quality

6.2.1 *Introduction*

This section reports on the predicted effects of the various scheme layout options on Air Quality. The scheme would potentially affect air pollutant concentrations due to changes in magnitude of road traffic emissions, as experienced by residents of properties in the vicinity of the scheme, as well as residents in the vicinity of affected roads throughout the wider network. The wider change in emissions of pollutants of relevance to Regional air quality is also considered.

Compounds released to the air by motor vehicles, both Light Duty Vehicles (LDV), including cars and small vans, and Heavy Duty Vehicles (HDV) including buses, rigid and articulated lorries, result in a variety of environmental effects. Emitted pollutants are dispersed by wind following emission into the atmosphere. The concentration of these pollutants in the air at a given location varies throughout the day depending on traffic volume, traffic speeds and meteorological conditions. The pollutants emitted by road vehicles are also produced by a wide range of industrial, commercial and domestic processes within the Belfast Metropolitan

Area. The background concentrations of these pollutants may be locally raised by emissions from road traffic on nearby roads. The pollutants of most concern near roads are Nitrogen Dioxide (NO_2) and Particulates (PM_{10} and $PM_{2.5}$) in relation to human health and Oxides of Nitrogen (NO_x) in relation to vegetation and ecosystems.

The incomplete combustion of fuel in vehicle engines results in the presence of hydrocarbons (HC) such as benzene and 1,3 butadiene, and CO and PM_{10} in the exhaust emissions. In addition, at the high temperatures and pressures found in vehicle engines, some nitrogen in the air and in the fuel is oxidised to form Oxides of Nitrogen (NO_X) mainly in the form of Nitric Oxide (NO), which is then converted to NO_2 in the atmosphere. Carbon Dioxide (CO_2) is produced by vehicle engines, as in any combustion process. Whilst CO_2 is not considered a concern at a local scale, it is a concern at a regional scale as a greenhouse gas, contributing to the phenomenon of climate change. Better emission control technology and fuel specifications are expected to reduce emissions of pollutants per vehicle over time.

Road projects are primarily aimed at reducing congestion, improving journey times and road user safety. Measures that reduce congestion normally also reduce emission of air pollutants, as emission rates are typically highest when vehicles are driven in congested stop/start conditions. Where road projects have aims that are not directly aimed at improving local air quality, changes to air quality is still considered and a scheme can normally be brought forward even if the effects are largely neutral.

The principal objective of the air quality assessment at this secondary stage is to indicate whether there are likely to be significant air quality impacts associated with any of the interchange options (A-D) under consideration, by comparing the Do-Minimum scenario with the Do-Minimum alternative.

6.2.1.1 *Previous Studies*

Air quality impacts associated with the scheme have been previously assessed and reported in the Stage 1 York Street Interchange Preliminary Options Report: Volume 1; March 2009 (S105296/G/01/03/PRR1), Section 6.2 Air Quality.

Belfast City Council has also undertaken work on the impact on local air quality within the M1-Westlink Air Quality Management Area (AQMA) in the following reports:

- Detailed Air Quality Assessment 2007
- Detailed Air Quality Assessment 2010.

6.2.1.2 *Scope of this Assessment*

During the construction phase, there is potential for construction-related activities to generate fugitive emissions of particulate matter (dust and PM_{10}). There is the risk of such emissions giving rise to significant adverse effects on amenity and/or health of receptors located within 100m of the source unless appropriate mitigation measures are adopted. As there are receptors located within 100m of the scheme, an assessment of the significance of effects from such emissions has been undertaken.

The operational impacts of the scheme on air quality are all associated with emissions from road traffic. Predicted flows and speeds for both LDVs and HDVs, for sections of road (referred to as links) have been used as the basis for this assessment. Two assessments have been carried out to determine how these emissions would affect both local air quality sensitive receptors and the wider environment:

- at the local scale, this assessment focuses on annual mean concentrations of the pollutants; nitrogen dioxide (NO2) and particulate matter (PM10 and PM2.5); plus hourly mean NO2 concentrations and the 24-hour mean PM10 concentration
- at the regional scale, the total quantity of oxides of nitrogen (NOx), PM10, CO and Total HydroCarbons (THC) produced with and without the scheme has been calculated. The total quantity of carbon dioxide (CO2) that would be produced by the various options has been used as an indicator of the impact on climate change.

During the operational phase, a major component of emissions from road traffic is particulate matter within the size fraction of 2.5µm, therefore justifying why the impact of the scheme on local annual mean concentrations of $PM_{2.5}$ is assessed.

Hourly mean NO_2 concentrations are only considered to be at risk of exceeding the respective limit value when annual mean concentrations of NO_2 are above 60 µg/m^3 at a particular location. As annual mean concentrations of NO_2 have been shown to be at risk of exceeding this value within the study area, the assessment of impacts of hourly mean NO_2 concentrations have also been considered.

There are no designated nature conservation sites within close proximity to the study area and therefore it has not been necessary to consider the impact of operational emissions on such sites.

The significance of effect on local air quality is based on the change in the predicted pollutant concentrations at each receptor, with and without the scheme, and by comparison with the relevant UK air quality assessment criteria/limit values. The significance of effect at a regional scale and on climate change is based on the change in the predicted total quantity of pollutants emitted with and without the scheme.

A DMRB ‘Detailed’ assessment of air quality impacts has been undertaken for the four interchange options under consideration at this stage.

6.2.2 *Methodology*

6.2.2.1 *Overview*

With regard to the assessment of operational phase impacts, a review of baseline air quality within the local area has been undertaken in **Section 6.2.4** and found that certain locations within the study area are at risk of exceeding the annual mean NO_2 limit value. Detailed modelling has been undertaken, as stated within Appendix B of the Air Quality Report (**Appendix E** of this report), for the Do-Minimum and the Do-Minimum scenarios for each options under consideration. The results for each scenario are presented in **Section 6.2.5.1.2**. The change in the predicted concentrations as a result of the implementation of each option is compared to the significance criteria in **Section 6.2.2.4** in order to assess the impact on local air quality of each interchange option.

The assessment considers the significance of potential effects with standard mitigation in place (where necessary) and recommends mitigation measures appropriate to the identified risks to receptors.

6.2.2.2 *Air Quality Sensitive Receptors*

6.2.2.2.1 ***Potentially Sensitive Receptors during the Construction Phase***

When assessing the impact of dust emissions generated during the construction phase, receptors are defined as the nearest potentially sensitive receptor to the boundary of the site in each direction. They have the potential to experience impacts of greater magnitude due to emissions of particulate matter generated by works, when compared with more distant or less sensitive receptors.

There are a number of receptors that are considered to be sensitive to dust in the immediate vicinity of the proposed scheme. These receptors include the existing residential properties on Little George's Street and North Queen Street (to the north of Westlink) and Great George's Street, Thomas Street and North Queen Street (to the south of Westlink). Some receptors (R1 – R3 and R11 – R13) have also been used in the assessment of impacts from road traffic exhaust emissions and these receptors are also included in **Table 6.2.1**. The location of these receptors is illustrated on **Figure 6.2.1**.

6.2.2.2.2 ***Potentially Sensitive Receptors during the Operational Phase***

The concentration of road traffic emitted pollutants at the roadside or at sensitive receptors is influenced by a number of factors. These include background pollution levels and the amount of traffic emissions, which is dictated by traffic flow rates, composition and speed.

The UK air quality objective values for pollutants associated with road traffic emissions have been set by the Expert Panel on Air Quality Standards. They have been set at a level below the lowest concentration at which the more sensitive members of society have been observed to be adversely affected by exposure to each pollutant. Therefore all receptors that represent exposure of the public are of equal sensitivity as any member of the public could be present at those locations.

The locations of all sensitive receptors surrounding the proposed scheme selected for modelling have also been identified on **Figure 6.2.1**. All surrounding receptor locations have been considered relevant due to the detailed nature of the assessment being undertaken, as stated within Appendix B of the Air Quality Report (**Appendix E** of this report).

The impacts from road traffic emissions have been quantified at eighteen representative receptor locations, chosen to represent the maximum level of exposure that would be experienced at other sensitive receptors within their vicinity. They have been selected as they are in close proximity to the various scheme options and parts of the wider local road network, (where there is the potential for variation in road traffic flows). The details of the selected receptors are listed in **Table 6.2.1**, with all modelled at a height of 1.5 m.

TABLE 6.2.1: AIR QUALITY SENSITIVE RECEPTORS			
Receptor	Description	Irish Grid Reference (IGR)	
		X	Y
R1	47 Little George's Street	334008	375235
R2	17 Little George's Street	333883	375232
R3	97 / 99 North Queen Street	333794	375254
R4	14 North Hill Street	333935	375296
R5	40 North Queen Street	333804	375324
R6	62 Carlisle Road	333603	375246
R7	78 North Queen Street	333894	375496
R8	108 North Queen Street	333954	375616
R9	13 Bentinck Street	334053	375628
R10	28 to 34 Stella Maris, Garmoyle St	334365	375395
R11	2 Thomas Street	333931	375122
R12	1 Portland Place, Great George's Street	333887	375144
R13	56 North Queen Street	333762	375195
R14	10 North Queen Street	333682	375111
R15	48 Lancaster Street	333725	375120
R16	1 Lancaster Street	333936	375037
R17	205 Donegall St	333672	374989
R18	3 Clifton House Mews	333587	375173

6.2.2.3 *Impact Assessment Methodology*

6.2.2.3.1 ***Construction Phase Impacts***

At present, there are no statutory UK or EU standards relating to the assessment or control of nuisance dust. The emphasis of regulation and control of demolition and construction dust should therefore be the adoption of good working practice on site. This is a process that is informed by impact assessments and is able to avoid the potential for significant adverse environmental effects at the design stage. This approach assumes that mitigation measures, beyond those inherent in the proposed design, identified as being necessary in the impact assessment, will be applied during works (possibly secured by planning conditions, legal requirements or required by regulations) to ensure potential significant adverse effects are avoided.

A qualitative assessment methodology has been adopted that considers (where necessary) the potential for suggested mitigation measures to provide the required level of protection at sensitive receptors. With reference to the Construction Industry Research and Information

Association (CIRIA) guidance document 'C692 Environmental good practice on site' (3RD edition) 2010, common sources of dust, emissions and odours are:

- unpaved haul roads
- mud on public roads
- tipping
- uncovered vehicle movements
- material stockpiles
- cutting, grinding and drilling operations
- blasting
- earthworks.

6.2.2.3.2 ***Operational Phase Road Traffic Emissions***

The assessment of the air quality impacts of the scheme has been carried out following the approach set out in the DMRB 11.3.1 (HA207/07) and the magnitude of air quality impacts are predicted in two ways:

- Local impact assessment: Pollution concentrations for annual mean NO2, PM10, PM2.5, hourly mean NO2 and 24-hour mean PM10 have been predicted, based upon the 'Detailed' assessment methodology within DMRB 11.3.1.3 for the Do-Minimum and Do-Something scenarios for each scheme option in the Assumed Year of Opening (2020).
- Regional impact assessment: predicts the total quantity of NOx, PM10, CO, CO2 and THC (Total HydroCarbons) produced in the existing year (2010), assumed first year of operation (2020) with and without the scheme, and the project design year (2034) - 15 years after opening, with and without the scheme.

6.2.2.3.3 ***Local Impact Assessment***

The Local impact assessment has been carried out using the dispersion modelling software ADMS-Roads to predict pollutant concentrations at sensitive receptors within the study area. The technical details of the air quality modelling undertaken for this assessment are presented within Appendix B of the Air Quality Report (**Appendix E** of this report).

6.2.2.3.4 ***Regional Impact Assessment***

The Regional air quality impact assessment has been carried out for the years 2010, 2020 and 2034, using traffic data and emission factors for these years. CO_2 (expressed as carbon) is included to enable the contribution of the scheme to climate change to be assessed. The magnitude of the impact, in terms of the total quantity of pollution generated by affected roads in the Traffic Model study area, has been predicted using the method set out in DMRB 11.3.1.3.

6.2.2.4 *Assessing the Significance of Effects*

6.2.2.4.1 ***Construction Phase Emissions Significance Criteria***

For amenity effects (including dust deposition), the aim is to bring forward a scheme, including mitigation measures (if necessary), that does not introduce the potential for additional complaints to be generated as a result of the proposed development. Determination of whether an effect is considered to be significant is based on professional judgement, taking account of whether effects are considered to be positive or negative, permanent or temporary, direct or indirect, the duration/frequency of the effect, and whether any secondary effects are caused.

The scale of the risk of adverse effects occurring during construction works, with mitigation in place is described using the terms High, Medium and Low risk. The basis for the choice of descriptor is set out for each section. Experience in the UK is that good site practice is capable of mitigating the impact of fugitive emissions of particulate matter effectively, so that in all but the most exceptional circumstances, effects at receptors (**Table 6.2.2**) can be controlled to ensure effects are of Negligible or Minor significance at worst.

TABLE 6.2.2: DESCRIPTORS APPLIED TO THE PREDICTED ADVERSE EFFECTS OF FUGITVE EMISSIONS OF PARTICULATE MATTER

Significance of Effect at Single Receptor	Description
Major	Impact is likely to be intolerable for any more than a very brief period of time and is very likely to cause complaints.
Moderate	Impact is likely to cause annoyance and might cause complaints, but can be tolerated for a short period of time if prior warning and explanation has been given.
Minor	Impact may be perceptible, but of a magnitude or frequency that is unlikely to cause annoyance to a reasonable person or to cause complaints.
Negligible	An effect that is not a significant change.

6.2.2.4.2 ***Operational Road Traffic Emissions Significance Criteria***

The significance of impacts on local air quality is achieved by using the recommendations published by the Institute of Air Quality Management (IAQM) and Environmental Protection UK (EPUK) for describing the magnitude and impact at individual receptors, as presented in **Tables 6.2.3 - 6.2.5**. These have been used in place of a matrix of significance criteria within DMRB HA 205/08. The air quality impact descriptors are consistent with the five significance categories set out within HA 205/08, and by considering the magnitude of change in air pollutant concentrations in relation to the impact descriptors, reference may be made directly to the UK National Air Quality Standards, which are significance criteria of direct relevance to the issues under consideration.

For all receptors, the principal assessment criteria for nitrogen dioxide (NO_2) are annual mean and hourly mean concentration values, as set out in the UK National Air Quality Strategy (**Table 6.2.6**). The principal assessment criteria for particulate matter (PM_{10} and $PM_{2.5}$) are the annual mean concentration values and the number of days exceeding the 24 hour mean PM_{10} objective value, as set out in **Table 6.2.6**. Local residents should be exposed to air pollutants at concentrations that do not pose a threat to their health. Where annual mean concentrations of nitrogen dioxide (NO_2) or particulate matter (PM_{10}) are 40 µg/m^3 or less, and 25 µg/m^3 or less for $PM_{2.5}$, no such adverse health effects should occur. With regards to the short term health objective values, no adverse effects should occur if hourly mean NO_2 values exceed 200 µg/m^3 less than 18 times per year and if the number of days exceeding the 24-hour mean PM_{10} of 50 µg/m^3 is less than 35 days per year.

For a change of a given magnitude (**Table 6.2.3**), the IAQM have published recommendations for describing the effect at receptors and these descriptors are applied in this assessment to the relevant assessment criteria. A decrease in air pollutant concentrations represents an improvement in air quality, whereas an increase represents a worsening in air quality. The significance of changes to short term concentrations of nitrogen dioxide and particulate matter are assessed with respect to the hourly mean NO_2 objective value and the 24-hour mean air quality objective value for PM_{10} respectively (**Table 6.2.6**). The magnitude descriptors in **Tables 6.2.4 and 6.2.5** are as proposed by the IAQM and Environmental Protection UK.

The change in magnitude is calculated by subtracting the Do-Minimum pollutant concentrations from the Do-Minimum pollutant concentrations for each interchange option in the assumed year of opening (2020). The latest guidelines issued by the IAQM classify the magnitude of change in annual mean concentrations at these receptors using four descriptors 'Large', 'Medium', 'Small' and 'Imperceptible' with regards to the relevant objective value (as shown in **Table 6.2.3**). For example a 'Large' magnitude of change is considered to be > 4 µg/m^3 and 'Imperceptible' being a change of magnitude of < 0.4 µg/m^3 for annual mean NO_2 and PM_{10} concentrations. For receptors experiencing an 'Imperceptible' change, they will overall experience no significant change in air quality.

TABLE 6.2.3: MAGNITUDE OF CHANGES IN AIR QUALITY STATISTICS

Magnitude of Change	Annual Mean Concentrations			Hourly Mean NO_2 Concentration (µg/m^3)	Exceedances of the 24-hour mean objective for PM_{10} (days)
	NO_2 (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)		
Large	> ± 4	> ± 4	> ± 2.5	> ± 20	> ± 4
Medium	± 2 to 4	± 2 to 4	± 1.25 to 2.5	± 10 to 20	± 2 to 4
Small	± 0.4 to 2	± 0.4 to 2	± 0.25 to 1.25	± 2 to 10	± 1 to 2
Imperceptible	< ± 0.4	< ± 0.4	< ± 0.25	< ± 2	< ± 1

Source: IAQM (2009), Position on the Description of Air Quality Impacts and their Significance Assessment.

The air quality objective values have been set at concentrations that provide protection to all members of society, including more vulnerable groups such as the very young, elderly or unwell. As such, the sensitivity of receptors was considered in the definition of the air quality objective values and therefore no additional subdivision of human health receptors on the basis of building or location type is necessary.

For receptors that are predicted to experience a perceptible change, the effect of the change on local air quality and the risk of exceeding the air quality objective value is summarised in **Table 6.2.4** for annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$. The effect of change and risk of exceeding the 24-hour mean PM_{10} objective value has been adapted from EPUK and is shown in **Table 6.2.5**.

A small increase in annual mean concentrations of NO_2 and PM_{10}, at receptors exposed to baseline concentrations that are just below the objective value (36 µg/m^3 to 40 µg/m^3) is considered to have a 'Slight Adverse' effect, as the slight increase in the risk of exceeding the objective value is significant. The equivalent values for just below the annual mean $PM_{2.5}$ and hourly mean NO_2 objective values, where a small increase would cause a Slight Adverse effect on air quality, are 22.5 to 25 µg/m^3 and 180 to 200 µg/m^3 respectively.

However, a small increase in annual mean concentrations of NO_2 and PM_{10} at receptors exposed to baseline concentrations that are below or well below (< 36 µg/m^3) is not likely to affect the achievement of the objective value and is therefore not a significant effect ('Negligible'). The equivalent values for well below the annual mean $PM_{2.5}$ and hourly mean NO_2 objective values, where a small increase is not likely to have a significant effect on air quality, are <18.75 µg/m^3 and <150 µg/m^3 respectively.

TABLE 6.2.4: AIR QUALITY IMPACT DESCRIPTORS FOR CHANGES TO ANNUAL MEAN NO_2 PM_{10} & $PM_{2.5}$ AND HOURLY MEAN NO_2 CONCENTRATIONS AT A RECEPTOR

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration		
	Small	**Medium**	**Large**
Increase with Scheme			
Above Objective/Limit Value *With* Scheme	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below (90 – 100%) Objective/Limit Value *With* Scheme	Slight Adverse	Moderate Adverse	Moderate Adverse
Below (90 – 75%) Objective/Limit Value *With* Scheme	Negligible	Slight Adverse	Slight Adverse
Well Below (<75%) Objective/Limit Value *With* Scheme	Negligible	Negligible	Slight Adverse
Decrease with Scheme			
Above Objective/Limit Value Without Scheme	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below (90 – 100%) Objective/Limit Value Without Scheme	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below (90 – 75%) Objective/Limit Value Without Scheme	Negligible	Slight Beneficial	Slight Beneficial
Well Below (<75%) Objective/Limit Value Without Scheme	Negligible	Negligible	Slight Beneficial

Source: IAQM (2009), Position on the Description of Air Quality Impacts and their Significance Assessment.

TABLE 6.2.5: AIR QUALITY IMPACT DESCRIPTORS FOR CHANGES TO THE NUMBER OF DAYS EXCEEDING THE 24 HOUR MEAN PM_{10} OBJECTIVE VALUE AT A RECEPTOR

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration		
	Small	Medium	Large
Increase with Scheme			
Above Objective/Limit Value *With* Scheme (>35 days)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value *With* Scheme (32 - 35 days)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value *With* Scheme (26 – 32 days)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value *With* Scheme (<26 days)	Negligible	Negligible	Slight Adverse
Decrease with Scheme			
Above Objective/Limit Value *Without* Scheme (>35 days)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value *Without* Scheme (32 - 35 days)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value *Without* Scheme (26 – 32 days)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value *Without* Scheme (<26 days)	Negligible	Negligible	Slight Beneficial

Source: EPUK (2010), Development Control: Planning for Air Quality.

The change in pollutant concentrations due to each scheme layout option with respect to Do-Minimum concentrations has been quantified at receptors that are representative of exposure to impacts on local air quality within the study area. The magnitude of change in annual mean NO_2 concentrations has been expressed on **Figures 6.2.3 – 6.2.6** using the scale shown in **Table 6.2.3** for every sensitive receptor in the study area. The absolute magnitude of pollutant concentrations in the Do-Minimum and Do-Minimum scenarios are also quantified and used to consider the risk of the air quality limit values being exceeded in each scenario, although there are uncertainties within these predictions at all receptors.

6.2.3 ***Regulatory/Policy Framework***

6.2.3.1 *Legislation*

The Clean Air for Europe (CAFE) programme revisited the management of Air Quality within the EU and replaced the EU Framework Directive 96/62/EC, its associated Daughter Directives 1999/30/EC, 2000/69/EC, 2002/3/EC, and the Council Decision 97/101/EC with a single legal act, the Ambient Air Quality and Cleaner Air for Europe Directive 2008/50/EC.

Directive 2008/50/EC is currently transcribed into national legislation by the Air Quality Standards Regulations (Northern Ireland) 2010. This legislation contains binding limit values for certain airborne pollutants and have been set with the aim of avoiding, preventing or reducing harmful effects on human health and on the environment as a whole. Air quality limit values are therefore an appropriate measure to use in assessing the significance of effects on air quality sensitive receptors.

6.2.3.2 *Local Air Quality Management*

The first UK National Air Quality Strategy was initially published in 2000, under the requirements of the Environment Act 1995. The most recent revision of the strategy was published on 17 July 2007, and sets objective values for key pollutants, as a tool to help local authorities manage local air quality improvements. Some of these objective values are now laid out within The Air Quality Standards (Northern Ireland) Regulations 2010.

The UK National Air Quality Objective Values for the pollutants considered in this assessment are shown in **Table 6.2.6**.

TABLE 6.2.6: UK NATIONAL AIR QUALITY OBJECTIVE VALUES

Pollutant	Concentration	Measured as	Objective to be achieved by	Limit value to be achieved by
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31 December 2005	31 December 2005
	40 µg/m^3	Annual mean	31 December 2005	31 December 2005
Particles (PM_{10}) (gravimetric)	50 µg/m^3, not to be exceeded more than 35 times a year	24-hours running mean	31 December 2004	31 December 2004
	40 µg/m^3	Annual mean	31 December 2004	31 December 2004
Particles ($PM_{2.5}$) (gravimetric)	25 µg/m^3 (target)	Annual mean	2020	2020
	15% cut in urban background exposure	Annual mean	2020	2020

The Environment Act 1995 introduced the system of Local Air Quality Management (LAQM) and requires local authorities to work towards the objectives set up in the National Air Quality Strategy. The requirements for local air quality assessment and management were updated by The Environment (Northern Ireland) Order 2002 and later amendments.

The air quality objective values referred to above have been set down in regulation solely for the purposes of Local Air Quality Management. Under Local Air Quality Management, Belfast City Council has a duty to carry out assessment against the objective values, and if it is unlikely that the objective values will be met in the given timescale, they must designate an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) with the aim of achieving the objective values. The boundary of an AQMA is set by the governing local authority to define the geographical area that is to be subject to the management measures set out in a subsequent action plan. Consequently it is not unusual for the boundary of an AQMA to include within it, relevant locations where air quality is not at risk of exceeding an air quality objective or EU Limit Value.

The local air quality review and assessment undertaken by Belfast City Council to date has confirmed that the relevant Air Quality Objective Values for carbon monoxide, benzene, 1,3-butadiene, lead and ozone are being met throughout their administrative area.

Exceedances of the nitrogen dioxide and particulate matter objective values were predicted in some areas of the city. As a result, Belfast City Council declared four AQMAs in 2004, with the M1 Motorway and Westlink corridor AQMA being within the air quality study area of this report. The M1-Westlink AQMA was declared based on exceedances of the annual mean and hourly mean nitrogen dioxide objective value and the annual mean and 24-hour mean particulate matter (PM_{10}) objective value.

An Air Quality Action Plan (AQAP) was published by Belfast City Council in May 2006 outlining measures to improve air quality in the AQMAs and across the city as a whole. The AQAP specifies that actions to improve air quality will focus on initiatives to promote increased use of public transport, better vehicle fleet management, greener energy options, policies that will reduce air pollution, highways and road improvements to reduce air pollution and increased public awareness of air pollution issues. The Action Plan focuses on reducing emissions from road transport sources but does not have any measures included within it that relate to the York Street interchange improvements.

The latest progress report published by Belfast City Council in April 2011 reviewed the most up to date monitoring data available and identified that nitrogen dioxide concentrations were in excess of the annual mean objective value at a number of locations outside the existing AQMAs. However, relevant exposure was not identified at these locations and therefore no further actions were taken. At all other locations outside of the defined AQMA boundaries, no other exceedances of any of the objective values were reported.

6.2.3.3 *Environmental Assessment Guidance*

This assessment of impacts from the proposed road scheme on local air quality has been carried out at the appropriate level of detail, in accordance with the assessment level that is 'fit-for-purpose' as specified within DMRB HA 207/07. The need for a 'Detailed' air quality assessment on the proposed scheme was identified. This has been undertaken in accordance with the requirements for a 'Detailed' assessment level on local air quality, as specified within Section 3.33 – 3.37 of DMRB HA 207/07. The information included within this assessment is consistent with the requirements outlined in Section 3.9 of DMRB HA 207/07.

The regional and construction phase elements of the assessment have adopted a 'Simple' assessment, as specified within DMRB HA 207/07.

The methodology stated within the DMRB Advice Note HA 207/07 relies on Technical Guidance note LAQM TG(09). The relevant tools and techniques within this Technical Guidance note have been used within this assessment.

Highways Agency Advice Note HA205/08 includes generic criterion for arriving at the assessment of environmental effects. The approach described uses significance criteria, to report the effect of the impact and significance of the effect, that is formulated as a function of the receptor or resource environmental value (or sensitivity) and the magnitude of project impact (change). However for local air quality, established assessment levels for impacts upon sensitive receptors (e.g. human health and designated sites) already exist. As these assessment level values already take full account of receptor sensitivity, the generic matrix of criterion described in HA 205/08 are not wholly appropriate.

In the assessment of local air quality impacts, the significance of effects is achieved by using the recommendations published by the IAQM for describing the magnitude and impact at individual receptors, as presented in **Table 6.2.3**, **Table 6.2.4** and **Table 6.2.5** in place of a matrix of significance criteria. The air quality impact descriptors, as listed in **Table 6.2.3** above, are consistent with the five significance categories set out in HA 205/08, although a combined Negligible/No change outcome is used for an 'Imperceptible' effect on air quality effects.

By considering the magnitude of change in air pollutant concentrations in relation to the impact descriptors, reference may be made directly to the National Air Quality Standards, which are significance criteria of direct relevance to the issue under consideration.

6.2.4 *Baseline Conditions*

6.2.4.1 *Data from Belfast City Council*

Belfast City Council undertakes measurement and monitoring of NO_2 and PM_{10} concentrations in their administrative area, as part of the review and assessment of local air quality management.

Monitoring of NO_2 and PM_{10} is currently undertaken at four locations within the City using continuous monitoring equipment. One location (Belfast Centre) is located towards the city centre, to the south of the air quality study area and measures air pollutant concentrations in an urban background location. Another monitoring station (Belfast Westlink Roden Street) monitors pollutant concentrations along the Westlink, to the south west of the study area. However this monitoring site has only been in operation since 2010 and as such no historic data is available. Annual mean PM_{10} and NO_2 concentrations from the Belfast Centre monitoring site for 2008 – 2010 are presented in **Table 6.2.7** below.

TABLE 6.2.7: ANNUAL MEAN NO_2 AND PM_{10} CONCENTRATIONS REPORTED AT CONTINUOUS MONITORING SITES BY BELFAST CITY COUNCIL

Site name	Site type	Location	Annual mean NO_2 Concentrations (µg/m^3)			Annual mean PM_{10} Concentrations (µg/m^3)		
			2008	2009	2010	2008	2009	2010
Belfast Centre	Urban Centre	Junction of Lombard St and High St	32	32	35	18	20	22

Measured annual mean NO_2 concentrations from diffusion tube locations have been obtained from Belfast City Council. The Belfast City Council diffusion tube located on Great George's Street is the only one located within close proximity to the proposed scheme. Other nearby diffusion tubes are either located alongside roads to the north of the York Street junction or to the south near the City Centre. Bias adjusted annual mean concentrations from a selection of nearby diffusion tubes for 2008-2010 are presented in **Table 6.2.8** below.

TABLE 6.2.8: ANNUAL MEAN NO_2 CONCENTRATIONS MEASURED AT DIFFUSION TUBES BY BELFAST CITY COUNCIL

Diffusion Tube	Site type	Location	Annual mean NO_2 Concentrations (µg/m^3)		
			2008	2009	2010
13	Kerbside	Great George's St	51	44	55
17	Roadside	Albert Clock	43	43	47
18	Roadside	Victoria Street	42	39	48
42	Roadside	228 Antrim Road	34	34	41
44	Roadside	Shore Road (Ivan Street end)	35	36	37

These results show that annual mean concentrations at the current York Street junction are elevated above the air quality objective value of 40 µg/m^3, as represented by the concentrations measured at Diffusion Tube 13. The elevated annual mean NO_2 concentrations reported in 2010 also indicate that the hourly mean NO_2 objective value might be at risk of being exceeded at this location. This is consistent with the designation of this area as being within the far eastern edge of the M1-Westlink AQMA. The results at the urban centre location (Belfast Centre) show that there is a drop off in NO_2 concentrations at locations sited away from the major road sources.

The annual mean NO_2 concentrations measured at other locations surrounding the proposed scheme report values that are close to the annual mean objective value. The diffusion tubes positioned on Antrim Road and Shore Road, both located to the north of the proposed scheme and on roads that feed into the study area, report annual mean concentrations that are generally below but near to the objective value. The two other locations located within the city centre to the south of the proposed scheme report annual mean NO_2 concentrations at or above the objective value, indicating elevated concentrations adjacent to major roads in the city centre.

No local measurements of annual mean PM_{10} concentrations are available in close proximity to the proposed scheme. Annual mean PM_{10} concentrations reported from the Belfast Centre location are shown to be well below the objective value throughout the last three years, indicating that PM_{10} concentrations are relatively low at a distance from major road sources.

6.2.4.2 *Project-Specific Data*

A diffusion tube survey was undertaken by URS, at the locations shown on **Figure 6.2.1**, in order to generate baseline NO_2 concentrations to be used in the model verification process. Currently, results for a three month period (from December 2011 to March 2012) are available for six locations. These concentrations have been annualised to 2010 using the ratio of annual mean to period mean data calculated from automatic monitoring stations within the region in 2010, in accordance with the procedures outlined in LAQM TG(09). The annual means were adjusted for laboratory bias using the 2011 national adjustment factor published by Defra for the Gradko laboratory.

The period mean, annualised mean and bias adjusted annual mean NO_2 concentrations obtained from the three month URS diffusion tube survey are presented in **Table 6.2.9** below.

TABLE 6.2.9: ANNUAL MEAN NO_2 CONCENTRATIONS MEASURED IN THE URS DIFFUSION TUBE SURVEY

Diffusion Tube	Location	NO_2 Concentrations (µg/m^3)		
		Period Mean[1]	Annualised Mean to 2010	Bias adjusted annualised mean
T1	Facing Westlink on back of residential property on Little George's Street	45.5	52.5	46.7
T2	North side of Henry Street	40.8	47.0	41.8
T3	North Queen Street near the North Queen Street Bridge	64.7	74.6	66.4
T4	Meadow Place	29.6	34.2	30.4
T5	Junction of Garmoyle Street and Dock Street, outside apartments	50.7	58.5	52.1
T6	York Street, south of junction with Great George's Street	42.5	49.0	43.7

[1] This is the measured NO_2 concentration for three months covering the period 12/12/2011 – 05/03/2012.

The diffusion tubes positioned at roadside locations (T1, T2, T5 and T6) in the URS diffusion tube survey reported 2010 annual mean NO_2 concentrations above the air quality objective value of 40 µg/m^3. These locations are shown to be in excess of the annual mean NO_2 objective value and consistent with the designation of the M1-Westlink AQMA. NO_2 concentrations were shown to decline as the distance from major road sources increased, as illustrated by the lower concentrations reported at roadside location T2. The lowest annual mean NO_2 concentrations were reported at diffusion tube T4, which was positioned at a background location in a residential cul-de-sac, away from main roads and the major source of pollutant emissions.

The 2010 annual mean NO_2 concentration reported at location T3 is not only in excess of the air quality objective value but elevated when compared to values from the other monitoring locations positioned at the side of major roads in the study area. Diffusion tube T3 is located on a fence post with surrounding vegetation that is adjacent to the North Queen Street Bridge. The specific micro meteorological conditions occurring at this location have led to an elevated annual mean NO_2 concentration being reported that is not considered representative of concentrations occurring at nearby properties located away from the bridge.

6.2.5 ***Predicted Impacts***

6.2.5.1 *Operational Local Air Quality Assessment*

6.2.5.1.1 ***Do-Minimum Scenario***

The road links used within the air quality model for the Do-Minimum scenario are shown on Figure A2 within Appendix A of the Air Quality Report (**Appendix E** of this report). The predicted annual mean concentrations of NO_2, PM_{10}, $PM_{2.5}$, the hourly 99.79th percentile of NO_2 concentrations, and the number of exceedances of the 24-hour 50 µg/m^3 air quality objective value, at the selected receptors during the future Do-Minimum scenario for the assumed year of scheme opening (2020), are listed in **Table 6.2.10**. The predicted annual mean concentrations of NO_2 at all sensitive receptors in the study area are shown on **Figure 6.2.2**.

TABLE 6.2.10: AIR QUALITY STATISTICS PREDICTED FOR THE DO MINIMUM SCENARIO IN 2020

Receptor	Annual Mean NO_2 Concentration (µg/m^3)	99.79 %tile NO_2 Concentration (µg/m^3)	Annual Mean PM_{10} Concentration (µg/m^3)	Annual Mean $PM_{2.5}$ Concentration (µg/m^3)	No. of exceedances of the 24-hour mean PM_{10} objective (days)
R1	37.2	146	17.0	10.7	1
R2	35.8	140	17.0	10.6	1
R3	35.7	140	17.2	10.8	1
R4	33.3	130	16.6	10.4	1
R5	34.8	136	17.1	10.7	1
R6	35.8	140	17.0	10.7	1
R7	33.5	131	16.9	10.5	1
R8	33.4	131	16.9	10.5	1
R9	33.2	130	16.3	10.2	1
R10	41.7	163	18.6	11.6	2
R11	34.8	136	17.2	10.7	1
R12	34.3	134	16.9	10.5	1
R13	35.6	139	17.3	10.8	1
R14	34.1	133	17.0	10.6	1
R15	34.1	133	17.0	10.6	1
R16	34.8	136	17.4	10.8	1
R17	34.2	134	16.6	11.3	1
R18	36.9	144	17.2	10.8	1

The annual mean concentrations predicted at the receptors in the assumed year of scheme opening (2020) for the Do-Minimum scenario have been calculated using 2020 vehicle emission factors. These emission factors are calculated based on an assumed reduction over time in vehicle emissions, due to better emission control technology and fuel specifications. This has led to the reduction in annual mean concentrations being predicted at all receptors within the study area for the future scenarios.

Table 6.2.10 and **Figure 6.2.2** both show that in the future Do-Minimum scenario, annual mean concentrations of NO_2 are only predicted to be above the air quality objective value of 40 µg/m^3 at a property on Dock Street (R10), to the east of the M2 Motorway. This could be due to the specific conditions experienced at this receptor location and the application of a separate road NO_X adjustment factor. At all other receptor locations within the study area, annual mean NO_2 concentrations are predicted to be below the objective value in the Do-Minimum scenario. Elevated annual mean NO_2 concentrations are predicted to occur at properties directly adjacent to the Westlink dual carriageway. Those residential properties located on Little George's Street to the north side of the Westlink (R1 and R2), towards the junction with York Street and those at Clifton House Mews on the south side of the Westlink (R18), towards the junction with Clifton Street, are predicted to experience the slightly elevated annual mean NO_2 concentrations of just below the objective, when compared to other receptors in the study area. These are the same locations that were shown to be at risk of exceeding the annual mean NO_2 limit values in the baseline.

Concentrations are shown to decline at locations away from the major roads in the study area, as evident by some of the lowest concentrations (<36 µg/m^3) being predicted at the residential properties on Henry Street (R4) and to the north end of North Queen Street (R8 and R9). At all other locations annual mean NO_2 concentrations are predicted to be between these two extremes and below 30 - 36 µg/m^3 (i.e. below the objective value).

The predicted 99.79th percentile of hourly mean NO_2 concentrations are below the objective value of 200 µg/m^3 at all receptor locations within the study area. The highest 99.79th percentile of NO_2 concentrations of 163 µg/m^3, is predicted to occur at the receptor located on Dock Street. The predicted concentration are consistent with the fact that the annual mean NO_2 concentrations are not predicted to approach 60 µg/m^3 at any receptor location within the study area in the Do-Minimum scenario.

All receptors are predicted to be exposed to particulate matter concentrations that are well below the annual mean air quality objective values for both PM_{10} and $PM_{2.5}$ in the future. There is a single day predicted to be above the 24-hour objective value for PM_{10} (50 µg/m^3) at all the receptors within the study area, apart from the receptor located on Dock Street (R10) where two days are predicted to be in excess of the objective value. These predictions are well below the objective value of 35 days per year. Predicted PM_{10} concentrations are lower than concentrations reported at the urban centre monitoring site (Belfast Centre).

6.2.5.1.2 ***Do-Something Scenario***

<u>Option A</u>

Summary

A summary of the air quality impacts on local sensitive receptors as a result of implementing Option A is presented in **Table 6.2.11**.

TABLE 6.2.11: SUMMARY OF AIR QUALITY IMPACTS: OPTION A IN 2020

Magnitude of Impact Descriptor	Tally of Impacts at Relevant Receptors in Dispersion Model Domain			
	Annual mean concentration of NO_2 (µg/m^3)	Annual mean concentration of PM_{10} (µg/m^3)	Annual mean concentration of $PM_{2.5}$ (µg/m^3)	No. of exceedances of the 24-hour mean PM_{10} objective. (days)
Large Improvement	0	0	0	0
Medium Improvement	0	0	0	0
Small Improvement	39	2	1	0
Imperceptible (no change)	598	637	638	644
Small Worsening	3	5	5	0
Medium Worsening	4	0	0	0
Large Worsening	0	0	0	0
Total number of Receptors	644	644	644	644
Total of Predicted Impacts at Relevant Receptors in the Model Domain				
Total +'ve Impact Value	60.50	18.43	11.05	11.19
Total –'ve Impact Value	-50.67	-12.46	-7.50	-6.49
Net Impact Value	+9.83	+5.97	+3.55	+4.70

The results presented in **Table 6.2.11** show that implementation of Option A would generally have a neutral effect on local air quality across the study area as a whole. A 'Slight Beneficial' effect is predicted in Option A for those receptors at risk of exceeding the annual mean NO_2 objective value on the north side of the Westlink, nearest to the Westlink / York Street junction. A 'Slight Beneficial' effect is also predicted at the properties on the south side of the junction. A medium worsening of annual mean NO_2 concentrations is predicted at receptors at the north end of Garmoyle Street, which would have a 'Moderate Adverse' effect on air quality at these receptors. A 'Slight Adverse' effect is predicted at receptors adjacent to Dock Street and Clifton Street, due to a small worsening of annual mean NO_2 concentrations. A 'Neutral' effect on local air quality is predicted for the other pollutant concentrations of interest.

Quantitative Comment

The road links used within the air quality model for Option A are shown on Figure A4, within Appendix A of the Air Quality Report (**Appendix E** of this report). **Table 6.2.12** shows predicted annual mean concentrations of NO_2, PM_{10}, $PM_{2.5}$, the 99.79th percentile of NO_2

concentrations, and the number of days in which the PM_{10} 24-hour mean objective value is exceeded at the selected sensitive receptors for Option A in the assumed Year of Opening (2020).

TABLE 6.2.12: AIR QUALITY STATISTICS PREDICTED FOR OPTION A IN 2020

Receptor	Annual Mean NO_2 Concentration ($\mu g/m^3$)	99.79 %tile NO_2 Concentration ($\mu g/m^3$)	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Annual Mean $PM_{2.5}$ Concentration ($\mu g/m^3$)	No. of exceedances of the 24-hour mean PM_{10} objective (days)
R1	35.5	139	16.6	10.5	1
R2	35.6	139	17.1	10.7	1
R3	35.9	140	17.3	10.8	1
R4	33.2	130	16.6	10.4	1
R5	35.1	137	17.2	10.7	1
R6	35.9	140	17.0	10.7	1
R7	33.7	132	16.9	10.5	1
R8	33.6	131	16.9	10.5	1
R9	33.4	131	16.3	10.3	1
R10	43.3	169	19.1	11.9	3
R11	34.1	133	16.9	10.6	1
R12	34.0	133	16.8	10.5	1
R13	35.8	140	17.3	10.8	1
R14	34.4	134	17.1	10.6	1
R15	34.3	134	17.1	10.6	1
R16	33.9	132	17.0	10.6	1
R17	34.5	135	16.6	11.3	1
R18	37.2	145	17.4	10.9	1

The change in concentration of each pollutant that is predicted to occur as a result of implementing Option A, in relation to the Do-Minimum conditions at each of the selected sensitive receptors, are listed in **Table 6.2.13** below. The predicted change in annual mean concentrations of NO_2 as a result of implementing Option A (in relation to Do-Minimum conditions) at all sensitive receptors in the study area is shown on **Figure 6.2.3**.

TABLE 6.2.13: CHANGE IN AIR QUALITY STATISTICS PREDICTED BETWEEN OPTION A AND THE DO MINIMUM SCENARIO IN 2020					
Receptor	**Annual Mean NO_2 Concentration ($\mu g/m^3$)**	**99.79 %tile NO_2 Concentration ($\mu g/m^3$)**	**Annual Mean PM_{10} Concentration ($\mu g/m^3$)**	**Annual Mean $PM_{2.5}$ Concentration ($\mu g/m^3$)**	**No. of exceedances of the 24-hour mean PM_{10} objective (days)**
R1	-1.8 (s)	-6.8 (s)	-0.4 (s)	-0.2 (i)	<1 (i)
R2	-0.2 (i)	-<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R3	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R4	-<0.1 (i)	-<2 (i)	-<0.1 (i)	-<0.1 (i)	<1 (i)
R5	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R6	+<0.1 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R7	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R8	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R9	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R10	+1.7 (s)	+6.5 (s)	+0.5 (s)	+0.3 (i)	+11 (s)
R11	-0.7 (s)	-2.8 (s)	-0.3 (i)	-0.2 (i)	<1 (i)
R12	-0.3 (i)	-<2 (i)	-<0.1 (i)	-<0.1 (i)	<1 (i)
R13	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R14	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R15	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R16	-0.9 (s)	-3.6 (s)	-0.4 (s)	-0.2 (i)	<1 (i)
R17	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R18	+0.3 (i)	+<2 (i)	0.1 (i)	+<0.1 (i)	<1 (i)

Descriptors applied to the magnitude of change are Imperceptible (i), Small (s), Medium (m) and Large (L) applied to NO_2, PM_{10}, $PM_{2.5}$, 99.79th percentile NO_2 and the number of days exceedance of the 24-hour objective for PM_{10}

Figure 6.2.3 and **Table 6.2.13** show that implementing Option A would result in a small decrease in annual mean NO_2 concentrations at residential receptor locations on surrounding roads to the north and south of the Westlink and York Street junction (R1, R11 and R16). The decrease in concentrations at these locations can be attributed to the realignment of the York Street and the Westlink junction, the removal of some of the signalised junctions and the creation of direct slip roads onto and off the M2/M3 motorways. The creation of a bridge on York Street over the new link roads would reduce pollutant concentrations at nearby receptors as it would elevate the road emission source away from the receptors. The restriction of traffic entering the Westlink in a westbound direction from York Street would lead to a reduction in emissions and hence air pollutant concentrations at receptors adjacent to York Street and to the south of the Westlink / York Street junction (R16).

A small increase in annual mean NO_2 concentrations is predicted to occur at residential receptors surrounding the Garmoyle Street and Dock Street junction (R10). Figure A4 within Appendix A of the Air Quality Report (**Appendix E** of this report) shows that the creation of a new slip road from the southbound M2 motorway towards Westlink in a westbound direction would bring road traffic and an increased source of emissions closer to these receptors. In addition, a new link road from Corporation Street towards Westlink in a westbound direction would increase the quantity of vehicles passing these receptors which would both lead to an increase in emissions and pollutant concentrations. **Figure 6.2.3** also shows that a small magnitude of increase in annual mean NO_2 concentrations is predicted at residential receptors located adjacent to Clifton Street. This can be attributed to the change in local vehicle movements associated with the junction alterations at the York Street interchange in Option A. This would reduce the access to local surrounding roads that was previously available from the York Street junction and force traffic to seek an alternative route, which would result in a small increase in air pollutant concentrations at these receptors.

At all other receptor locations within the study area, implementation of Option A would result in an 'Imperceptible' change in the magnitude of annual mean NO_2 concentrations.

Given that the Do-Minimum concentrations at the receptors located to the north of Westlink are just below (36 – 40 µg/m^3) the objective value, a small improvement in annual mean NO_2 concentrations would have a 'Slight Beneficial' effect on local air quality.

Do-Minimum concentrations at receptors located on Dock Street and Clifton Street are predicted to be above (>40 µg/m^3) and just below (36 – 40 µg/m^3) the annual mean NO_2 objective value respectively. A small worsening in annual mean NO_2 concentrations is predicted at these receptor locations, which would have a 'Slight Adverse' impact on local air quality. Receptors located on Garmoyle Street are predicted to experience a Medium worsening in annual mean NO_2 concentrations on top of baseline concentrations of just below (36 – 40 µg/m^3) the objective value. This would result in a 'Moderate Adverse' impact on local air quality at this receptor location. Given that at all other receptors within the study area Do-Minimum annual mean NO_2 concentrations are predicted to be below the objective value (30 – 36 µg/m^3), a small or imperceptible magnitude of change in concentrations would have an effect on local air quality of 'Negligible' significance.

A similar trend in the magnitude of change is predicted in the 99.79th percentile NO_2 concentrations as that predicted for the annual mean NO_2 concentrations. Small improvements are predicted at locations adjacent to Westlink (R1 and R16) at the York Street junction, with small worsening predicted at Dock Street and Garmoyle Street junction (R10). Given that baseline 99.79th percentile NO_2 concentrations are either below or well below the objective value at all locations within the study area, a small or imperceptible magnitude of change in concentrations will have a 'Negligible' effect on local air quality.

An 'Imperceptible' magnitude of change in the annual mean PM_{10} and $PM_{2.5}$ concentrations and the number of days exceeding the 24-hour objective value for PM_{10} is predicted at the majority of receptors within the study area. A small improvement in annual mean PM_{10} concentrations is predicted at receptors located adjacent to Westlink (R1 and R16) at the York Street junction whilst a small worsening is predicted at the Dock Street and Garmoyle Street junction (R10). A small worsening in the number of days exceeding the 24-hour mean PM_{10} objective value is also predicted at the Dock Street and Garmoyle Street junction (R10). However, given that all particulate matter concentrations are well below their respective objective values, then a small to imperceptible magnitude of change in concentrations would have a 'Negligible' effect on air quality.

Option B

Summary

A summary of the air quality impacts on local sensitive receptors as a result of implementing Option B is presented in **Table 6.2.14**.

TABLE 6.2.14: SUMMARY OF AIR QUALITY IMPACTS: OPTION B IN 2020

Magnitude of Impact Descriptor	Tally of Impacts at Relevant Receptors in Dispersion Model Domain			
	Annual mean concentration of NO_2 ($\mu g/m^3$)	Annual mean concentration of PM_{10} ($\mu g/m^3$)	Annual mean concentration of $PM_{2.5}$ ($\mu g/m^3$)	No. of exceedances of the 24-hour mean PM_{10} objective. (days)
Large Improvement	0	0	0	0
Medium Improvement	7	0	0	0
Small Improvement	65	11	10	0
Imperceptible (no change)	547	628	630	644
Small Worsening	25	5	4	0
Medium Worsening	0	0	0	0
Large Worsening	0	0	0	0
Total number of Receptors	644	644	644	644
Total of Predicted Impacts at Relevant Receptors in the Model Domain				
Total +'ve Impact Value	57.22	15.60	9.52	8.79
Total –'ve Impact Value	-82.24	-21.86	-13.28	-11.05
Net Impact Value	-25.02	-6.26	-3.76	-2.26

The results presented in **Table 6.2.14** show that implementation of Option B would generally have a 'Slight Beneficial' effect on local air quality across the study area as a whole, with more properties experiencing an improvement in air quality than for Option A. A small to medium beneficial effect is predicted with Option B for those receptors at risk of exceeding the annual mean NO_2 objective value on the north side of the Westlink, nearest to the Westlink / York Street junction. A 'Slight Beneficial' effect is also predicted at the properties on the south side of the junction. A small worsening of annual mean NO_2 concentrations is predicted at receptors at the north end of Garmoyle Street and those adjacent to North Queen Street and Clifton Street. A small number of properties would experience a small improvement and worsening in relation to annual mean PM_{10} and $PM_{2.5}$ concentrations, although an overall 'Neutral' effect on air quality is predicted for these pollutants.

Quantitative Comment

The road links used within the air quality model for Option B are shown on Figure A6, within Appendix A of the Air Quality Report (**Appendix E** of this report). **Table 6.2.15** shows predicted annual mean concentrations of NO_2, PM_{10}, $PM_{2.5}$, the 99.79th percentile of NO_2 concentrations and the number of days in which the PM_{10} 24-hour objective is exceeded at the selected sensitive receptors for Option B in the Assumed Year of Opening (2020).

TABLE 6.2.15: AIR QUALITY STATISTICS PREDICTED FOR OPTION A IN 2020

Receptor	Annual Mean NO_2 Concentration ($\mu g/m^3$)	99.79 %tile NO_2 Concentration ($\mu g/m^3$)	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Annual Mean $PM_{2.5}$ Concentration ($\mu g/m^3$)	No. of exceedances of the 24-hour mean PM_{10} objective (days)
R1	34.9	136	16.5	10.4	1
R2	34.9	136	16.9	10.6	1
R3	35.9	140	17.3	10.8	1
R4	33.1	129	16.6	10.3	1
R5	35.1	137	17.2	10.7	1
R6	35.9	140	17.0	10.7	1
R7	33.8	132	16.9	10.5	1
R8	33.7	132	16.9	10.5	1
R9	33.5	131	16.3	10.3	1
R10	42.9	168	19.0	11.9	3
R11	33.7	132	16.8	10.5	1
R12	33.7	132	16.7	10.4	1
R13	36.0	141	17.4	10.8	1
R14	34.5	135	17.1	10.6	1
R15	34.5	135	17.1	10.7	1
R16	34.3	134	17.1	10.7	1
R17	34.7	136	16.7	11.4	1
R18	37.0	145	17.3	10.9	1

The changes that are predicted to occur as a result of implementing Option B, in relation to Do-Minimum conditions for each of the sensitive receptors, are listed in **Table 6.2.16** below. The predicted change in annual mean concentrations of NO_2 as a result of implementing Option B (in relation to Do-Minimum conditions) at all sensitive receptors in the study area is shown on **Figure 6.2.4**.

TABLE 6.2.16: CHANGE IN AIR QUALITY STATISTICS PREDICTED BETWEEN OPTION B AND THE DO MINIMUM SCENARIO IN 2020

Receptor	Annual Mean NO_2 Concentration ($\mu g/m^3$)	99.79 %tile NO_2 Concentration ($\mu g/m^3$)	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Annual Mean $PM_{2.5}$ Concentration ($\mu g/m^3$)	No. of exceedances of the 24-hour mean PM_{10} objective (days)
R1	-2.3 (m)	-9.1 (s)	-0.5 (s)	-0.3 (i)	<1 (i)
R2	-0.9 (s)	-3.4 (s)	-0.1 (i)	-<0.1 (i)	<1 (i)
R3	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R4	-0.2 (i)	-0.9 (s)	-0.1 (i)	-<0.1 (i)	<1 (i)
R5	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R6	+<0.1 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R7	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R8	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R9	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R10	+1.2 (s)	+4.6 (s)	+0.5 (s)	+0.3 (i)	<1 (i)
R11	-1.1 (s)	-4.4 (s)	-0.4 (s)	-0.3 (i)	<1 (i)
R12	-0.6 (s)	-2.3 (s)	-0.1 (i)	-0.1 (i)	<1 (i)
R13	+0.4 (s)	+<2 (i)	+0.1 (i)	+<0.1 (i)	<1 (i)
R14	+0.4 (s)	+<2 (i)	+0.1 (i)	+<0.1 (i)	<1 (i)
R15	+0.4 (s)	+<2 (i)	+0.1 (i)	+<0.1 (i)	<1 (i)
R16	-0.5 (s)	-2.0 (s)	-0.2 (i)	-0.1 (i)	<1 (i)
R17	+0.5 (s)	+2.0 (s)	+0.1 (i)	+<0.1 (i)	<1 (i)
R18	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)

Descriptors applied to the magnitude of change are Imperceptible (i), Small (s), Medium (m) and Large (L) applied to NO_2, PM_{10}, $PM_{2.5}$, 99.79th percentile NO_2 and the number of days exceedance of the 24-hour objective for PM_{10}

Figure 6.2.4 and **Table 6.2.16** show that implementing Option B would result in a small to medium decrease in annual mean NO_2 concentrations at residential receptor locations on surrounding roads to the north and south of the Westlink and York Street junction (R1, R2, R11, R12 and R16). **Figure 6.2.4** shows that the extent and magnitude of the decrease in annual NO_2 concentrations would be larger and of a greater spatial extent (i.e. experienced at receptors located further away from Westlink) when compared to predictions obtained for Option A. A medium decrease in annual mean NO_2 concentrations is only predicted at receptors located directly adjacent to the Westlink towards the York Street Junction. The decrease in concentrations at these locations can be attributed to similar reasons as would occur for Option A. However elevating the M2 to Westlink road link, and creating a bridge for M3 to Westlink road link over York Street would further reduce pollutant concentrations at nearby receptors, as it has elevated a greater proportion of the road emission source away from the surrounding receptors. The creation of a York Street bridge over the Westlink to M3 and M2 slip roads would also slightly elevate the road traffic emission source, which would further improve air pollutant concentrations at the surrounding receptors.

A small increase in annual mean NO_2 concentrations is predicted to occur at residential receptors surrounding the Garmoyle Street and Dock Street junction (R10). Figure A6 within Appendix A of the Air Quality Report (**Appendix E** of this report) shows that the creation of a new slip road from the southbound M2 motorway and that from Nelson Street, both towards the Westlink in a westbound direction, would bring road traffic and an increased source of emissions closer to these receptors.

Figure 6.2.4 also shows that a small magnitude of increase in annual mean NO_2 concentrations is predicted at residential receptors located adjacent to Clifton Street and the Donegall Street, Clifton Street and Carrick Hill Junction (R17) and on North Queen Street (R15). This can be attributed to the change in vehicle movements associated with local traffic flows, due to the junction alterations being made at the York Street interchange with scheme Option B implemented. This option would reduce access to local surrounding roads that was previously available from the York Street junction and force traffic to seek an alternative route, which would result in a small increase in air pollutant concentrations at these receptors.

At all other receptor locations within the study area, the implementation of Option B would result in an imperceptible change in the magnitude of annual mean NO_2 concentrations.

Given that the Do-Minimum concentrations at receptors located to the north of Westlink are just below (36 – 40 µg/m^3) the objective value, a small to medium improvement in annual mean NO_2 concentrations would have a Slight to Moderate Beneficial effect on local air quality at these locations.

A small worsening in annual mean NO_2 concentrations is predicted at receptors located on Dock Street, Garmoyle Street and Clifton Street, which will have a 'Slight Adverse' impact on local air quality, given that Do-Minimum concentrations are predicted to be either just below (36 – 40 µg/m^3) and above (>40 µg/m^3) the objective value. Do-Minimum annual mean NO_2 concentrations are predicted to be below (30 – 36 µg/m^3) the objective value at receptors located on North Queen Street and Donegall Street, and thus a small worsening in concentrations would have an effect on local air quality of 'Negligible' significance. Given that at all other receptors within the study area Do-Minimum annual mean NO_2 concentrations are predicted to be below the objective value (30 – 36 µg/m^3), a small or imperceptible magnitude of change in concentrations would have an effect on local air quality of 'Negligible' significance.

A similar trend in the magnitude of change is predicted in the 99.79th percentile NO_2 concentrations as that predicted for the annual mean NO_2 concentrations. Small improvements are predicted at locations adjacent to Westlink (R1, R2, R4, R11, R12 and R16) at the York Street junction, with small worsening predicted at Dock Street and Garmoyle Street junction (R10) and on Donegall St (R17). Given that baseline 99.79th percentile NO_2 concentrations are either below or well below the objective value at all locations within the study area, a small or imperceptible magnitude of change in concentrations would have a 'Negligible' effect on local air quality.

A small decrease in annual mean PM_{10} concentrations is predicted at residential receptors on Little George's Street (R1) and Great George's Street (R11), to the north and south side of the Westlink / York Street junction respectively. A small increase in annual mean PM_{10} concentrations is predicted at residential receptors on Dock Street (R10). At all other receptors within the study area an 'Imperceptible' magnitude of change is predicted in the annual mean PM_{10} concentrations.

An 'Imperceptible' magnitude of change in the annual mean $PM_{2.5}$ concentrations and the number of days exceeding the 24-hour objective value for PM_{10} is predicted at all receptors within the study area.

As all particulate matter concentrations are well below their respective objective values, then a small to imperceptible magnitude of change in concentrations would have a 'Negligible' effect on air quality.

<u>Option C</u>

Summary

A summary of the air quality impacts on local sensitive receptors as a result of implementing the Option C alternative of the scheme layout is presented in **Table 6.2.17**.

TABLE 6.2.17: SUMMARY OF AIR QUALITY IMPACTS: OPTION C IN 2020

Magnitude of Impact Descriptor	Tally of Impacts at Relevant Receptors in Dispersion Model Domain			
	Annual mean concentration of NO_2 ($\mu g/m^3$)	Annual mean concentration of PM_{10} ($\mu g/m^3$)	Annual mean concentration of $PM_{2.5}$ ($\mu g/m^3$)	No. of exceedances of the 24-hour mean PM_{10} objective. (days)
Large Improvement	0	0	0	0
Medium Improvement	0	0	0	0
Small Improvement	30	4	2	0
Imperceptible (no change)	606	635	637	644
Small Worsening	4	5	5	0
Medium Worsening	4	0	0	0
Large Worsening	0	0	0	0
Total number of Receptors	644	644	644	644
Total of Predicted Impacts at Relevant Receptors in the Model Domain				
Total +'ve Impact Value	52.68	12.51	7.84	7.99
Total –'ve Impact Value	-39.39	-16.53	-9.07	-8.35
Net Impact Value	13.29	-4.02	-1.23	-0.37

The results presented in **Table 6.2.17** show that implementation of Option C would generally have a neutral effect on local air quality across the study area as a whole, with a similar effect on local air quality as predicted for Option A. A 'Slight Beneficial' effect is predicted in Option C for those receptors at risk of being in exceedance of the annual mean NO_2 objective value on the north side of the Westlink, nearest to the Westlink / York Street junction. A 'Slight Beneficial' effect is also predicted at the properties on the south side of the junction.

A medium worsening of annual mean NO_2 concentrations is predicted at receptors at the north end of Garmoyle Street, which would have a 'Moderate Adverse' effect on air quality at these receptors. A 'Slight Adverse' effect is predicted at receptors located on Dock Street and those adjacent to Clifton Street, due to a small worsening of annual mean NO_2 concentrations. A neutral effect on air quality is predicted for the other pollutant concentrations of interest.

Quantitative Comment

The road links used within the air quality model for Option C are shown on Figure A8, within Appendix A of the Air Quality Report (**Appendix E** of this report). **Table 6.2.18** shows predicted annual mean concentrations of NO_2, PM_{10}, $PM_{2.5}$, the 99.79th percentile of NO_2 concentrations, and the number of days in which the PM_{10} 24-hour objective is exceeded at the selected sensitive receptors for Option C in the assumed Year of Opening (2020).

TABLE 6.2.18: AIR QUALITY STATISTICS PREDICTED FOR OPTION C IN 2020

Receptor	Annual Mean NO_2 Concentration ($\mu g/m^3$)	99.79 %tile NO_2 Concentration ($\mu g/m^3$)	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Annual Mean $PM_{2.5}$ Concentration ($\mu g/m^3$)	No. of exceedances of the 24-hour mean PM_{10} objective (days)
R1	35.6	139	16.6	10.5	1
R2	35.6	139	17.0	10.6	1
R3	35.8	140	17.3	10.8	1
R4	33.3	130	16.6	10.4	1
R5	34.9	137	17.2	10.7	1
R6	35.9	140	17.0	10.7	1
R7	33.6	131	16.9	10.5	1
R8	33.5	131	16.9	10.5	1
R9	33.4	131	16.3	10.3	1
R10	43.2	169	19.0	11.9	3
R11	34.1	133	16.8	10.5	1
R12	34.1	133	16.8	10.5	1
R13	35.9	140	17.4	10.8	1
R14	34.4	135	17.1	10.6	1
R15	34.4	135	17.1	10.6	1
R16	34.4	135	17.2	10.7	1
R17	34.7	136	16.7	11.4	1
R18	37.0	145	17.3	10.8	1

The changes that are predicted to occur as a result of Option C, in relation to ‘Do-Minimum’ conditions for each of the sensitive receptors, are listed in **Table 6.2.19** below. The predicted change in annual mean concentrations of NO_2 as a result of implementing Option C (in relation to ‘Do-Minimum’ conditions) at all sensitive receptors in the study area is shown on **Figure 6.2.5**.

TABLE 6.2.19: CHANGE IN AIR QUALITY STATISTICS PREDICTED BETWEEN OPTION C OF THE PROPOSED SCHEME AND THE DO MINIMUM SCENARIO IN 2020

Receptor	Annual Mean NO_2 Concentration ($\mu g/m^3$)	99.79 %tile NO_2 Concentration ($\mu g/m^3$)	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Annual Mean $PM_{2.5}$ Concentration ($\mu g/m^3$)	No. of exceedances of the 24-hour mean PM_{10} objective (days)
R1	-1.6 (s)	-6.4 (s)	-0.4 (s)	-0.2 (i)	<1 (i)
R2	-0.2 (i)	-<2 (i)	-<0.1 (i)	-<0.1 (i)	<1 (i)
R3	+<0.1 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R4	-<0.1 (i)	-<2 (i)	-<0.1 (i)	-<0.1 (i)	<1 (i)
R5	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R6	+<0.1 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R7	+0.1 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R8	+0.1 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R9	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R10	+1.5 (s)	+5.8 (s)	+0.4 (s)	+0.3 (i)	+1 (i)
R11	-0.7 (s)	-2.8 (s)	-0.4 (s)	-0.2 (i)	<1 (i)
R12	-0.2 (i)	-<2 (i)	-0.1 (i)	-<0.1 (i)	<1 (i)
R13	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R14	+0.3 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)
R15	+0.3 (i)	+<2 (i)	+0.1 (i)	+<0.1 (i)	<1 (i)
R16	-0.3 (i)	-<2 (i)	-0.2 (i)	-0.1 (i)	<1 (i)
R17	+0.5 (s)	+2.0 (s)	+0.1 (i)	+<0.1 (i)	<1 (i)
R18	+0.2 (i)	+<2 (i)	+<0.1 (i)	+<0.1 (i)	<1 (i)

Descriptors applied to the magnitude of change are Imperceptible (i), Small (s), Medium (m) and Large (L) applied to NO_2, PM_{10}, $PM_{2.5}$, 99.79th percentile NO_2 and the number of days exceedance of the 24-hour objective for PM_{10}

The changes in the local highway network due to implementation of Option C would be relatively similar to those occurring from implementation of Option A. The only major difference between the two scheme options occurs on the M3 to Westlink slip road. Figure A8 within Appendix A of the Air Quality Report (**Appendix E** of this report) shows that Option C separates the flow from the motorway into a slip road which directly passes underneath York Street to join up with the M2 to Westlink slip road and a slip road off to the York Street junction. **Figure 6.2.5** shows that implementing Option C would lead to a very similar trend in the magnitude of change and the extent of these changes in annual mean NO_2 concentrations at all receptors. A small decrease in annual mean NO_2 concentrations is again predicted at residential receptor locations on surrounding roads to the north and south of the Westlink and York Street junction (R1 and R11). This is due to similar reasons that occur for Option A, in that the realignment (in height and distance from receptors) of the Westlink / York Street junction would move the road traffic emission source away from the surrounding receptors.

A small increase in annual mean NO_2 concentrations is also predicted to occur at residential receptors surrounding the Garmoyle Street and Dock Street junction (R10) as with Option A. The proposed highway scheme is the same for both Option A and C at this locality and therefore the increase in pollutant concentrations would be due to the same reasons as discussed for Option A.

Figure 6.2.5 also shows that a small magnitude of increase in annual mean NO_2 concentrations is predicted at residential receptors located adjacent to Clifton Street and the Donegall Street, Clifton Street and Carrick Hill Junction (R17). This is attributed to the change in vehicle movements associated with local traffic flows, due to the junction alterations being made at the York Street interchange with Option C; in particular, the closing off of through traffic on Nelson Street and closing access from York Street to the Westlink. This would reduce access to local surrounding roads that was previously available from the York Street junction and would force traffic to seek an alternative route, which would result in a small increase in air pollutant concentrations at receptors along surrounding roads, similar to that which would occur with Option A.

At all other receptor locations within the study area, the implementation of Option C would result in an imperceptible change in the magnitude of annual mean NO_2 concentrations.

Given that the 'Do-Minimum' concentrations at receptors located to the north of Westlink are just below (36 – 40 µg/m^3) the objective value, a small improvement in annual mean NO_2 concentrations would have a 'Slight Beneficial' effect on local air quality.

'Do-Minimum' concentrations at receptors located on Dock Street and Clifton Street are predicted to be above (>40 µg/m^3) and just below (36 – 40 µg/m^3) the annual mean NO_2 objective value respectively. A small worsening in annual mean NO_2 concentrations is predicted at these receptor locations, which would have a 'Slight Adverse' impact on local air quality. Receptors located on Garmoyle Street are predicted to experience a medium worsening in annual mean NO_2 concentrations on top of baseline concentrations of just below (36 – 40 µg/m^3) the objective value. This would result in a 'Moderate Adverse' impact on local air quality at these receptor locations. Given that at all other receptors within the study area 'Do-Minimum' annual mean NO_2 concentrations are predicted to be below the objective value (30 – 36 µg/m^3), a small or imperceptible magnitude of change in concentrations would have an effect on local air quality of 'Negligible' significance.

A similar trend in the magnitude of change is predicted in the 99.79th percentile NO_2 concentrations as that predicted for the annual mean NO_2 concentrations. Small improvements are predicted at locations adjacent to Westlink (R1 and R16) at the York Street junction, with small worsening predicted at Dock Street and Garmoyle Street junction (R10) and on Donegall Street (R17). Given that baseline 99.79th percentile NO_2 concentrations are either below or well below the objective value at all locations within the study area, a small or imperceptible magnitude of change in concentrations would have a 'Negligible' effect on local air quality.

A small decrease in PM_{10} concentrations is predicted at residential receptors on Little George's Street (R1) and Great George's Street (R11), to the north and south side of the Westlink / York Street junction respectively. A small increase in annual mean PM_{10} concentrations is predicted at residential receptors on Dock Street (R10). At all other receptors within the study area an imperceptible magnitude of change is predicted in the annual mean PM_{10} concentrations.

An imperceptible magnitude of change in the annual mean $PM_{2.5}$ concentrations and the number of days exceeding the 24-hour objective value for PM_{10} is predicted at all receptors within the study area. A small worsening in the number of days exceeding the 24-hour mean PM_{10} objective value is also predicted at the Dock Street and Garmoyle Street junction (R10). At all other receptors, an imperceptible magnitude of change in the number of days exceeding the 24-hour objective value for PM_{10} is predicted.

As all particulate matter concentrations are well below their respective objective values, then a small to imperceptible magnitude of change in concentrations would have a 'Negligible' effect on air quality.

Option D

Summary

A summary of the air quality impacts on local sensitive receptors as a result of implementing Option D is presented in **Table 6.2.20**.

TABLE 6.2.20: SUMMARY OF AIR QUALITY IMPACTS: OPTION D IN 2020				
Magnitude of Impact Descriptor	**Tally of Impacts at Relevant Receptors in Dispersion Model Domain**			
	Annual mean concentration of NO_2 (µg/m^3)	**Annual mean concentration of PM_{10} (µg/m^3)**	**Annual mean concentration of $PM_{2.5}$ (µg/m^3)**	**No. of exceedances of the 24-hour mean PM_{10} objective. (days)**
Large Improvement	0	0	0	0
Medium Improvement	18	0	0	0
Small Improvement	70	1	5	0
Imperceptible (no change)	468	638	634	644
Small Worsening	88	5	5	0
Medium Worsening	0	0	0	0
Large Worsening	0	0	0	0
Total number of Receptors	644	644	644	644
Total of Predicted Impacts at Relevant Receptors in the Model Domain				
Total +'ve Impact Value	95.56	31.09	17.76	16.55
Total –'ve Impact Value	-120.59	-14.67	-10.97	-7.61
Net Impact Value	-25.03	16.42	6.79	8.94

The results presented in **Table 6.2.20** show that implementation of Option D would generally have a 'Slight Beneficial' effect on annual mean NO_2 across the study area as a whole, with more properties experiencing an improvement in air quality than for any other scheme layout option. However, the greatest number of properties would experience a small worsening of air quality with implementation of this option. The majority of these worsening effects are predicted to occur at receptors on North Queen Street where annual mean NO_2 concentrations are not at risk of exceeding the objective value and therefore no adverse effect would be experienced.

A small to medium beneficial effect is predicted with Option D for those receptors at risk of exceeding the annual mean NO_2 objective value, on the north side of the Westlink, nearest to the Westlink / York Street junction. A 'Slight Beneficial' effect is also predicted at properties located further away from this junction and on the south side of the junction. A small worsening of annual mean NO_2 concentrations is predicted at receptors at the north end of Garmoyle Street and those adjacent to Clifton Street. A neutral effect on air quality is predicted for the other pollutant concentrations of interest.

Quantitative Comment

The road links used within the air quality model for Option D are shown on Figure A10, within Appendix A of the Air Quality Report (**Appendix E** of this report). **Table 6.2.21** shows predicted annual mean concentrations of NO_2, PM_{10}, $PM_{2.5}$, the 99.79th percentile of NO_2 concentrations, and the number of days in which the PM_{10} 24-hour objective is exceeded at the selected sensitive receptors for Option D in the assumed year of opening (2020).

TABLE 6.2.21: AIR QUALITY STATISTICS PREDICTED FOR OPTION D IN 2020

Receptor	Annual Mean NO_2 Concentration ($\mu g/m^3$)	99.79 %tile NO_2 Concentration ($\mu g/m^3$)	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Annual Mean $PM_{2.5}$ Concentration ($\mu g/m^3$)	No. of exceedances of the 24-hour mean PM_{10} objective (days)
R1	34.9	137	16.8	10.6	1
R2	33.5	131	16.7	10.4	1
R3	36.0	141	17.4	10.8	1
R4	32.9	129	16.6	10.4	1
R5	35.4	139	17.3	10.8	1
R6	35.6	139	16.9	10.6	1
R7	34.1	133	17.0	10.6	1
R8	34.0	133	17.0	10.6	1
R9	33.7	132	16.4	10.3	1
R10	43.2	169	19.1	11.9	3
R11	33.6	131	16.8	10.5	1
R12	33.4	131	16.7	10.4	1
R13	36.0	141	17.5	10.9	2
R14	34.7	136	17.2	10.7	1
R15	34.7	136	17.2	10.7	1
R16	34.9	136	17.4	10.8	1
R17	35.2	137	16.8	11.4	1
R18	36.8	144	17.2	10.8	1

The changes that are predicted to occur as a result of implementing Option D, in relation to Do-Minimum conditions for each of the sensitive receptors, are listed in **Table 6.2.22**. The predicted change in annual mean concentrations of NO_2 as a result of implementing Option D (in relation to Do-Minimum conditions) at all sensitive receptors in the study area is shown on **Figure 6.2.6**.

TABLE 6.2.22: CHANGES IN AIR QUALITY STATISTICS PREDICTED BETWEEN OPTION D AND THE DO MINIMUM SCENARIO IN 2020					
Receptor	**Annual Mean NO_2 Concentration ($\mu g/m^3$)**	**99.79 %tile NO_2 Concentration ($\mu g/m^3$)**	**Annual Mean PM_{10} Concentration ($\mu g/m^3$)**	**Annual Mean $PM_{2.5}$ Concentration ($\mu g/m^3$)**	**No. of exceedances of the 24-hour mean PM_{10} objective (days)**
R1	-2.3 (m)	-9.0 (s)	-0.1 (i)	-0.2 (i)	<1 (i)
R2	-2.2 (m)	-8.7 (s)	-0.3 (i)	-0.2 (i)	<1 (i)
R3	+0.3 (i)	+<2 (i)	+0.2 (i)	+<0.1 (i)	<1 (i)
R4	-0.4 (s)	-<2 (i)	-<0.1 (i)	-<0.1 (i)	<1 (i)
R5	+0.7 (s)	+2.6 (s)	+0.2 (i)	+0.1 (i)	<1 (i)
R6	-0.3 (i)	-<2 (i)	-0.1 (i)	-<0.1 (i)	<1 (i)
R7	+0.6 (s)	+2.4 (s)	+0.2 (i)	+<0.1 (i)	<1 (i)
R8	+0.6 (s)	+2.4 (s)	+0.1 (i)	+<0.1 (i)	<1 (i)
R9	+0.5 (s)	+<2 (i)	+0.1 (i)	+<0.1 (i)	<1 (i)
R10	+1.5 (s)	+5.7 (s)	+0.5 (s)	+0.3 (i)	+1 (s)
R11	-1.3 (s)	-4.9 (s)	-0.4 (s)	-0.2 (i)	<1 (i)
R12	-0.9 (s)	-3.4 (s)	-0.1 (i)	-<0.1 (i)	<1 (i)
R13	+0.5 (s)	+<2 (i)	+0.2 (i)	+0.1 (i)	+1 (s)
R14	+0.6 (s)	+2.5 (s)	+0.2 (i)	+0.1 (i)	<1 (i)
R15	+0.7 (s)	+2.5 (s)	+0.2 (i)	+0.1 (i)	<1 (i)
R16	+0.1 (i)	+<2 (i)	-<0.1 (i)	-<0.1 (i)	<1 (i)
R17	+1.0 (s)	+<2 (i)	+0.2 (i)	+0.2 (i)	<1 (i)
R18	-<0.1 (i)	-<2 (i)	-<0.1 (i)	-<0.1 (i)	<1 (i)

Descriptors applied to the magnitude of change are Imperceptible (i), Small (s), Medium (m) and Large (L) applied to NO_2, PM_{10}, $PM_{2.5}$, 99.79th percentile NO_2 and the number of days exceedance of the 24-hour objective for PM_{10}

The changes in local highway network due to implementation of Option D would be relatively similar to those occurring from implementation of Option B, in that the use of elevated link roads would be preferred to link roads in cutting. The major changes in highway design in Option D from that in Option B is that the Westlink to M2 would be an elevated link road, York Street remains as existing, with Westlink to M3 continuing at ground level via a signalised junction and a new junction at Nelson Street. The eastbound on-slip road to Westlink from Clifton Street would also be closed.

Figure 6.2.6 shows that implementing Option D would lead to a larger spatial extent and larger magnitude of decrease in annual mean NO_2 concentrations at receptors surrounding the York Street and Westlink junction, both north and south. A medium magnitude of decrease in annual mean NO_2 concentrations is predicted at residential receptor locations on Little George's Street, located adjacent to the Westlink (R1, R2 and R4). Small magnitudes of decrease in annual mean NO_2 concentrations are predicted at residential receptor locations on surrounding roads to the north and south of the Westlink and York Street junction (R12 and R11). These changes occur over a greater spatial extent of properties than predicted with any other scheme layout option, as shown on **Figure 6.2.6**. This is due to similar reasons as occurred for Option B, in that the realignment (in height and distance from receptors) of the Westlink / York Street junction would move the road traffic emission source away from the surrounding receptors. In particular for Option D, the elevation of the Westlink to M2 link road would lead to further reductions in air pollutant concentrations at properties on the north side of the Westlink.

A small increase in annual mean NO_2 concentrations has been predicted to occur at residential receptors surrounding the Garmoyle Street and Dock Street junction (R10). This is a similar change as occurred with Option B, as the creation of a new slip road from the southbound M2 motorway and that from Nelson Street both towards the Westlink in a westbound direction would bring road traffic and an increased source of emissions closer to these receptors.

Figure 6.2.6 also shows that a small magnitude of increase in annual mean NO_2 concentrations is predicted at residential receptors located adjacent to Clifton Street, the Donegall Street, Clifton Street and Carrick Hill Junction (R17), Brougham Street (R9) and all the way along North Queen Street (R15, R14, R13, R8, R7 and R5). These increases in concentrations can be attributed to the change in vehicle movements associated with local traffic flows due to the junction alterations that would be made at the York Street interchange with scheme Option D. In particular, the closing off of through traffic on Nelson Street, the closing of the Clifton Street slip and the remodelling of the York Street junction would alter local traffic flow patterns. This would reduce access to local surrounding roads that was previously possible from the York Street junction and force traffic to seek an alternative route, particularly along North Queen Street and Frederick Street, which would result in a small increase in air pollutant concentrations at receptors along these roads.

At all other receptor locations within the study area, the implementation of Option D would result in an imperceptible change in the magnitude of annual mean NO_2 concentrations.

Given that Do-Minimum concentrations at the receptors located to the north of Westlink are just below (36 – 40 $\mu g/m^3$) the objective value, a medium improvement in annual mean NO_2 concentrations will have a 'Moderate Beneficial' effect on local air quality at these locations. This 'Moderate Beneficial' effect would be experienced at a greater number of residential properties with implementation of Option D than for any other option, as a medium magnitude of change is predicted at a larger number of properties. At other receptor locations to the north and south of Westlink, Do-Minimum annual mean NO_2 concentrations are below (30 – 36 $\mu g/m^3$) the objective value and a small improvement in concentrations would have a 'Negligible' effect on air quality.

A small worsening in annual mean NO_2 concentrations is predicted at receptors located on Dock Street, Garmoyle Street and Clifton Street, which would have a 'Slight Adverse' impact on local air quality, given that Do-Minimum concentrations are predicted to be either just below (36 – 40 $\mu g/m^3$) and above (>40 $\mu g/m^3$) the objective value. As Do-Minimum annual mean NO_2 concentrations are predicted to be below (30 – 36 $\mu g/m^3$) the objective value at receptors located on North Queen Street and Donegall Street, a small worsening in concentrations would have an effect on local air quality of 'Negligible' significance. Given that at all other receptors within the study area Do-Minimum annual mean NO_2 concentrations are predicted to be below the objective value (30 – 36 $\mu g/m^3$), a small or imperceptible magnitude of change in concentrations would have an effect on local air quality of 'Negligible' significance.

A similar trend in the magnitude of change is predicted in the 99.79th percentile NO_2 concentrations as that predicted for the annual mean NO_2 concentrations. Small improvements are predicted at locations adjacent to Westlink (R1, R2, R11 and R12) at the York Street junction with small worsening predicted at Dock Street and Garmoyle Street junction (R10) and on North Queen Street (R5, R7, R8, R10, R14, R15). Given that baseline 99.79th percentile NO_2 concentrations are either below or well below the objective value at all locations within the study area, a small or imperceptible magnitude of change in concentrations will have a negligible effect on local air quality.

A small decrease in PM_{10} concentrations is predicted at residential receptors on Great George's Street (R11), to the south side of the Westlink / York Street junction. A small increase in annual mean PM_{10} concentrations is predicted at residential receptors on Dock Street (R10). At all other receptors within the study area, an imperceptible magnitude of change is predicted in the annual mean PM_{10} concentrations.

An imperceptible magnitude of change in the annual mean $PM_{2.5}$ concentrations is predicted at all receptors within the study area. A small worsening in the number of days exceeding the 24-hour mean PM_{10} objective value is also predicted at the Dock Street and Garmoyle Street junction (R10) and on North Queen Street adjacent to Westlink (R13). At all other receptors, an imperceptible magnitude of change in the number of days exceeding the 24-hour objective value for PM_{10} is predicted.

As all particulate matter concentrations are well below their respective objective values, then a small to imperceptible magnitude of change in concentrations would have a 'Negligible' effect on air quality.

6.2.5.2 *Operational Regional Air Quality Assessment*

6.2.5.2.1 ***Baseline & Do-Minimum Scenario***

The total quantities of NO_X, PM_{10}, CO_2 (expressed as carbon), CO and THC produced by baseline traffic on the surrounding roads in 2010, 2020 and 2034 are presented in **Table 6.2.23** below.

TABLE 6.2.23: BASELINE TOTAL TRAFFIC EMISSIONS

Year	Total Quantity of Pollutants (tonnes/yr)				
	NO_X	PM_{10}	Carbon	CO	THC
2010	101	3	11,420	185	24
2020	78	2	11,918	204	26
2034[1]	84	2	13,210	229	29

[1] calculated using emission factors for 2025 as the emission factors published in the DMRB do not currently extend beyond 2025

The net variation in the magnitude of baseline pollution emissions from 2010 to 2020 and 2034 is determined by the combination of the increase in vehicle kilometres travelled (i.e. increase traffic volume over time x same distance travelled), which increases emissions over time, and the introduction of controls on the magnitude of emissions per vehicle, which reduces emissions over time.

As a result of the removal of older vehicle models from the national fleet, a trend of reduced emissions is predicted for NO_X and PM_{10}. Over the same time period, increasing numbers of vehicle kilometres travelled would result in increasing emissions of CO_2 despite the improved efficiency of most vehicle types. For the pollutants CO and THC, the benefits achieved by the removal of older vehicle models from the national fleet are offset by the increased number of vehicle kilometres travelled and forecast changes in the mix of petrol and diesel vehicles in operation.

6.2.5.2.2 ***Do-Something Scenarios***

The total quantities of NO_X, PM_{10}, CO_2 (expressed as carbon), CO and THC produced by traffic in all scheme layout options in 2020 are presented in **Table 6.2.24** below.

TABLE 6.2.24: OPERATIONAL TOTAL TRAFFIC EMISSIONS FOR ALL SCHEME OPTIONS IN 2020

Scheme Option	Total Quantity of Pollutants (tonnes/yr)				
	NO_X	PM_{10}	Carbon	CO	THC
A	78	2	11,827	202	25
B	78	2	11,852	202	26
C	78	2	11,799	201	25
D	79	2	12,022	207	26

The change in the total emissions of NO_x, PM_{10}, CO_2, CO and THC produced by traffic in all of the scheme option scenarios in 2020 are presented in **Table 6.2.25**.

TABLE 6.2.25: CHANGE IN TOTAL TRAFFIC EMISSIONS FOR ALL SCHEME OPTIONS IN 2020

Scheme Option	Total Quantity of Pollutants (tonnes/yr)				
	NO_X	PM_{10}	Carbon	CO	THC
A	-<1 (-0.1%)	-<1 (-0.8%)	-91 (-0.8%)	-2 (-1.0%)	-<1 (-0.8%)
B	+<0 (+0.1%)	-<1 (-0.6%)	-67 (-0.6%)	-2 (-0.8%)	-<1 (-0.8%)
C	-<1 (-0.3%)	-<1 (-1.1%)	-119 (-1.0%)	-3 (-1.3%)	-<1 (-1.1%)
D	+1 (+1.0%)	+<1 (+0.8%)	+103 (+0.9%)	+3 (+1.3%)	+<1 (+1.2%)

The total quantities of NO_X, PM_{10}, CO_2 (expressed as carbon), CO and THC produced by traffic in all scheme options in 2034 are presented in **Table 6.2.26** below.

TABLE 6.2.26: OPERATIONAL TOTAL TRAFFIC EMISSIONS FOR ALL SCHEME OPTIONS IN 2034

Scheme Option	Total Quantity of Pollutants (tonnes/yr)				
	NO_X	PM_{10}	Carbon	CO	THC
A	84	2	13,128	227	29
B	84	2	13,149	227	29
C	84	2	13,093	226	29
D	85	2	13,331	232	29

The change in the total emissions of NO_x, PM_{10}, CO_2, CO and THC produced by traffic in all of the scheme layout option scenarios in 2020 are presented in **Table 6.2.27**.

TABLE 6.2.27: CHANGE IN TOTAL TRAFFIC EMISSIONS FOR ALL SCHEME OPTIONS IN 2034

Scheme Option	Total Quantity of Pollutants (tonnes/yr)				
	NO_X	PM_{10}	Carbon	CO	THC
A	-<1 (-0.1%)	-<1 (-0.8%)	-91 (-0.8%)	-2 (-1.0%)	-<1 (-0.8%)
B	+<0 (+0.1%)	-<1 (-0.6%)	-67 (-0.6%)	-2 (-0.8%)	-<1 (-0.8%)
C	-<1 (-0.3%)	-<1 (-1.1%)	-119 (-1.0%)	-3 (-1.3%)	-<1 (-1.1%)
D	+1 (+1.0%)	+<1 (+0.8%)	+103 (+0.9%)	+3 (+1.3%)	+<1 (+1.2%)

The change in total vehicle kilometres travelled by the traffic in all scheme options in 2020 and 2034 are presented in **Table 6.2.28**.

TABLE 6.2.28: CHANGE IN TOTAL VEHICLE KILOMETRES FOR ALL SCHEME LAYOUT OPTIONS IN 2020 AND 2034

Scheme Option	Total change in vehicle Kilometres travelled	
	2020	2034
A	3,062 (+0.5%)	3,357 (+0.5%)
B	4,114 (+0.6%)	4,511 (+0.6%)
C	2,028 (+0.3%)	2,224 (+0.3%)
D	6,662 (+1.0%)	7,304 (+1.0%)

In the first year of operation (2020) the quantity of exhaust emissions are predicted to decline with all scheme layout options apart from Option D, where an increase is predicted. The use of the new road links in all scheme options would slightly decrease emissions of pollutants due to the net average increase in vehicle speeds. The increased efficiency of travelling at higher speeds on the roads, in the form of reduced emissions per kilometre, outweighs the impact of an overall increase in the number of vehicle kilometres travelled. For Option D, there would be a greater proportion of vehicle kilometres travelled.

Overall, the small change in pollutant emission rates of between -0.1 % and +1.3 % relative to future baseline conditions, for all options is considered to represent a neutral effect that is not of significance.

6.2.5.3 *Construction*

Dust and air pollution can cause disruption to properties and the public adjacent to the construction works and can also have adverse impacts upon other environmental receptors, including watercourses and ecologically designated sites, which have not formed part of this assessment.

The DMRB 11.3.3 states that studies have shown at least half the people living within 50 metres of a construction site boundary are seriously bothered by construction nuisance in one form or another, but beyond 100 metres, less than 20% of the people are seriously bothered. In terms of potential disruption to the properties, from an air quality perspective, nuisance may be in the form of excessive dust and air pollution, generated particularly during prolonged dry periods, and operation of construction machinery, which can emit higher than normal levels of airborne contaminants. These impacts could have significant effects on nearby residents, and hence monitoring may be necessary during the construction period. During prolonged dry periods, higher than normal airborne dust levels may pose a problem. This is typical on any project which involves movement of large quantities of material for earthworks and road construction. Dust can have several undesirable impacts:

- Health and safety - airborne dust can irritate the eyes and respiratory system
- Road safety - reduced visibility if dust blows across roads
- Nuisance - settling on washing, windows and ledges of surrounding property etc.

York Street and the area in the vicinity of the existing junction currently experience considerable traffic flows through the area. Nevertheless, disruption from dust and air pollution due to the presence of heavy construction traffic, as well as the construction itself, could have an impact on residents, in particular those in close proximity to the existing route. Of particular note is the significant amount of housing to the western side of the scheme, which may be affected.

Undesirable impacts on air quality may arise from the creation of dust (as previously discussed), and other operations such as jack-hammering. Site fires are a potential nuisance and should be avoided where possible. Other construction impacts include site wide elements, such as the location of storage areas and site huts. Stores of raw material, borrow and fill and site offices, for example, should be placed in areas where no loss of amenity is perceived. Site traffic entering and exiting the works have the potential to carry dust and dirt along the surrounding roads.

The proposed construction phase activities associated with the scheme are all capable of being effectively mitigated using existing good site practices. With such measures appropriately applied, there would not be significant effects at any dust sensitive receptors as a result of the works.

6.2.6 ***Mitigation and Enhancement Measures***

6.2.6.1 *Introduction*

Overall mitigation measures would need to be considered to avoid or reduce adverse impacts or enhance the possible environmental performance of the scheme, in terms of both health impacts from construction and operation.

6.2.6.2 *Construction*

There are many ways in which negative effects on air quality during the construction phase could be minimised to avoid creating nuisance. Irrespective of the preferred layout option, consideration must be given to construction impacts, particularly dust. The potential for deterioration in local air quality due to emissions from plant and vehicles is also a risk during the construction phase.

Appropriate measures should reflect the nature of the construction activity (type, dust source points, construction operation periods and time of year) as well as ameliorating conditions (such as prevailing wind directions and speeds, typical precipitation and the dampening effect of retained soil moisture). Monitoring may be necessary during the construction period. Possible dust control measures associated with soil handling and storage would include *inter alia* restricting duration of the activity and protecting surfaces from the wind. Other measures might include for example, dampening haul roads and stockpiles, keeping roads clean and using covers to minimise dust blow from lorries.

Measures to limit emissions would typically include selection of well-maintained plant and equipment to minimise exhaust emission levels, operation of plant in accordance with the manufactures written recommendations, and reasonable minimisation of plant movements around the site.

6.2.6.3 *Operational*

The selection of a scheme layout option that does not have the potential to significantly worsen local air quality is an important element of the options assessment process, and in itself can be considered a form of mitigation.

6.2.7 ***Summary and Conclusions***

The proposed construction phase activities associated with any scheme option are capable of being effectively mitigated using good site practice within best practicable means. With such measures appropriately applied there would be no significant effects at any dust sensitive receptors as a result of the works.

During the operational phase, each of the four options would result in a change in pollutant emission rates that would be too small to have a significant effect on Regional air quality.

A summary of local air quality impacts is provided in **Table 6.2.29**. All four options would lead to changes in pollutant concentrations at similar localities throughout the study area. However the spatial extent and magnitude of changes in pollutant concentrations would vary.

Options A and C provide links that are predominately in cutting beneath existing ground level, whereas Options B and D provide links that are predominately elevated above adjacent links. Nevertheless, for all options the grade-separation of links would improve air quality at locations predicted to be at risk of exceeding annual mean NO_2 objective values in 2020. These locations include properties at Little George’s Street (R1 – R2) and Great George’s Street (R11 – R12) within the Belfast AQMA.

The grade-separation of the M2 to Westlink link and closure of Nelson Street to through traffic with all options would lead to a small worsening of air quality at properties surrounding the Garmoyle Street and Dock Street junction. Changes to traffic flows as a result of modification to the road network would also lead to a small worsening of air quality at residential receptor locations on some side roads (i.e. North Queen Street, Clifton Street and Frederick St) which would not be directly affected by any of the options.

Impacts predicted at all receptors for Options A and C are relatively similar and are all small to imperceptible in magnitude. Changes in air pollutant concentrations of this magnitude are likely to have a 'Neutral' effect on local air quality over the entire study area, with any benefits cancelling out any adverse effects.

Options B and D predict an improvement in air pollutant concentrations of medium magnitude at receptors on Little George's Street adjacent to the Westlink. Changes of this magnitude would have a beneficial effect on local air quality at the surrounding residential properties that were at risk of exceeding the annual mean NO_2 objective value. It is considered that the provision of grade-separation via elevated links as opposed to the current situation of signalised junctions at ground level would reduce the quantity of the road traffic emission source impacting upon the surrounding residential properties and hence lower air pollutant concentrations at these receptors.

The largest improvement in air quality would be experienced with Option D, which provides elevated links between the Westlink and M2. However Option B also provides improvements of similar magnitude at similar locations and also less of a worsening in air quality at other locations and for other pollutant concentrations. The largest improvements in air pollutant concentrations for both Options B and D are predicted for properties at Little George's Street (R1- R2) and Great George's Street (R11 – R12). These properties are currently predicted to be at risk of exceeding the annual mean NO_2 objective value and therefore would experience the largest beneficial effect to local air quality. There are also small increases in air pollutant concentrations predicted at receptors located on Dock Street (R10) and other side roads (North Queen Street, Clifton Street and Frederick St), not directly affected by the scheme with Options B and D. However the majority of these worsenings in air quality would occur at properties not at risk of exceeding any objective value and therefore the adverse effect on air quality at these locations is not significant. Overall, a beneficial effect on local air quality would be experienced throughout the entire study area, with implementation of either Option B or D.

It is recommended that upon selection of the Preferred Option, the air quality assessment should be updated at that time with the latest available traffic data to include modelling of the additional details that has not been possible at this stage. In addition, any future assessments will also be able to make use of the full baseline NO_2 measurement data in the verification of model performance, which would improve the predictions of air pollutant concentrations at surrounding sensitive receptors.

TABLE 6.2.29: SUMMARY FOR EACH SCHEME OPTION

Option	Potential Effect	Ranking of Option with Respect to Effect on Local Air Quality
A	39 Small improvements in total in NO_2 concentrations for properties at Little York Street and Great George's Street. 3 small worsenings in NO_2 concentrations at properties on Clifton Street and Dock Street. 4 medium worsenings at properties on Garmoyle Street.	Ranked 2nd (joint)
B	7 medium and 65 small improvements in NO_2 concentrations at properties surrounding the York Street Junction. 25 small worsenings in NO_2 concentrations at properties on Garmoyle Street, Clifton Street and North Queen Street.	Ranked 1st (joint)
C	30 small improvements in NO_2 concentrations at properties surrounding the York Street Junction. 4 small and 4 medium worsenings in NO_2 concentrations at properties on Garmoyle Street and Clifton Street.	Ranked 2nd (joint)
D	18 medium and 70 small improvements in NO_2 concentrations at properties surrounding the York Street Junction. 88 small worsenings in NO_2 concentrations at properties on Garmoyle Street, Clifton Street, North Queen Street and Brougham Street.	Ranked 1st (joint)

6.3 Cultural Heritage

6.3.1 *Introduction*

The Council of Europe, in the Framework Convention on the Value of Cultural Heritage for Society (Faro 2005), has defined cultural heritage as: '*…a group of resources inherited from the past which people identify, independently of ownership, as a reflection and expression of their constantly evolving values, beliefs, knowledge and traditions. It includes all aspects of the environment resulting from the interaction between people and places through time.'*

The existing landscape is the product of human activity over thousands of years. It contains settlements and remains of every period, from the camps of the first settlers in Ireland, some 9,000 years ago, to Christian heritage sites and remains from early Twentieth Century activities. These remains vary enormously in their state of preservation and in the extent of their appeal to the public.

The assessment of Cultural Heritage within the study area reviews the three subtopics of Archaeological Remains, Historic Buildings, and Historic Landscapes. Archaeological Remains (Raths, Cashels, Souterrains etc.) are the materials created or modified by past human activities that contribute to the study and understanding of past human societies and behaviour. Archaeology can include the study of a wide range of artefacts, field monuments, structures and landscape features, both visible and buried.

Historic Buildings are architectural or designed or other structures with a significant historical value. These may include structures that have no aesthetic appeal, so in addition to great houses, churches, vernacular buildings or other listed buildings/structures, it incorporates some relatively modern structures, such as WWII and Cold War defence heritage structures (airfields, pillboxes, observation posts etc.). It also incorporates industrial buildings and sometimes other structures not usually thought of as 'buildings', such as railways, mills, milestones, bridges and bleach greens for example.

Historic Landscapes are defined by perceptions that emphasise the evidence of the past and its significance in shaping the present landscape. They encompass all landscapes, including the countryside, townscapes and industrial landscapes as well as designed landscapes, such as Historic Parks, Gardens and Demesnes.

In order to assess the impact of the proposed scheme upon cultural heritage, the guidance provided in the Design Manual for Roads and Bridges (DMRB) HA 208/07 (Volume 11, Section 3, Part 2, Cultural Heritage) has been used in conjunction with relevant professional standards and guidelines (IfA 2010, IfA 2011).

6.3.2 *Methodology*

In accordance with DMRB 11.3.2.3 (The Assessment Process, August 2007) there are three levels of assessment; Scoping, Simple Assessment, and Detailed Assessment. The detail of the assessment depends on the stage in scheme delivery, and the nature of information required at a particular stage in the design process. It is important to note that these levels of assessment are not sequential, in that one must follow another, but they should be regarded as consequential, in that the results of one determines what further work, if any, is required.

A Scoping Assessment is usually deemed most appropriate for preliminary stage assessments. The objective of scoping is to determine whether any further study is required, beyond the desk-based collection and analysis of readily available information, and if it is required, then at what level of detail. Scoping typically relies on readily available data sources. The results may indicate that no further cultural heritage studies are necessary, or that a Simple Assessment is needed, or alternatively that a Detailed Assessment is needed.

A Simple Assessment is carried out if Scoping Assessment reveals any unknown aspects. Completing this limited assessment allows design to be finalised if an understanding of the effect of the proposed scheme is reached. This assessment may involve new non-intrusive fieldwork, such as geophysical survey or field walking, to confirm the conclusions of desk-based studies.

If a Simple Assessment is insufficient in establishing the value of affected assets, the impact of the scheme, determining satisfactory mitigation measures or enabling the need for mitigation to be discounted, then a Detailed Assessment must be carried out.

A Detailed Assessment may require new fieldwork, either non-intrusive or intrusive, to clarify uncertainties about the location, character, extent, survival or value of cultural heritage assets, that may be affected by the scheme, or the magnitude of the impact upon them.

For the purposes of the Stage 2 Report, a Simple Assessment was deemed most appropriate as it is based and builds on the findings of the Cultural Heritage section contained within the Stage 1 'Preliminary Options' Report. The 'Simple' Assessment has been prepared by a team of cultural heritage specialists, and a copy of their report is included at **Appendix F**. It has been prepared in accordance with the DMRB 11.3.2 (HA 208/07), the Standard and Guidance for Desk Based Assessment, and the Code of Conduct of the Institute for Archaeologists.

6.3.2.1 *Preliminary Site Walkover and Study Area*

A site walkover was undertaken in order to verify current ground conditions and land use, and to inform the assessment. Access during this visit was limited to the public footway network.

Targeted visits were undertaken to designated heritage assets that were considered likely to incur the greatest impact with any of the options under consideration (e.g. Listed Buildings, Conservation Areas).

At the same time, consideration was given to the extent of an appropriate study area for the assessment. Factors that influenced the decision included the irregular site boundary, as well as the urban and historic setting of the proposed scheme and its relationship to the city and dockland environment. Bearing in mind these factors, a study area with a 1km radius centred on IGR J34227533 was chosen for the archaeological resource (Scheduled Monuments and MBR records) and also for registered historic battlefields.

For other designated and non-designated assets (e.g. Listed Buildings, Conservation Areas, Industrial Heritage Records) a smaller search area with a 400m radius was utilised, in order to ensure that the assessment was relevant to the proposed scheme. The walkover established that many listed buildings that were also located in the historic core of the city would unlikely be affected by the scheme due to the existing urban nature of the site.

6.3.2.2 *Assessment Sources*

Databases of known sites, and the 'Maps in Action' GIS database, were consulted at the Northern Ireland Environment Agency (NIEA) Monuments and Buildings Record (NI MBR, Hill Street, Belfast). Sources comprise:

- Archaeological Sites and Monuments Record (SMR)
- Architectural or Historic Buildings Record and Northern Ireland Buildings Database
- Industrial Archaeology or Industrial Heritage Record (IHR)
- Defence Heritage Project
- Northern Ireland Heritage Gardens Inventory (1992)
- Register of Parks, Gardens and Demesnes of Special Historic Interest (2007)
- Buildings at Risk in Northern Ireland (BaRNI) Register
- Maritime Sites and Monuments Record (no assets identified for this project).

Primary and secondary sources, including historic mapping, antiquarian surveys, Land & Property Services (LPS (formerly Ordnance Survey)) mapping and archaeological journals were consulted at the NIEA MBR office, Belfast.

Internet resources were also investigated to provide social and oral histories describing the impact of WWII bombing raids and information about the development of the cross-city road network.

RAF photographs held by PRONI have not been consulted at this stage as historic map coverage indicates adequately the development sequence of the area.

Digital resources consulted include the Archaeology Data Service, the CBA Defence of Britain Database, the British and Irish Archaeological Bibliography, the British Geological Survey, and relevant NIEA web pages.

6.3.2.3 *Assessing the Significance of Effects*

Cultural heritage assets are evaluated in relation to formal statutory designations, and priorities or recommendations published in national, regional, and local research agendas, priorities, or framework documents. Assets may be valued due to rarity, particularly good preservation, or typicality. Others contribute to local distinctiveness and identity, and have community value. They are considered principally with reference to their value to the quality and understanding of the country's cultural heritage resource, as set out in national, regional and local cultural heritage legislation, priorities and frameworks (see Appendix 1 of the Cultural Heritage: DMRB Simple Assessment (**Appendix F** of this report).

Values are ranked as Very High, High, Medium, Low, Negligible and Unknown, based on criteria noted in **Tables 6.3.1 to 6.3.3**.

TABLE 6.3.1: FACTORS FOR ASSESSING THE VALUE OF ARCHAEOLOGICAL ASSETS

Value	Typical Descriptor
Very High	World Heritage Sites (including nominated sites); Assets of acknowledged international importance; Assets that can contribute significantly to acknowledged international research objectives.
High	Scheduled Monuments (including proposed sites); Undesignated assets of schedulable quality and importance; Assets that can contribute significantly to acknowledged national research agendas.
Medium	Designated or undesignated assets that contribute to regional research objectives.
Low	Designated and undesignated assets of local importance; Assets compromised by poor preservation and/or poor survival of contextual associations; Assets of limited value, but with potential to contribute to local research objectives.
Negligible	Assets with very little or no surviving archaeological interest.
Unknown	The importance of the resource has not been ascertained.

Source: DMRB 11.3.2 HA208/07, Table 5.1

TABLE 6.3.2: FACTORS FOR ASSESSING THE VALUE OF HISTORIC BUILDINGS

Value	Typical Descriptor
Very High	Structures inscribed as of universal importance as World Heritage Sites; Other buildings of recognised international importance.
High	Scheduled Monuments with standing remains; Grade A and B+ Listed Buildings; Buildings in State Care; Conservation Areas containing very important buildings; Undesignated structures of clear national importance.

TABLE 6.3.2:	FACTORS FOR ASSESSING THE VALUE OF HISTORIC BUILDINGS
Value	**Typical Descriptor**
Medium	Grade B (including B1 and B2) Listed Buildings; Historic (undesignated) buildings that can be shown to have exceptional qualities in their fabric or historical associations; Conservation Areas containing buildings that contribute significantly to its historic character; Historic Townscape or built-up areas with important historic integrity in their buildings, or built settings (e.g. including street furniture and other structures).
Low	Historic (undesignated) buildings of modest quality in their fabric or historical association; Historic Townscape or built-up areas of limited historic integrity in their buildings, or built settings (e.g. including street furniture and other structures); Buildings that appear on the Industrial Heritage Record; Buildings that have been delisted, but retain historic interest.
Negligible	Buildings of no architectural or historical note; buildings of an intrusive character.
Unknown	Buildings with unknown (i.e. inaccessible) potential for historic significance.

Source: DMRB 11.3.2 HA208/07, Table 6.1

TABLE 6.3.3:	FACTORS FOR ASSESSING THE VALUE OF HISTORIC LANDSCAPE CHARACTER UNITS
Value	**Typical Descriptor**
Very High	World Heritage Sites inscribed for their historic landscape qualities; Historic landscapes of international value, whether designated or not; Extremely well preserved historic landscapes with exceptional coherence, time-depth or other critical factor(s).
High	Designated historic landscapes of outstanding interest; Undesignated landscapes of outstanding interest; Undesignated landscapes of high quality and importance, and of demonstrable national value; Well preserved historic landscapes, exhibiting considerable coherence, time-depth or other critical factor(s).
Medium	Designated special historic landscapes; Undesignated historic landscapes that would justify special historic landscape designation, landscapes of regional value; Averagely well-preserved historic landscapes with reasonable coherence, time-depth or other critical factor(s).
Low	Robust undesignated historic landscapes; Historic landscapes with importance to local interest groups; Historic landscapes whose value is limited by poor preservation and/or poor survival of contextual associations.

TABLE 6.3.3:	FACTORS FOR ASSESSING THE VALUE OF HISTORIC LANDSCAPE CHARACTER UNITS
Value	**Typical Descriptor**
Negligible	Assets with very little or no significant historical interest.
Unknown	The importance of the resource has not been ascertained.

Source: DMRB 11.3.2 HA208/07, Table 7.1

Factors for assessing the magnitude of impacts for archaeological, historic buildings and historic landscape assets are described in **Tables 6.3.4 to 6.3.6** below:

TABLE 6.3.4:	FACTORS IN THE ASSESSMENT OF THE MAGNITUDE OF IMPACTS FOR ARCHAEOLOGICAL REMAINS
Magnitude	**Impact**
Major	Change to key archaeological elements, such that the resource is totally altered; Comprehensive changes to setting.
Moderate	Change to many key archaeological elements, such that the resource is clearly modified; Considerable changes to setting that affect that character of the asset.
Minor	Change to key archaeological materials, such that the asset is slightly altered; Slight changes to setting.
Negligible	Very minor changes to archaeological materials, or setting.
No change	No change.

Source: DMRB 11.3.2 HA208/07, Table 5.3

TABLE 6.3.5:	FACTORS IN THE ASSESSMENT OF THE MAGNITUDE OF IMPACTS FOR HISTORIC BUILDINGS
Magnitude	**Impact**
Major	Change to key historic building elements, such that the resource is totally altered; Comprehensive changes to setting.
Moderate	Change to many key historic building elements, such that the resource is significantly modified; Changes to the setting of an historic building, such that it is significantly modified.
Minor	Change to key historic building elements, such that the asset is slightly different; Change to setting of an historic building, such that it is noticeably changed.
Negligible	Slight changes to historic buildings elements or setting that hardly affect it.
No change	No change to fabric or setting.

Source: DMRB 11.3.2 HA208/07, Table 6.3

TABLE 6.3.6: FACTORS IN THE ASSESSMENT OF THE MAGNITUDE OF IMPACTS FOR HISTORIC LANDSCAPE	
Magnitude	**Impact**
Major	Change to most or all key historic landscape elements, parcels or components; extreme visual effects; gross change or noise or change to sound quality; fundamental changes to use or access; resulting in total change to historic landscape character unit.
Moderate	Changes to many key historic landscape elements, parcels or components; visual change to many key aspects of the historic landscape, noticeable differences in noise or sound quality, considerable changes to use or access; resulting in moderate changes to historic landscape character.
Minor	Changes to few historic landscape elements, parcels or components, slight visual changes to few key aspects of historic landscape, limited changes to noise levels or sound quality; slight changes to use or access; resulting in limited changes to historic landscape character.
Negligible	Very minor changes to historic landscape elements, parcels or components, virtually unchanged visual effects, very slight changes in noise levels or sound quality; very slight changes to use or access; resulting in a very small change to historic landscape character.
No change	No change to historic landscape elements, parcels or components; no visual or audible changes; no changes arising from amenity or community factors.

Source: DMRB 11.3.2 HA208/07, Table 7.3

The assessment of the significance of effect is judged in accordance with the matrix set out in **Table 6.3.7** below:

TABLE 6.3.7: ESTIMATING THE SIGNIFICANCE OF POTENTIAL EFFECTS						
Value / Sensitivity	**Very High**	Neutral	Slight	Moderate / Large	Large or Very Large	Very Large
	High	Neutral	Slight	Moderate / Slight	Moderate / Large	Large / Very Large
	Medium	Neutral	Neutral / Slight	Slight	Moderate	Moderate / Large
	Low	Neutral	Neutral / Slight	Neutral / Slight	Slight	Slight / Moderate
	Negligible	Neutral	Neutral	Neutral / Slight	Neutral / Slight	Slight
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
		Magnitude of Impact				

Source: DMRB 11.3.2 HA208/07, Table 5.4

6.3.3 *Regulatory/Policy Framework*

The Cultural Heritage requirements of current planning regulations are set out in Planning Policy Statement (PPS) 6, ‘Planning, Archaeology and the Built Heritage’ (DoE March 1999). PPS 6 sets out the planning policies for the protection and conservation of archaeological remains and features of the built heritage. It provides guidance on direct physical impacts upon the natural or man-made environments. In particular, areas of concern for the proposed York Street Interchange scheme include archaeological sites and monuments, listed buildings, industrial heritage and registered historic parks, gardens & demesnes. PPS 6 also details a section on Transport and Traffic, where the impact of new routes and routes in the vicinity of existing historic structures shall be assessed. Key policies are detailed in Appendix 1 of the Cultural Heritage: DMRB Simple Assessment (**Appendix F** of this report).

The Regional Development Strategy 2035 'Building a Better Future' sets out Strategic Guidance for the protection of the environment. Strategic Guidance **RG11** highlights the need to '*conserve, protect and, where possible, enhance our built heritage and our natural environment*' (RDS, p47). The policy goes on to identify three sub criteria with specific regard to the built heritage:

- Identify, protect and conserve the built heritage, including archaeological sites and monuments and historic buildings.
- Identify, protect and conserve the character and built heritage assets within cities towns and villages.
- Maintain the integrity of built heritage assets, including historic landscapes.

The Draft Belfast Metropolitan Area Plan (BMAP) is a ten-year development plan for the Belfast Metropolitan Area for the period 2005-2015. This includes the city council areas of Belfast and Lisburn, and the Borough councils of Carrickfergus, Castlereagh, Newtownabbey and North Down. It is produced by Planning NI, an agency of the Department of the Environment (DoE). The plan aims to provide a planning framework which facilitates growth and high quality development in the Belfast Metropolitan Area, while protecting, and where appropriate enhancing, the natural and man-made environments. The Plan gives protection to Historic Gardens, Parks & Demesnes, Conservation Areas, City Centre Character Areas and Areas of Archaeological Potential (O'Keeffe 2008) and Areas of Significant Archaeological Interest in the District (Appendix 1 of the Cultural Heritage: DMRB Simple Assessment (**Appendix F** of this report).

6.3.4 ***Baseline Conditions***

6.3.4.1 *Study Area*

The study area is situated in the townland of Town Parks (Belfast), the civil parish of Shankill, the historic barony of Upper Belfast, and the ancient diocese of Down and Conor.

The study area lies to the north of Belfast City Centre, close to the historic docks along the River Lagan in an area that contains fragmentary surviving elements of its 19th Century industrial past. The site is dominated by the main arterial road routes that link the south of the City (A12 Westlink), the east (M3 Motorway) and the north (M2 Motorway). The major trunk road interchange that was developed between the mid 1960s and the 1990s separates the remains of the historic docks area to the east from the commercial and residential properties to the north and west and also from the City Centre to the south. The walkover survey and a review of available historic mapping indicate that all the land occupied by the site has been developed in the past, although some areas of open ground survive where buildings have been demolished. Some maturing vegetation (trees and shrubs) that provides screening exists along earthen embankment sections of the M2/M3 motorways.

To the north, the urban fabric consists of residential and commercial properties; and the southern end of the study area is located on the periphery of the historic city centre. The existing junction arrangement has severed and altered the historic road network that was laid out at the beginning of the 19th Century. A few historic buildings, related to the former industrial and residential use of the area have survived both the construction of the road network and the impact of World War II bombing and the subsequent clearance.

The urban landscape within and surrounding the site consists of scattered light industrial and commercial premises (historic and modern) and groups of residential housing, including modern dockside apartments to the east. Within the site and the wider area are a series of dispersed scattered car parks and 'park & ride' facilities, and areas of vacant open ground where buildings have been cleared.

The scheduled monuments, archaeological sites, findspots and historic buildings/structures recorded within the study area are described in detail within **Appendix F** of this report (Cultural Heritage: DMRB Simple Assessment Report). Sites are identified by their asset number (e.g. AR07), and are generally numbered from north to south within the zones that make up the study area (Zone A, Docks; Zone B, York Street; Zone C, city core; and Zone D, scheme impact). **AR** prefixes refer to archaeological assets, **HB** prefixes to historic building assets and **HL** prefixes, to historic landscape assets. A central grid reference, provisional classification, designation and period are provided for each cultural heritage asset. Historic Buildings have been identified by designation and period. The locations of the cultural heritage sites are shown on **Figure 6.3.1**.

6.3.4.2 *Statutory and Other Designated Assets*

6.3.4.2.1 ***World Heritage Sites***

There are no World Heritage Sites located within the site or wider area. The nearest is located on the north Antrim coastline, at the Giant's Causeway and Causeway Coast, Moyle.

Mount Stewart Gardens (Co. Down) was on the UK's tentative list of 2006, but was not on the revised tentative list submitted to UNESCO in 2011. This list featured the Hill of Derry (Co. Derry), Gracehill Conservation Area (Co. Antrim), Malone and Stranmillis Historic Urban landscape (Belfast), and Navan Fort (Royal Sites of Ireland, Co. Armagh). None of these sites were retained in the new UK tentative list (2011).

6.3.4.2.2 ***Scheduled Monuments***

There are two Scheduled Monuments within the study area (**Figure 6.3.1**).

TABLE 6.4.1: ECOLOGICAL CONSULTEE RESPONSES

Asset No.	Description	Period
AR02	Twin slipways of the Titanic and Olympic ships, Belfast	Modern
AR03	Hamilton Graving Docks, Belfast	19th century

6.3.4.2.3 ***Areas of Significant Archaeological Interest***

There are no Areas of Significant Archaeological Interest within the study area.

6.3.4.2.4 ***Areas of Archaeological Potential***

These areas indicate to developers where, on the basis of current knowledge, it is likely that archaeological remains will be encountered in the course of continuing development and change. There is an extensive Area of Archaeological Potential that encompasses the southeast corner of the immediate study area. Its northern boundary includes Westlink, Great George's Street, Dock Street, Corry Link and then passes south on Albert Quay and along the west bank of the River Lagan. This stretch continues south beneath Lagan Bridge (**AR11**) (**Figure 6.3.1**).

6.3.4.2.5 ***Conservation Areas***

There is one Conservation Area within the study area – the Cathedral Conservation Area (**HB28**), which is located to the south of the immediate study area (**Figure 6.3.1**). It is centred on Lower Donegall Street and north of Waring Street. The position of the Cathedral Conservation Area on the northern fringe of the City Centre and adjacent to the Port of Belfast, has resulted in a piecemeal collection of retail, office, warehousing and port orientated uses. The central focus is provided by St Anne's Cathedral itself, surrounded by a predominantly 17th and 18th century street pattern. Interest within the conservation area is provided by the abundance of historic structures of '*considerable merit which mark the transition of Belfast from a small port to an internationally important commercial city'* (DoENI 1990).

6.3.4.2.6 ***Registered Historic Parks, Gardens and Demesnes***

There is one asset that is listed on the register of historic parks, gardens and demesnes; the 18th century gardens of Clifton House, which was built in 1774 by Belfast Charitable Society (**HL37**) (**Figure 6.3.1**).

6.3.4.2.7 ***Battlefields and Defence Heritage Sites***

There are five entries on the Northern Ireland Battlefield Database located within the study area.

- **HL69**: 17th century siege of Belfast. Civil War battle between the Parliamentary forces under Colonel Venables and the defending Belfast garrison that took place in October 1649.
- **HL71**: Beal-Feirste. 16th century battle between Rughraidhe Mac Uibilin & Conn & Domnall O'Neil.
- **HL72**: Fearsat (unlocated). 7th century battle between the tribes of the Ulidians & the Cruithni; 16th century battle between the Earl of Essex & Sir Brian O'Neill.
- **HL73**: Ford of Belfast. 16th century battle between the Earl of Essex and Sir Brian O'Neill.
- **HL74**: Belfast (unlocated). 16th century battle between The Lord Justice & Niall-Og-O'Neill.

There is one asset that is a Defence Heritage Site, **HL70**, an emergency water supply (destroyed), located in the wider study area, approximately 465m to the south of the site.

6.3.4.3 *Archaeological Remains*

There are 13 archaeological assets within the study area. These comprise the remains of early medieval, medieval, post medieval and modern settlement; the possible site of a medieval chapel; a post medieval defensive town ditch around historic Belfast; a graving dock of 19th century date and ships' slipway; the unknown potential for the remains of Mesolithic occupation/activity that could be buried beneath the sleech; and the palaeo-environmental potential of the sleech to contain a record of landscape change during the later prehistoric period (Neolithic to Iron Age).

All Scheduled assets have been allocated **High** value. Sites that are unlocated or known to have been destroyed have been allocated **Negligible** value. The values of archaeological assets are listed in **Table 6.3.9** and shown on **Figure 6.3.1**.

TABLE 6.3.9: EVALUATION OF ARCHAEOLOGICAL ASSETS

Asset No.	Description	Period	Value
AR01	A watching brief carried out in 2006 within the dockland area located traces of post medieval occupation and modern activity. Undesignated.	Post medieval, Modern	Low
AR02	Twin slipways of the Titanic and Olympic ships, Belfast. Scheduled.	Modern	High
AR03	Hamilton Graving Docks, Belfast. Scheduled.	19th century	High
AR04	Site of a destroyed rath. Located at the Junction of Jane Street and former Carlisle Street. Undesignated.	Early Christian	Negligible
AR05	Town ditch, C17 ditch around the historic core of Belfast. Undesignated.	17th century	Medium
AR06	Historic Belfast. Undesignated.	Medieval and later	Medium
AR07	Post medieval settlement site, destroyed by later development. Undesignated.	Post medieval	Negligible
AR08	Chapel of the Ford. Possible site of medieval chapel reportedly illustrated on historic maps of the town. Site now occupied by a parish church. Undesignated.	Medieval	Negligible
AR09	Structure on site of Benny's Bar. Excavations located the remains of a C17 brick built structure. Undesignated.	Post medieval	Low
AR10	Post medieval settlement site on Gordon Street. Excavations in 1999 located the remains of C18 & C19 buildings, and C17 artefacts. Undesignated.	Post medieval	Low
AR11	Area of Archaeological Potential that has been determined by the local authority. Undesignated.	Medieval, Post medieval and Modern	Low
AR12	The fragmentary buried remains of industrial North Belfast cleared to make way for the post war arterial road network in Zone D. Undesignated.	Post medieval, Modern	Negligible

TABLE 6.3.9: EVALUATION OF ARCHAEOLOGICAL ASSETS			
Asset No.	**Description**	**Period**	**Value**
AR13	Buried remains of early Holocene land surfaces and post-glacial alluvial, estuarine and marine deposits. Undesignated.	Mesolithic, prehistoric	Medium

6.3.4.4 *Historic Landscape*

There are 69 historic landscape assets within the study area. These comprise industrial and commercial premises that have been demolished, elements of the historic dockside fabric, the remains of the historic transport infrastructure (post medieval and modern); and a registered historic garden park and four registered battlefields. In addition, this Simple Assessment has also identified six industrial heritage assets that may still exist and that have been retained here as historic landscape features until their status has been determined (**HL20**, **HL24**, **HL48**, **HL56**, **HL62** and **HL65**). Furthermore, there are seven other assets where there is greater uncertainty whether they survive and for which it is not possible to determine a value (**HL18**, **HL22**, **HL28**, **HL57**, **HL60**, **HL61** and **HL64**).

Historic buildings or structures that have been demolished and where there is unlikely to be buried evidence of industrial processes have been allocated a **Negligible** value. One registered historic garden has been allocated a **High** value as it is part of a complex of assets that includes a listed building. Unlocated registered battlefields have been allocated **Negligible** value. The value of the historic landscape assets are set out in **Table 6.3.10** and shown on **Figure 6.3.1**.

TABLE 6.3.10: EVALUATION OF HISTORIC LANDSCAPE ASSETS			
Asset No.	**Description**	**Period**	**Value**
HL01	Pacific Flour Mill. Belfast, Northern Road. Site redeveloped.	Modern	Negligible
HL02	Saw Mill. Belfast, Duncrue Street (off). Site redeveloped.	Post medieval	Negligible
HL03	Dufferin Flour & Meal Mills. Belfast, Duncrue Street. Site redeveloped.	Modern	Negligible
HL04	Grain Silo. Belfast, Dufferin Road. Site redeveloped.	Modern	Negligible
HL05	Saw Mill. Belfast, Duncrue Street. Site redeveloped.	Post medieval	Negligible
HL06	Headling Sheds. Belfast, Whitla Street / Nelson Street. Site redeveloped.	Unknown	Negligible
HL07	Limekilns (x2). Belfast, Albert Quay. Site redeveloped (modern ferry terminal).	Post medieval	Negligible
HL08	Saw Mill. Belfast, Garmoyle Street. Site redeveloped.	Post medieval	Negligible

TABLE 6.3.10: EVALUATION OF HISTORIC LANDSCAPE ASSETS

Asset No.	Description	Period	Value
HL09	Felt Works. Belfast, Garmoyle Street. Site redeveloped.	Post medieval	Negligible
HL10	Princes Dock Foundry, Garmoyle Street. Site redeveloped.	Post medieval	Medium
HL11	Albert Quay. Site redeveloped (now modern ferry terminal).	Post medieval	Negligible
HL12	Bonded Store. Belfast, Short Street. Site redeveloped.	Modern	Negligible
HL13	Princes Dock Mill (Maize). Belfast, Princes Dock Street. Site redeveloped.	Modern	Negligible
HL14	Felt Works, Saw Mills (Steam). Belfast, Garmoyle Street. Site redeveloped.	Post medieval	Negligible
HL15	Ship Repair Yard - Iron Workshops. Belfast, Pilot Place. Site redeveloped.	Post medieval	Negligible
HL16	Clarendon Mills (Oatmeal), Belfast, Corporation Street. Site redeveloped.	Post medieval	Negligible
HL18	Landing stage on outer edge of Clarendon Dock. Status not known.	Modern	Low
HL20	Ferry Terminal. Belfast Car Ferries passenger terminal. Possible extant building.	Modern	Low
HL21	Bonded Store, Donegall Quay. Site redeveloped.	Post medieval	Negligible
HL22	Bridge (road over river). Belfast, York Road. Status not known.	Post medieval	Low
HL23	Saw Mill. Belfast, York Road. Site redeveloped. One cast iron gate span survives.	Post medieval	Negligible
HL24	Engine Sheds. BNCR Branch Line, Bleach Green - Larne Harbour. Possible extant building.	Post medieval	Low
HL25	Saw Mill. Belfast, York Road. Site redeveloped.	Post medieval	Negligible
HL26	Ulster Bakery. Belfast, Lilliput Road. Site redeveloped.	Modern	Negligible
HL27	York Road Railway Station. BNCR Branch Line. Building replaced by modern structure.	Post medieval	Low

TABLE 6.3.10: EVALUATION OF HISTORIC LANDSCAPE ASSETS

Asset No.	Description	Period	Value
HL28	BNCR Terminus & Midland Hotel. BNCR Branch Line, Bleach Green - Larne Harbour. Replaced by Plumb Centre & modern NIR station. Status not known.	Post medieval	Low
HL29	Fisher's Wagon Works. Belfast, Brougham Street. Site redeveloped.	Post medieval	Negligible
HL30	Gallaher & Co. Tobacco Factory. Belfast, York Street. Site redeveloped.	Modern	Negligible
HL31	Meadow Street Flax Spinning Mill, Corn Mill, Flour Mill, Meadow Street. Site redeveloped.	Post medieval	Negligible
HL32	York Street Foundry. Belfast. Site redeveloped.	Post medieval	Medium
HL33	Saw Mill. Belfast, York Street. Site redeveloped.	Post medieval	Negligible
HL34	York Street Linen Factory (Spinning & Weaving). Belfast, York Street. Site redeveloped.	Post medieval	Negligible
HL36	Mulryne's Coach Building Works. Belfast, North Queen Street. Site redeveloped.	Post medieval	Negligible
HL37	18th century gardens of Clifton House. Registered historic garden.	Post medieval	High
HL38	Starch Works. Belfast, Little Donegall Street. Site redeveloped.	Post medieval	Negligible
HL39	Biscuit Factory. Belfast, Donegall Street. Site redeveloped.	Post medieval	Negligible
HL40	Starch Works. Belfast, York Lane. Site redeveloped	Post medieval	Negligible
HL41	Starch Works. Belfast, Frederick Lane. Site redeveloped.	Post medieval	Negligible
HL42	Foundry, Biscuit Factory. Belfast, Donegall Street. Site redeveloped.	Post medieval, Modern	Medium
HL43	Starch Works, Flour Mill. Belfast, York Lane. Site redeveloped.	Post medieval	Negligible
HL44	Factory. Belfast, Lancaster Street. Site redeveloped.	Unknown	Negligible
HL45	Cotton Manufactory. York Lane. Site now occupied by Irish News.	Post medieval	Negligible

TABLE 6.3.10: EVALUATION OF HISTORIC LANDSCAPE ASSETS			
Asset No.	**Description**	**Period**	**Value**
HL46	Tobacco Factory. York Street. Site redeveloped.	Post medieval	Negligible
HL47	Starch Works. Washington Street. Site redeveloped (from 1920 under housing).	Post medieval	Negligible
HL48	Starch Works. York Street. Possible extant historic building.	Post medieval	Low
HL49	Flax Stores. Academy Street. Site redeveloped.	Post medieval	Negligible
HL50	Bonded Store. Academy Street. Site redeveloped.	Modern	Negligible
HL51	Bonded Store. Between Coates Lane & Charles Lane. Site redeveloped.	Modern	Negligible
HL52	Bonded Store. Great Patrick Street. Site redeveloped.	Modern	Negligible
HL54	Bonded Store. Talbot Street. Site redeveloped.	Post medieval	Negligible
HL55	Phoenix Foundry. Great George's Street. Site redeveloped.	Post medieval	Medium
HL56	Bonded Store. Gordon Street. Possible extant historic building.	Post medieval	Low
HL57	Scott's Bedding Manufactory. Off Gordon Street. Status not known.	Modern	Negligible
HL58	Bonded Store. Albert Quay. Site redeveloped.	Post medieval	Negligible
HL60	Donegall Quay, Belfast. Status not known.	Post medieval	Low
HL61	Bacon Factory. Tomb Street. Site redeveloped.	Post medieval	Negligible
HL62	Bonded Stores. Tomb Street. Possible extant historic building.	Post medieval	Low
HL63	Bacon Factory - Donegall Quay Mills (Flour & Meal). Gamble Street. Site redeveloped.	Post medieval	Negligible
HL64	Distillery / Brewery. Belfast, Corporation Square. Status not known.	Unknown	Negligible
HL65	Engineering Works. Belfast, Great Patrick Street. Possible extant historic building.	Post medieval	Low
HL66	Bonded Store. Belfast, Corporation Street. Site redeveloped.	Modern	Negligible

TABLE 6.3.10: EVALUATION OF HISTORIC LANDSCAPE ASSETS

Asset No.	Description	Period	Value
HL67	Bonded Store (Mitchell & Co. Ltd). Great George's Street. Site redeveloped.	Modern	Negligible
HL68	Engineering Works. Belfast, Great George's Street. Site redeveloped.	Modern	Negligible
HL69	C17 siege of Belfast. Registered battlefield.	1649	Medium
HL70	Town Parks, Belfast. Emergency water supply. Destroyed.	Unknown	Negligible
HL71	Beal-Feirste. Registered battlefield.	1540	Low
HL72	Fearsat (unlocated). Registered battlefield.	665AD	Negligible
HL73	Ford of Belfast (unlocated). Registered battlefield.	1573	Negligible
HL74	Belfast (unlocated). Registered battlefield.	1552	Negligible

6.3.4.5 *Historic Buildings and Conservation Areas*

The listed buildings have been allocated either a **High** or **Medium** value according to the categories defined in **Table 6.3.2**. There are 26 listed buildings and one Conservation Area within the study area (**Table 6.3.11** and shown on **Figure 6.3.1**).

TABLE 6.3.11: EVALUATION OF HISTORIC BUILDING ASSETS

Asset No.	Description	Period	Listing Grade	Value
HB01	St Joseph's RC Church, Prince's Dock Street.	19th century	B1	Medium
HB02	St Joseph's RC, Parochial House, 38 Pilot Street, Belfast.	19th century	B1	Medium
HB03, **HL17**	Clarendon Dock Buildings, Harbour Estate.	19th century	A	High
HB04	Sinclair Seamen's Presbyterian Church, Corporation Square (includes gates & railings)	19th century	B+	High
HB05, **HL19**	Harbour Office, Corporation Square.	19th century	A	High
HB06	Administration and drawing office block (Harland & Wolff), Queen's Road.	20th century	B+	High
HB07	St. Paul's Church of Ireland, York Street.	19th century	B	Medium

TABLE 6.3.11: EVALUATION OF HISTORIC BUILDING ASSETS

Asset No.	Description	Period	Listing Grade	Value
HB08	Walls at burying ground, Henry Place (off Clifton Street).	18th century	B+	High
HB10	Carlisle Memorial Methodist Church, Carlisle Circus.	19th century	B+	High
HB11	The former Carlisle Memorial Church Hall (Indian Community Centre), 86 Clifton Street.	19th century	B+	High
HB12	Belfast Orange Hall, Clifton Street.	19th century	B1	Medium
HB13, HL35	Belfast Charitable Institution (Clifton House), Clifton Street (includes gates, railings & walls)	18th century	A	High
HB14	Gate Lodge at Clifton House, North Queen Street.	20th century	B1	Medium
HB15	Friends Institute, 47 Frederick Street.	19th century	B2	Medium
HB16	Lancaster St. School, (Former Ladies Industrial School), Lancaster Street.	20th century	B2	Medium
HB17	201-205 Donegall Street.	19th century	B1	Medium
HB18	St. Patrick's Parochial House, 199 Donegall Street.	19th century	B	Medium
HB19	St. Patrick's RC Church, Donegall Street.	19th century	B	Medium
HB20	St. Patrick's CB School, Donegall Street.	19th century	B1	Medium
HB21	Irish News Office, 113 Donegall Street.	20th century	B1	Medium
HB22	St. Anne's Cathedral, Donegall Street.	20th century	A	High
HB23, HL53	27-37 Talbot Street.	Pre-1834	B1	Medium
HB24	Northern Bank (Former Corn Exchange), 1-9 Victoria Street.	19th century	B1	Medium
HB25	Head Line Building, 10-14 Victoria Street.	19th century	B1	Medium
HB26	Custom House, Custom House Square.	19th century	A	High
HB27	Calder Fountain, Albert Square.	19th century	B1	Medium
HB28	Cathedral Conservation Area.	Post medieval	-	Medium

6.3.5 ***Predicted Impacts (Operation)***

The following Cultural Heritage assets (**Tables 6.3.12 to 6.3.14**) are located within or in the immediate vicinity of the interchange layout options. It is considered possible that physical or setting impacts are likely to affect these assets and as a result they may require mitigation in the form of preservation by design (including screening and landscaping), preservation in-situ in areas minimally impacted by the scheme, and preservation by record for archaeological assets.

6.3.5.1 *Archaeological Remains*

The various scheme options are predicted to have a range of impacts on the archaeological resource (**Table 6.3.12**):

- Removal of archaeological remains during ground investigations, site clearance and road construction.
- Compaction of archaeological remains due to construction traffic movement or materials storage; damage through rutting of superficial deposits from construction traffic.
- Desiccation of waterlogged archaeological deposits due to drainage, foundation construction, and excavation of deep cuttings; damage caused by changes to hydrology and chemical alteration.
- Vibration causing damage to archaeological remains during construction and operational stages.
- Impact on setting to archaeological assets from new structures and installation features.

TABLE 6.3.12: ARCHAEOLOGICAL ASSETS IMPACTED BY THE PROPOSED SCHEME OPTIONS

Asset No.	Description	Value	Option(s)	Magnitude of Impact (with mitigation)
AR02	***Twin slipways of the Titanic and Olympic ships, Belfast.*** The setting of the SAM has already been affected by the existing road layout located *c.*900m to the west. The addition of new link roads with new installation features would result in No Change or a Negligible impact. Construction of the proposed M2 to Westlink overbridge (with Options B & D) and the Westlink to M2 overbridge (with Option D) would increase the visual impact of the scheme.	High	**A & C**	**No change**
			B & D	**Negligible**
AR03	***Hamilton Graving Docks, Belfast.*** The setting of the SAM has already been affected by the existing road layout located *c.*800m to the west. The addition of new link roads with new installation features would result in No Change or a Negligible impact. Construction of the proposed M2 to Westlink overbridge (with Options B & D) and the Westlink to M2 overbridge (with Option D) would increase the visual impact of the scheme.	High	**A & C**	**No change**
			B & D	**Negligible**

TABLE 6.3.12: ARCHAEOLOGICAL ASSETS IMPACTED BY THE PROPOSED SCHEME OPTIONS

Asset No.	Description	Value	Option(s)	Magnitude of Impact (with mitigation)
AR11	***Area of Archaeological Potential.*** Construction of new link roads required for all options (including the provision of a new minor link to Corporation Street – Option D), the construction of bridge piers & retaining walls, & the realignment of existing roads could impact buried archaeological remains. Appropriate mitigation would include archaeological monitoring of geotechnical investigations, trial trenching & targeted detailed excavation.	Low	**All**	**Minor**
AR12	***The fragmentary buried remains of industrial North Belfast cleared to make way for the post war arterial road network in Zone D.*** Construction of new link roads, the construction of bridge piers & retaining walls & the realignment of a few existing roads could impact fragmentary buried archaeological remains that may survive from previous road construction.	Negligible	**All**	**Moderate**
AR13	***The buried remains of early Holocene land surfaces & post-glacial alluvial, estuarine & marine deposits.*** Excavation of deep cuttings to accommodate new road links and pier bases would impact alluvial deposits of palaeo-environmental significance, resulting in the destruction of the resource and localised desiccation; and may potentially impact upon buried land surfaces that have the potential to contain evidence of Mesolithic occupation /activity.	Medium	**All**	**Minor**

Note: Unaffected sites are not listed.

6.3.5.2 *Historic Landscape*

Most of the historic landscape assets contained in the study area, and listed in the Industrial Heritage Records, consists of references to former premises/buildings that are now demolished, and as a result, where they would be impacted by the various scheme options, they would incur the same impacts as if they were buried archaeological remains. It is considered unlikely that activity associated with these former historic buildings would extend significantly beyond their footprint and into the wider area.

The various scheme options are predicted to have a range of impacts on the historic landscape resource (**Table 6.3.13**):

- Removal of archaeological remains during ground investigations, site clearance and road construction.
- Compaction of archaeological remains due to construction traffic movement or materials storage; damage through rutting of superficial deposits from construction traffic.
- Vibration causing damage to archaeological remains during construction.
- Impact on setting to historic landscape assets from new structures and installation features.

TABLE 6.3.13: HISTORIC LANDSCAPE ASSETS IMPACTED BY THE PROPOSED SCHEME OPTIONS

Asset No.	Description	Value	Option(s)	Magnitude of Impact (with mitigation)
HL16	***Clarendon Mills (Oatmeal), Corporation Street.*** Option D requires a new link to Corporation Street for local access that would result in a significant impact.	Negligible	**A, B & C**	**No change**
			D	**Moderate**
HL18	***Landing stage on outer edge of Clarendon Dock.*** Construction of the proposed M2 to Westlink overbridge (with Options B & D) and the Westlink to M2 overbridge (with Option D) would increase the visual impact of the scheme.	Low	**A & C**	**No change**
			B & D	**Minor**
HL20	***Ferry Terminal. Belfast Car Ferries passenger terminal.*** Construction of the proposed M2 to Westlink overbridge (with Options B & D) and the Westlink to M2 overbridge (with Option D) would increase the visual impact of the scheme.	Low	**A & C**	**No change**
			B & D	**Minor**
HL24	***Engine Sheds. BNCR Branch Line, Bleach Green - Larne Harbour.*** There are views south from the roadside sheds along York Street toward the scheme. Construction of the proposed M2 to Westlink overbridge (with Options B & D) and the Westlink to M2 overbridge (with Option D) would increase the visual impact of the scheme.	Low	**A & C**	**No change**
			B & D	**Minor**
HL60	***Donegall Quay, Belfast.*** Construction of the proposed M2 to Westlink overbridge (with Options B & D) and the Westlink to M2 overbridge (with Option D) would slightly increase the visual impact of the scheme.	Low	**A & C**	**No change**
			B & D	**Minor**

TABLE 6.3.13: HISTORIC LANDSCAPE ASSETS IMPACTED BY THE PROPOSED SCHEME OPTIONS

Asset No.	Description	Value	Option(s)	Magnitude of Impact (with mitigation)
HL67	***Bonded Store (Mitchell & Co. Ltd), Great George's Street.*** Minor works for Options B & C require the provision of revised access arrangements to Shipbuoy Street under the Lagan Bridge that would impact the asset.	Negligible	**A & D**	**No change**
			B & C	**Moderate**
HL68	***Engineering Works, Great George's Street.*** The requirement in Option C for a new link up to 6m below existing ground level (Link D) between Westlink to M3 would result in an impact upon the asset.	Negligible	**A, B & D**	**No change**
			C	**Moderate**

Note: Unaffected sites are not listed.

6.3.5.3 *Historic Buildings*

A number of historic buildings would be indirectly impacted by the various scheme options (**Table 6.3.14**). Those that would incur impacts are located relatively close to the scheme; other buildings, particularly those located within the urban townscape of the city, are unlikely to be affected since they are screened from the scheme by surrounding buildings. The various scheme options are predicted to have a range of impacts on the historic building resource that would affect the setting of a number of the assets. The level of impact has been assessed in accordance with **Table 6.3.5**. There would be no physical impacts on the historic buildings. Impacts could include:

- Damage to the setting of historic buildings.
- Intrusion on the setting of historic buildings.
- Visual and noise intrusion on the setting of historic buildings during road construction and use.
- Vibration from road construction activities and use.

TABLE 6.3.14: HISTORIC BUILDING ASSETS IMPACTED BY THE PROPOSED SCHEME OPTIONS

Asset No.	Description	Value	Option(s)	Magnitude of Impact (with mitigation)
HB01	***St Joseph's RC Church, Prince's Dock Street.*** Fronts onto Prince's Dock Street, located in a residential area with Belfast Docks to the northeast and *c.*250m east of the motorway but with views along the street toward the motorway. Although the setting of St Joseph's RC Church has already been affected by the existing motorway, the feature would be impacted by construction of a new retaining wall required for all options and by either construction of New Dock Street overbridge (Options A & C) or by the proposed new elevated M2 to Westlink overbridge (Options B & D).	Medium	**All**	**Minor**
HB02	***St Joseph's RC Parochial House, 38 Pilot Street.*** Fronts onto Pilot Street, located in a mixed residential and light industrial area *c.*250m east of the motorway. Although enclosed by its street location, there are views through gaps in the buildings southwest toward the motorway. Its setting has already been affected by the existing motorway but the feature would be impacted by construction of the proposed M2 to Westlink overbridge (Options B & D).	Medium	**A & C**	**No change**
			B & D	**Negligible**
HB03, HL17	***Clarendon Dock Buildings, Harbour Estate.*** Located next to Clarendon Docks *c.*225m east of the motorway. It has views to the east over the dock and also uninterrupted views west across to the motorway. Its setting has already been affected by the existing motorway but the feature would be impacted by the proposed M2 to Westlink overbridge (Options B & D) that would intrude visually and would also bring the motorway closer. The proposed M2 to Westlink underpass (Options A & C) would also bring the motorway closer. Construction activities for all options would also impact the asset.	High	**A & C**	**Negligible**
			B & D	**Minor**

TABLE 6.3.14: HISTORIC BUILDING ASSETS IMPACTED BY THE PROPOSED SCHEME OPTIONS

Asset No.	Description	Value	Option(s)	Magnitude of Impact (with mitigation)
HB04	***Sinclair Seamen's Presbyterian Church, Corporation Square.*** The feature fronts onto Corporation Square and Corporation Street and has already been impacted by the motorway corridor that is *c.*55m to the southwest and already on a raised overbridge. Construction of the M2 to Westlink overbridge (Options B & D) to the northwest would be an additional visual intrusion on the setting of the feature. Construction activities for all options would also impact the asset.	High	**A & C**	**Negligible**
			B & D	**Minor**
HB05, HL19	***Harbour Office, Corporation Square.*** The feature fronts onto Corporation Square and is located *c.*90m east of the M3 motorway. There would be very slight affects, resulting in short term impacts caused by construction activities. Construction of the Westlink to M3 and Dock Street to M3 link would result in permanent slight setting impacts. Construction activities for all options would also impact the asset.	High	**All**	**Negligible**
HB07	***St. Paul's Church of Ireland, York Street.*** Located in mixed commercial and residential area *c.*140m west of the M2 motorway. The feature is screened from the motorway to the east but it has distant views to the southeast along York Street to the motorway. Construction of the elevated Westlink to M2 overbridge (Option D) and M2 to Westlink overbridge (Option B & D) would impact the setting of the asset.	Medium	**A & C**	**No change**
			B & D	**Negligible**

TABLE 6.3.14: HISTORIC BUILDING ASSETS IMPACTED BY THE PROPOSED SCHEME OPTIONS

Asset No.	Description	Value	Option(s)	Magnitude of Impact (with mitigation)
HB28	***Cathedral Conservation Area.*** The northern perimeter of the conservation area runs along Dunbar Link and Great Patrick Street and returns south along York Street. There are distant views to the road network from the corner of York Street and Great Patrick Street and along Nelson Street. The works proposed for all options to alter the configuration of Dunbar Link and Nelson Street will have an insignificant affect upon the asset, although construction activities would result in short term increases in noise and dust. In addition the following options would result in Negligible impacts: Options A & C requires the junction of York Street and Great George's Street to be raised & York Street to be raised by 5m with the addition of a new overbridge. Option B would introduce a new elevated overbidge for the M3 to Westlink road & M2 to Westlink. In addition the junction of York Street and Great George's Street would be raised. Option D, same as Option B but with the addition of a new elevated overbridge over York Street.	Medium	**All**	**Negligible**

Note: Unaffected sites are not listed.

6.3.6 *Predicted Impacts (Construction)*

There is a possibility for the discovery of unknown buried archaeological remains, particularly that relate to the historic (18th century and later) development of the site during construction.

There is an unknown but potential risk for the discovery of archaeological remains buried in alluvium (possibly including remains relating to trade along the river, including river craft) or from buried ground surfaces beneath the sleech (Mesolithic or Palaeolithic activity). Remains or deposits contained within or buried beneath the alluvium are likely to be deeply buried and well preserved, including datasets of palaeo-environmental value and interest.

The potential impact of scheme construction on the hydrology of the buried strata is presently not known.

There is a significant risk of contamination as a result of previous industrial processes that have taken place at the site and in the wider area (petrol stations / fuel storage, printing works, food preparation, tobacco works, timber treatment, foundries, ship building and repair, industrial storage). If remediation work is required at the initial or subsequent stages of development of the scheme, it may be necessary to include appropriate archaeological mitigation measures to protect or record the archaeological resource.

6.3.7 *Mitigation and Enhancement Measures*

6.3.7.1 *Archaeological Remains*

During the development of the scheme, mitigation to avoid or reduce adverse impacts on archaeological assets may include the following strategies:

6.3.7.1.1 ***Preservation by design***

- Avoidance of impacts upon buried archaeological remains.

6.3.7.1.2 ***Preservation in-situ***

- Appropriate protection during construction works to avoid damage from machine movements, vibration, crushing and compaction.
- Appropriate physical protection, such as the use of geotextile sheeting in conjunction with the use of imported material to raise ground levels and the sensitive engineering of embankments and retaining walls.

6.3.7.1.3 ***Preservation by record***

- Documentary research (targeted and detailed desk-based research and hydrological and deposit modelling based on geotechnical data and the results of archaeological investigations).
- Evaluation of the archaeological resource by monitoring preliminary geotechnical works, use of archaeological trial trenching.
- Geoarchaeological assessment, recovery and analysis of samples from palaeo-environmental deposits.
- If appropriate, detailed mitigation which may include archaeological excavation and targeted archaeological watching brief work during site clearance (advanced archaeological works ahead of construction – where feasible) and in the main construction phase, and detailed geo-archaeological investigation.

6.3.7.1.4 ***Summary of Possible Mitigation strategies for individual assets***

Table 6.3.15 below provides a detailed summary of possible mitigation strategies for potentially affected archaeological remains, based on predicted impacts given in **Sub-sections 6.3.5 and 6.3.6**.

TABLE 6.3.15: SUMMARY OF POSSIBLE MITIGATION STRATEGIES FOR ARCHAEOLOGICAL REMAINS

Asset No.	Value	Magnitude of Impact	Mitigation Strategy
AR11 Area of Archaeological Potential	Low	All options would have a Minor direct impact on the asset caused by the construction work.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work. Preservation by record would be appropriate mitigation.
AR12 The fragmentary buried remains of industrial North Belfast cleared to make way for the post war arterial road network in Zone D.	Negligible	Construction of the scheme would result in a Moderate direct impact on the asset. The buried remains of former premises are likely to survive in a fragmentary condition caused by clearance works in the 1960s or post WWII and preparatory ground works for the existing road layout. WWII bombing would also have destroyed buildings within Zone D. Pockets of remains may survive and the scheme would result in further destruction of this resource.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work. Preservation by record would be appropriate mitigation.
AR13 The buried remains of early Holocene land surfaces & post-glacial alluvial, estuarine & marine deposits.	Medium	All options would have a Minor direct impact on the buried asset, which it is understood covers an extensive area well beyond the scheme footprint.	Mitigation would include archaeological monitoring of geotechnical investigations and assessment of the palaeo-environmental resource by targeted geoarchaeological borehole recording. This work would inform a strategy for detailed mitigation work. Preservation by record would be appropriate mitigation. Appropriate measures would be taken to ensure that the resource would be protected from damage in areas where deep excavation is not required.

Note: Assets for which no mitigation strategy is anticipated are omitted.

6.3.7.2 *Historic Landscape*

Most of the historic landscape assets that would be impacted by the various scheme options have been demolished, and it would be appropriate to consider mitigation similar to that proposed for buried archaeological remains. Mitigation for historic landscape assets may include the following strategies:

6.3.7.2.1 ***Preservation by design***

- Avoidance of impacts upon buried historic landscape assets.

6.3.7.2.2 ***Preservation in-situ***

- Appropriate protection during construction works to avoid damage from machine movements, vibration, crushing and compaction.
- Appropriate physical protection, such as the use of geotextile sheeting in conjunction with the use of imported material to raise ground levels and the sensitive engineering of embankments and retaining walls.

6.3.7.2.3 ***Preservation by record***

- Documentary research (targeted and detailed desk-based research and hydrological and deposit modelling based on geotechnical data and the results of archaeological investigations)
- Evaluation of the historic landscape assets by monitoring preliminary geotechnical works, use of archaeological trial trenching.
- If appropriate, detailed mitigation which may include archaeological excavation and targeted archaeological watching brief work during site clearance (advanced archaeological works ahead of construction – where feasible) and in the main construction phase.
- Acoustic barriers or low noise road surfacing to mitigate changes in noise levels and ambience.
- Appropriate landscape mitigation to screen key assets and to reduce impacts that would affect historic landscape assets, particularly around junctions and overbridges.

6.3.7.2.4 ***Summary of Possible Mitigation strategies for individual assets***

Table 6.3.16 below provides a detailed summary of possible mitigation strategies for potentially affected historic landscape assets, based on predicted impacts given in **Sub-sections 6.3.5 and 6.3.6**.

TABLE 6.3.16: SUMMARY OF POSSIBLE MITIGATION STRATEGIES FOR HISTORIC LANDSCAPE ASSETS

Asset No.	Value	Magnitude of Impact	Mitigation Strategy
HL16 Clarendon Mills (Oatmeal) Corporation Street. Demolished	Negligible	Option D would result in a Moderate direct impact on the asset. The buried remains of the former premises are likely to survive in a fragmentary condition.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work. Preservation by record would be appropriate mitigation.

TABLE 6.3.16: SUMMARY OF POSSIBLE MITIGATION STRATEGIES FOR HISTORIC LANDSCAPE ASSETS

Asset No.	Value	Magnitude of Impact	Mitigation Strategy
HL67 Bonded Store (Mitchell & Co Ltd), Great George's Street Demolished	Negligible	Options B & C would result in a Moderate direct impact on the asset. The buried remains of the former premises are likely to survive in fragmentary condition.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work. Preservation by record would be appropriate mitigation.
HL68 Engineering Works, Great George's Street Demolished	Negligible	Option C would result in a Moderate direct impact on the asset. The buried remains of the former premises are likely to survive in fragmentary condition.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work. Preservation by record would be appropriate mitigation.

Note: Assets for which no mitigation strategy is anticipated are omitted

6.3.7.3 *Historic Buildings*

During development of the scheme, mitigation to avoid or reduce adverse impacts on historic buildings may include the following strategies:

- Avoidance of impacts upon historic buildings.
- If appropriate, detailed historic building recording ahead of demolition.
- Acoustic barriers or low noise road surfacing to mitigate changes in noise levels and ambience.
- Appropriate historic building mitigation to screen key assets and to reduce impacts that would affect historic buildings, particularly around junctions and overbridges. Due to the height of the proposed overbridges, options for screening are limited.

6.3.7.3.1 ***Summary of Possible Mitigation strategies for individual assets***

Table 6.3.17 below provides a detailed summary of possible mitigation strategies for potentially affected historic building assets, based on predicted impacts given in **Sub-sections 6.3.5 and 6.3.6**.

TABLE 6.3.17: SUMMARY OF POSSIBLE MITIGATION STRATEGIES FOR HISTORIC LANDSCAPE ASSETS

Asset No.	Value	Magnitude of Impact	Mitigation Strategy
HB01 St Joseph's RC Church Prince's Dock Street	Medium	Minor impact. The setting of the asset would be slightly affected by a proposed 7m high retaining wall required for Link A and construction of new overbridges (all options).	Appropriate landscaping could be used in mitigation for the proposed new retaining wall. No mitigation is proposed for the new overbridges.
HB03, **HL17** Clarendon Dock Buildings Harbour Estate	High	Negligible impacts (Options A & C) & Minor impacts (Options B & D)	Acoustic barriers or low noise road surfacing could be used to mitigate changes in noise levels and ambience (Options A & C). No mitigation is proposed for the new overbridge. Controlled working procedures to reduce the impact of construction activities.
HB04 Sinclair Seamen's Presbyterian Church, Corporation Square	High	Negligible short term impacts during construction caused by an increase in dust and noise (Options A & C). Minor permanent impacts caused by construction of elevated overbridges for Options B & D.	No mitigation is proposed for the new overbridges. Working procedures would need to be controlled to reduce the impact of construction activities.
HB05, **HL19** Harbour Office, Corporation Square	High	Negligible impacts.	No mitigation is proposed for the new overbridges. Working procedures would need to be controlled to reduce the impact of construction activities.
HB28 Cathedral Conservation Area	Medium	Negligible impact.	Working procedures would need to be controlled to reduce the impact of construction activities. No mitigation is proposed for the new overbridges.

Note: Assets for which no mitigation strategy is anticipated are omitted

6.3.8 ***Residual Impacts***

6.3.8.1 *Significance of Potential Effects*

The following is an assessment of the significance of effects on the cultural heritage resources, based on the evaluation and assessment of the magnitude of impacts. The methodology for establishing the significance of effects is contained in **Table 6.3.7**.

The significant effects on the cultural heritage assets that the four layout options may create as a result of construction and operation of the proposed scheme are considered. This information is summarised in tabular format (**Table 6.3.18**) and records for each identified asset:

- its value as assessed by a review of the existing baseline conditions
- a description of impacts arising from construction of the options
- the magnitude of impact
- proposed mitigation
- the significance of residual effects.

The options would impact a number of statutory and non-statutorily designated heritage assets. The impact of the proposed scheme on these assets can only be established at the 'Detailed' assessment stage, once the preferred layout option has been selected. In addition to the construction works, consideration would also need to be given to the location of any associated works, such as areas set aside for construction compounds, storage areas and works access roads; and there may also be considerations required for the diversion or replacement of utilities (overground and underground).

TABLE 6.3.18: SUMMARY OF CULTURAL HERITAGE EFFECTS

Asset No.	Name	Value	Impact from scheme Design, Construction & Operation	Mitigation	Magnitude of impact (with mitigation)	Significance of Residual Effect
AR02	Twin slipways of the Titanic and Olympic ships	High	Permanent slight impacts to the setting of the feature as a result of Options B & D.	No mitigation proposed.	Negligible	Slight Adverse
AR03	Hamilton Graving Docks	High	Permanent slight impacts to the setting of the feature as a result of Options B & D.	No mitigation proposed.	Negligible	Slight Adverse
AR11	Area of Archaeological Potential	Low	All options - direct and permanent impact from construction of the scheme.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work.	Minor	Neutral
AR12	The fragmentary buried remains of industrial North Belfast cleared to make way for the post war arterial road network in Zone D	Negligible	Permanent direct impacts caused by construction.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work.	Moderate	Neutral
AR13	The buried remains of early Holocene land surfaces & post-glacial alluvial, estuarine & marine deposits	Medium	Permanent direct impacts caused by construction.	Mitigation would include archaeological monitoring of geotechnical investigations and assessment of the palaeo-environmental resource by targeted geoarchaeological borehole recording. This work would inform a strategy for detailed mitigation work. Appropriate measures would be taken to ensure that the resource would be protected from damage in areas where deep excavation is not required.	Minor	Slight Adverse

TABLE 6.3.18: SUMMARY OF CULTURAL HERITAGE EFFECTS

Asset No.	Name	Value	Impact from scheme Design, Construction & Operation	Mitigation	Magnitude of impact (with mitigation)	Significance of Residual Effect
HL16	Clarendon Mills (Oatmeal), Corporation Street	Negligible	Option D would result in permanent direct impacts from construction.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work.	Moderate	Neutral
HL18	Landing stage on outer edge of Clarendon Dock	Low	Permanent slight impacts to the setting of the feature as a result of Options B & D.	No mitigation proposed.	Minor	Neutral
HL20	Ferry Terminal. Belfast Car Ferries passenger terminal	Low	Permanent slight impacts to the setting of the feature as a result of Options B & D.	No mitigation proposed.	Minor	Neutral
HL24	Engine Sheds. BNCR Branch Line, Bleach Green - Larne Harbour	Low	Permanent slight impacts to the setting of the feature as a result of Options B & D.	No mitigation proposed.	Minor	Neutral
HL60	Donegall Quay	Low	Permanent slight impacts to the setting of the feature as a result of Options B & D.	No mitigation proposed.	Minor	Neutral
HL67	Bonded Store (Mitchell & Co. Ltd). Great George's Street	Negligible	Options B & C would result in permanent direct impacts from construction.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work.	Moderate	Neutral

TABLE 6.3.18: SUMMARY OF CULTURAL HERITAGE EFFECTS

Asset No.	Name	Value	Impact from scheme Design, Construction & Operation	Mitigation	Magnitude of impact (with mitigation)	Significance of Residual Effect
HL68	Engineering Works. Great George's Street	Negligible	Option C would result in permanent direct impacts from construction.	Documentary research at Detailed Assessment stage; deposit modelling; monitoring of geotechnical works; and archaeological trial trenching to inform a strategy for detailed mitigation work.	Moderate	Neutral
HB01	St Joseph's RC Church Prince's Dock Street	Medium	All options - permanent slight impacts to the setting of the feature.	Appropriate landscaping could be used to screen the proposed high retaining wall. No mitigation is proposed for the proposed new overbridges.	Minor	Slight Adverse
HB02	St Joseph's RC, Parochial House, 38 Pilot Street	Medium	Options B & D - permanent slight impacts to the setting of the feature.	No mitigation is proposed.	Negligible	Neutral
HB03, **HL17**	Clarendon Dock Buildings, Harbour Estate	High	All options - permanent slight impacts to the setting of the feature & short term impacts from construction.	Acoustic barriers or low noise road surfacing could be used to mitigate changes in noise levels and ambience (Options A & C). No mitigation is proposed for the proposed new overbridge (Options B & D). Controlled working procedures during construction.	Minor	Slight Adverse
HB04	Sinclair Seamen's Presbyterian Church, Corporation Square	High	Short term impacts from construction and for Options B & D permanent slight impacts to the setting of the feature.	Controlled working procedures during construction. No mitigation is proposed for the proposed new overbridge.	Minor	Slight Adverse
HB05, **HL19**	Harbour Office, Corporation Square	High	Short term impacts from construction and for Options A, B & C permanent slight impacts to the setting of the feature.	Controlled working procedures during construction. No mitigation is proposed for the proposed new overbridges.	Negligible	Slight Adverse

TABLE 6.3.18: SUMMARY OF CULTURAL HERITAGE EFFECTS

Asset No.	Name	Value	Impact from scheme Design, Construction & Operation	Mitigation	Magnitude of impact (with mitigation)	Significance of Residual Effect
HB07	St. Paul's Church of Ireland, York Street	Medium	Options B & D would result in permanent slight impacts to the setting of the feature.	No mitigation is proposed.	Negligible	Neutral
HB28	Cathedral Conservation Area	Medium	All options - short term impacts from construction & permanent slight impacts to the setting of the feature.	Controlled working procedures during construction. No mitigation is proposed for the proposed new overbridges.	Negligible	Neutral

6.3.9 ***Summary and Conclusions***

Options A and C would have the greater impact upon the buried archaeological resource, since they require extensive areas of excavation; however Options B and D would result in greater impacts upon the setting of a number of designated listed buildings. All options would result in a Slight Adverse effect upon the cultural heritage but overall Option A would be the preferred junction layout since it would result in the least number of designated assets being affected. No scheduled monuments would be impacted but four listed buildings that are of high and medium value would be impacted (two at grade A, one at B+ and one at B1). There would also an impact upon a conservation area and three non-designated archaeology assets. Options B and D would result in the greatest number of impacts upon all elements of the cultural heritage (archaeology, historic landscape features and historic buildings) both designated and non-designated.

6.3.9.1 *Option A*

There would be three Neutral residual effects on archaeological remains and historic buildings; and five Slight Adverse effects on archaeological remains and historic buildings as a result of this option.

There would be Neutral residual effects on two undesignated archaeology assets (**AR11**, **AR12**) and a Slight Adverse effect on one other (**AR13**). Appropriate archaeological mitigation (preservation by record) would minimise the adverse impacts. There would be Neutral effects on one designated conservation area, the Cathedral Conservation Area (**HB28**) and Slight Adverse effects on four other designated historic buildings (**HB01, HB03**/**HL17**, **HB04** and **HB05** /**HL19**).

6.3.9.2 *Option B*

There would be ten Neutral residual effects on all three elements of the cultural heritage (archaeological remains, historic landscape and historic buildings); and six Slight Adverse effects on the cultural heritage as a result of this option.

There would be Neutral residual effects on two undesignated archaeology assets (**AR11**, **AR12**) and a Slight Adverse effect on three other assets, including two Scheduled Monuments (**AR02**, **AR03**) and one undesignated asset (**AR13**). There would be Neutral effects on five historic landscape features (**HL18**, **HL20**, **HL24**, **HL60** and **HL67**). There would be Neutral effects on three designated historic buildings (**HB02**, **HB07 and HB28**) and Slight Adverse effects on four other designated historic buildings (**HB01**, **HB03** /**HL17**, **HB04** and **HB05** /**HL19**).

6.3.9.3 *Option C*

There would be five Neutral effects on all three elements of the cultural heritage; and five Slight Adverse effects on archaeological remains and historic buildings as a result of this option.

There would be Neutral residual effects on two undesignated archaeology assets (**AR11**, **AR12**) and a Slight Adverse effect on one other (**AR13**). There would be Neutral effects on two historic landscape features (**HL67** and **HL68**). There would be Neutral effects on one designated historic building (**HB28**) and Slight Adverse effects on four other designated historic buildings (**HB01, HB03** /**HL17**, **HB04** and **HB05** /**HL19**).

6.3.9.4 *Option D*

There would be eleven Neutral effects on all elements of the cultural heritage and six Slight Adverse effects on archaeological remains and historic buildings as a result of this option.

There would be Neutral residual effects on two undesignated archaeology assets (**AR11**, **AR12**) and a Slight Adverse effect on three other assets, including two Scheduled Monuments (**AR02**, **AR03**) and one undesignated asset (**AR13**). There would be Neutral effects on six historic landscape features (**HL16**, **HL18**, **HL20**, **HL24, HL60** and **HL67**). There would be Neutral effects on three designated historic buildings (**HB02**, **HB07** and **HB28**) and Slight Adverse effects on four other designated historic buildings (**HB01**, **HB03** /**HL17**, **HB04**, and **HB05** /**HL19**).

6.4 Ecology and Nature Conservation

6.4.1 *Introduction*

The Design Manual for Roads and Bridges (DMRB) defines ecology as 'the scientific study of living organisms and their relationship with each other and their environment' whilst nature conservation is concerned with 'maintaining a viable population of the country's characteristic fauna and flora and the communities which they comprise'.

This section of the report examines the ecological and nature conservation aspects associated with each of the scheme layout options; the environmental protection which exists within the area; and the potential impact of the proposed scheme on ecology and nature conservation interests within the study area.

The principal objective of the Ecological Assessment at Stage 2 is to undertake sufficient assessment to identify the nature conservation factors, and the significance of effects upon them, to be taken into account in developing and selecting a preferred layout option.

6.4.2 *Approach and Methods*

This assessment has been based on current best practice outlined in legislation and planning policy and incorporates many of the principles set out in the guidance for ecological impact assessment developed by a working group of the Institute of Ecology and Environmental Management (IEEM) (IEEM, 2006) and is based on guidance set out in DMRB Volume 11 (including Interim Advice Note 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment IAN 130 (2010)).

The objective of DMRB Volume 11, Section 3, Part 4 in relation to nature conservation is concerned with maintaining a viable population of the country's characteristic fauna and flora and the communities they comprise. This objective can be achieved as follows:

- the maintenance of the diversity and character of the countryside, including its wildlife communities and important geological and physical features
- the maintenance of viable populations of wildlife species, throughout their traditional ranges, and the improvement of the status of rare and vulnerable species.

In accordance with the requirements of DMRB 11.3.4.7 (Stages of Ecological Assessment), the steps to be taken include:

- Consultation with Northern Ireland Environment Agency (NIEA) – Natural Heritage, to confirm that the details on the location and nature of any designated sites within the study area have not changed or new sites designated since Stage 1, and to collate information on any further surveys that have been undertaken since that time.

- Where the Stage 1 assessment and subsequent verification indicate that there is no evidence that any nature conservation interest will be significantly affected by a layout option, confirm with NIEA – Natural Heritage that further work is not required.

Baseline information has been compiled by detailed desktop assessment, compiling information from a number of sources. Information regarding species and habitat status, and designations of relevance to the site was obtained through consulting the Northern Ireland Biodiversity Strategy; Belfast Metropolitan Area Plan (BMAP) (draft) 2015; the relevant Northern Ireland Habitat Action Plans; Northern Ireland Species Action Plans; and the UK Biodiversity Action Plan (BAP). The NIEA website was reviewed together with the Habitas Website (Ulster Museum), as a means of providing baseline information relating to protected species, where they have occurred within close proximity to the interchange layout options.

The existing ecological information was reviewed by an experienced ecologist, including conditions for all approved junction layout options and surrounding area within a 500m buffer. Recent aerial photography for areas of nature conservation interest, including semi-natural habitats, green corridors and areas of potential nature conservation interest were examined.

The habitat assessment was carried out during August and September 2011, using the Phase 1 methodology - Joint Nature Conservation Committee (JNCC), 2003 and protected species assessments. The entire corridor and adjacent habitats were walked by URS ecologists, noting plant communities, habitats, landscape features of ecological value, potential habitats for different ecological groups, and signs of any mammals and other species.

A walkover survey was undertaken to establish the site's key ecological receptors including protected mammals (e.g. Badgers and Otters etc.) that are protected at all times under Schedule 5 of the Wildlife (Northern Ireland) Order 1985 (as amended) and the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended).

The Northern Ireland Bat Group requested an assessment of scheme effects on bats be undertaken as part of Stage 2, including on-the-ground surveys in 2011, in accordance with NIEA specifications. NIEA also suggested that the impact on bats in the area should be investigated as part of the Environmental Assessment (**Table 6.4.1**). As a result, a bat activity survey was carried out to identify potential roosting and foraging areas of bats.

The research and surveys culminated in the preparation of two constraints maps showing the various designated sites (**Figure 6.4.1**), other areas of local ecological and nature conservation interest (**Figure 6.4.2**) and bat survey drawings (**Figures 6.4.3A and 6.4.3B**). A statement is also provided, setting out the nature conservation interest of the area, including sites regarded as being a constraint.

6.4.2.1 *Consultation*

During the review of the approved interchange layout options, the following statutory and non-statutory organisations were consulted. A summary of their responses and any suggested actions that would be required, are detailed in **Table 6.4.1**.

TABLE 6.4.1: ECOLOGICAL CONSULTEE RESPONSES

Organisation	Response
Council for Nature Conservation and the Countryside (CNCC)	No relevant information provided.
CEDaR Biological Records	Records of species occurring within the study area were provided.
The National Trust	No relevant information provided.
NIEA – Natural Heritage	NIEA - Natural Heritage would have no preferences in the Interchange Layout Options at Stage 2, however impact on bats in the area should be investigated as part of the Environmental Assessment, as the area may be a potential foraging area.
Northern Ireland Badger Group	No response.
Northern Ireland Bat Group	Site-based inspection and survey by suitably qualified bat specialist is recommended (as stated in DMRB). An assessment of scheme effects on bats should be undertaken as part of the Stage 2, including on-the-ground surveys in 2011 in accordance with NIEA specifications. By undertaking European Protected Species (EPS) survey, the assessment of the EPS along with the assessment of European Protected Sites could be included, in advance of Statutory Procedures.
Planning NI – Tree Preservation Order	There are no TPOs which would be affected by the Interchange Layout Options.
Royal Society for the Protection of Birds (RSPB)	RSPB have no preferences on any of the Interchange Layout Options. As potential impact upon Belfast Lough via the River Lagan is expected, appropriate measures regarding water pollution, noise & dust emission should be implemented and a Construction Environmental Management Plan (CEMP) presented. Removing any unused bird nests should be done outside of the breeding season (March-August).
Ulster Wildlife Trust	No response.
Woodland Trust	There is no foreseeable effect on Woodland Trust interests.

The Ulster Wildlife Trust did not provide an official response either during the Stage 1 or Stage 2 environmental consultation. Consulted at Stage 2, the Northern Ireland Badger Group did not introduce any comments at that time.

6.4.3 *Regulatory/Policy Framework*

6.4.3.1 *Legislation*

Nature conservation legislation aims to conserve and protect wildlife and its habitats through designation of protected areas or sites, such as Areas of Special Scientific Interest (ASSI). It also creates criminal offences for intentional, deliberate or reckless capturing, killing, disturbing protected animals and picking, collecting, cutting, uprooting, destroying or trading in protected plants.

This subsection takes into account the requirements of the following legislation:

- Ramsar Convention 1971
- Bonn Convention 1979
- Bern Convention 1979
- Biodiversity Convention 1992
- EC Birds Directive 1979 (as amended 2009) (2009/147/EC – codified version of Directive 79/409/EEC as amended)
- EC Habitats Directive 1992 (92/43/EEC)
- Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended)
  - Recent UK case law has clarified that planning authorities, in exercising their planning and other functions, must have regard to the requirements of the EC Habitats Directive when determining a planning application, as prescribed by Regulation 3(4) of the above regulations. Such due regard means that planning authorities must determine whether the proposed development meets the requirements of Article 16 of the Directive before planning permission is granted (where there is a reasonable likelihood of European Protected Species [for this scheme these are bats] being present). Therefore in the course of its consideration of a planning application, where the presence of a European protected species is a material consideration, the planning authority must satisfy itself that the proposed development meets the following three tests as set out in the Directive.
  - The proposed development must meet a purpose of (i) 'preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment'. In addition the authority must be satisfied that (ii) 'there is no satisfactory alternative' and (iii) 'that the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range' (Natural England, 2009).
- The Wildlife (Northern Ireland) Order 1985 (as amended);
- The Wildlife and Natural Environment Act (Northern Ireland) 2011;
- The Fisheries Act (Northern Ireland) 1966 (as amended);
- The Nature Conservation and Amenity Lands (Northern Ireland) Order 1985 (as amended);
- The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 1999 (as amended);
- The Environment (Northern Ireland) Order 2002 (as amended);

- The Environmental Liability (Prevention and Remediation) Regulations (Northern Ireland) 2009 (as amended); and
- The Welfare of Animals Act (Northern Ireland) 2011.

The EcIA process requires that valued ecological receptors affected by the scheme are addressed to determine their value and sensitivity to impacts, the nature, scale and duration of any impacts (both direct and indirect) of the scheme upon sensitive receptors, identification of potential mitigation measures to avoid or reduce adverse impacts and an assessment of the significance of any residual effects.

An Environmental Assessment is only required to report significant effects. A significant effect may be broadly defined as one that should be brought to the attention of those involved in the decision-making process. It is broadly accepted that significance is defined through the combination of the magnitude (scale) of the impact and the value (importance) of the ecological receptor experiencing that impact. Specifically, as advised within the IEEM EcIA Guidelines, significance is considered in relation to how the impact will affect the conservation status and integrity of the receptor/ecological processes, where integrity is understood as:

"The coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified".

6.4.4 *Planning Policy*

Planning policy relevant to ecology and nature conservation is listed below. Planning Policy Statements (PPS) and other planning policy documents or guidance directly relevant to this chapter comprises:

- PPS 2: Planning and Nature Conservation (Consultation Draft Revised Mar 2011)
- DCAN 10: Environmental Impact Assessment 1999
- Belfast Metropolitan Area Plan 2015 (draft) (in particular the following policies):
  - Policy ENV 1 Protection of Biodiversity
  - Policy ENV 2 Sites of Local Nature Conservation Importance
  - Policy ENV 3 Local Landscape Policy Areas.
- UK Biodiversity Action Plan 1995 (as amended)
- All Ireland Species Action Plans
- Northern Ireland Biodiversity Action Plan (as amended)
- Highways Agency Biodiversity Action Plan (relevant application to Northern Ireland)
- "Duty to conserve biodiversity" under the Wildlife and Natural Environment (Northern Ireland) Act 2011. (As applied to all public bodies).

6.4.5 *Ecological Guidance and Good Practice*

- Institute of Ecology and Environmental Management (IEEM) (2006) Guidelines for Ecological Impact Assessment in the UK
- DMRB Volumes 10 and 11 (http://www.dft.gov.uk/ha/standards/dmrb/ consulted January 2012)
- DMRB Interim Advice Note 116/08 Nature Conservation Advice In Relation To Bats (http://www.dft.gov.uk/ha/standards/dmrb/ consulted January 2012)

- DMRB Interim Advice Note 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment (http://www.dft.gov.uk/ha/standards/dmrb/ consulted January 2012)
- BS 5837:2005 Trees in relation to construction (2005)
- NIEA Protected Species Guidance for Development Management
- NIEA Bats and Development (2008)
- Bat Mitigation Guidelines for Ireland (2006)
- Trees and Development: A Guide to Best Practice (2003).

6.4.6 *Environmental Legislation and Policy Requirements*

In addition to the general legal requirements that must be considered in relation to potential environmental impacts of proposed developments, certain habitats and species are afforded legal protection under European and national law.

Several international conventions are implemented by European Directives and in turn by national legislation. The Bern Convention, the EC Habitats Directive and EC Birds Directive are implemented by The Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended), which protects habitats listed in the Habitats Directive Annex 1, and species listed in Annex IV (a), such as bats, through their inclusion in Schedule 2 to the Conservation Regulations.

The Wildlife (Northern Ireland) Order 1985 (as amended) also implements the requirements of the European Directives. Wild birds are protected and special penalties are available for offences related to birds listed in Schedule 1 and other animals through their inclusion in Schedule 5 to the Order. This makes it an offence to intentionally kill, injure, or take an animal, or to damage, destroy or obstruct access to its resting place. The legislative requirements associated with these protected habitats and species, and the implications of these for the proposed scheme are considered below.

Under the Wildlife and Natural Environment (Northern Ireland) Act 2011 (WANE), public bodies including local planning authorities have a duty to conserve biodiversity during the course of their duties.

6.4.6.1 *Statutory Designated Sites*

European sites (SAC and SPA), including candidate or proposed sites, are fully protected by the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended). Ramsar Sites (wetlands of international importance designated under the Ramsar Convention 1971) are afforded similar legal protection to European sites.

Areas of Special Scientific Interest (ASSI) are a national suite of sites that provide statutory protection for the best examples of habitats, flora, fauna, geological or physiographical features. In Northern Ireland, NIEA is the statutory nature conservation organisation responsible for identifying and protecting these special sites. ASSIs are protected against certain potentially damaging operations, which must be authorised by NIEA.

6.4.6.2 *Habitats*

Biodiversity Action Plan (BAP) priority habitats for conservation are identified in UK (UK BAP) and Regional (NI BAP). Priority habitats are of principal importance for conserving biodiversity within the geographical area of reference. Where possible such habitats must be protected from adverse impacts and where impacts are unavoidable, provision of sufficient compensatory habitat is advocated by planning policy.

Non-priority habitats (outside of protected sites) are common and widespread habitats. Such habitats are not subject to specific policy or legislative protection, but often have intrinsic value or form part of habitat networks supporting species and facilitating their dispersal. In some cases areas of non-priority habitat can be important 'functional land', supporting species within neighbouring protected sites, or may buffer protected sites from nearby changes in land use or development.

6.4.6.3 *Invasive Non-Native Species*

The Wildlife (Northern Ireland) Order 1985 (as amended) makes it an offence to cause Japanese knotweed or Himalayan balsam to grow in the wild. Excavated soil containing Japanese knotweed or Himalayan balsam tissue should be disposed of in a manner to comply with the Order.

6.4.6.4 *Bats*

Bats are protected under the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended). There are provisions in the legislation to allow actions to take place under licence that would otherwise contravene the above law. Licences must be obtained from NIEA for any activities that involve the taking or disturbance to European Protected Species or their resting places (bat roosts). Bats must not be disturbed and roosts must not be damaged, destroyed or obstructed during the construction works without a licence. Granting of a licence would ensure appropriate and proportionate mitigation is employed as a legal requirement under the terms of such a licence.

6.4.6.5 *Birds*

All wild birds are protected from intentional or reckless killing, injury and taking under the Wildlife (Northern Ireland) Order 1985 (as amended).

The nests and contents of breeding birds are protected against intentional or reckless taking, damage or destruction while in use or being built. Species listed in Schedule 1 to the Wildlife Order are protected by special penalties at all times from intentional or reckless killing and injuring and from intentional or reckless disturbance to the adults or dependent young while they are at or near a nest site.

6.4.7 ***Baseline Conditions***

6.4.7.1 *Statutory Designated Sites*

With reference to NIEA - Natural Heritage digital data sets of designated ecological sites, it is evident that there are no national or international sites within the immediate study area, however, several are located within the wider area (**Figure 6.4.1**).

Belfast Lough, located approximately 1.5 km northeast of the study area is designated at both national and international level. The inner part of the lough comprises areas of intertidal foreshore, which includes mudflats and lagoons, and reclaimed land which form important feeding/roosting sites for significant numbers of wintering waders and wildfowl. The outer lough is restricted to mainly rocky shores, with some small sandy bays and beach-head saltmarsh. The shoreline of mudflats, sandy bays and rocky shores are designated as an Area of Special Scientific Interest (ASSI), a Ramsar site, and a Special Protection Area (SPA). The open water portion of the lough is designated separately as a SPA. The ASSI designations consist of two separate sites; Inner Belfast Lough ASSI and Outer Belfast Lough ASSI.

Inner Belfast Lough ASSI is designated for the internationally important number of wintering Redshank it holds. The site encompasses the southern part of Belfast Lough and contains important feeding and roosting sites for overwintering waders and wildfowl, particularly Redshank (Tringa totanus), Oystercatcher (Haematopus ostralegus), Goldeneye (Bucephala clangula) and Scaup (Aythya marila) which feed in the area at high water. Although artificial in origin, Victoria Park Lake (also included within this designation) is an example of a brackish lagoon. Inner Belfast Lough ASSI also contains several Earth Science Conservation Review (ESCR) sites of national geological interest in the form of Ordovician, Carboniferous and Permian features (**Section 6.11**).

Outer Belfast Lough ASSI is important geologically, due to the Ordovician series of spilitic lavas, black shales and greywackes, amongst other series located here. The area consists of a varied habitat including boulder and rock shore, open mud flats, extensive mussel beds and a narrow shoreline strip of semi-natural vegetation including small, isolated pockets of beach-head saltmarsh. This outer lough area supports important populations of Great Crested Grebe (Podiceps cristatus) and nationally important wintering populations of Oystercatcher (Haematopus ostralegus), Ringed Plover (Charadrius hiaticula), Redshank (Tringa totanus) and Turnstone (Arenaria interpres), as well as providing feeding areas for birds from the nearby Inner Belfast Lough ASSI.

The Belfast Lough Ramsar site is designated as it is a wetland of international importance. It provides a habitat for the significant numbers of Redshank (Tringa totanus), it supports during the winter. Nationally important numbers of Shelduck (Tadorna tadorna), Oystercatcher (Haematopus ostralegus), Dunlin (Calidris alpine) and Purple Sandpiper (Calidris maritime) are also supported, amongst others such as Black-tailed Godwit (Limosa limosa), Bar-tailed Godwit (Limosa lapponica), Curlew (Numenius arquata) and Turnstone (Arenaria interpres). The Ramsar boundary in Belfast Lough is entirely coincident with the Special Protection Area (SPA), covering a total area of 432.14 hectares, and is coincident with all of Outer Belfast Lough ASSI and most of Inner Belfast Lough ASSI.

The Belfast Lough SPA designation is attributed to the area being an internationally important site for breeding, overwintering and migrating birds. These birds are the same population sustained by the Ramsar site. Belfast Lough Open Water SPA is designated for the internationally important numbers of Great Crested Grebe (Podiceps cristatus) that it supports.

Belfast Lough Open Water SPA takes in the portion of open sea lough surrounded by the other designations. It continues out into the lough to its eastern boundary, passing between Kilroot and Horse Rock. The site qualifies under Article 4.2 of the 2009/147/EC – codified version of Directive 79/409/EEC (as amended) as it supports an internationally important wintering population of Great Crested Grebe (Podiceps cristatus).

Within the designated Ramsar, SPA and ASSI sites, but also situated within the industrial Belfast Harbour Estate is an area of land, just under 14ha, maintained as Belfast Lough Nature Reserve by the Royal Society for the Protection of Birds (RSPB). This area includes mudflats, grassland and a pool & ditch complex, as well as a lagoon with a hide and viewpoints. The RSPB provide an educational programme for schools, including use of an observation room to view the birds. Belfast Lough Nature Reserve is situated approximately 3.5km to the north west of the study area, on the opposite bank of Belfast Harbour.

6.4.7.2 *Sites of Local Nature Conservation Importance*

In accordance with PPS 2 (Planning and Nature Conservation), 41 Sites of Local Nature Conservation Importance (SLNCI's) are designated within Belfast City Council Area. Such sites are of nature conservation importance on the basis of their flora, fauna or earth science interest.

With reference to the Countryside Assessment (Vol. 2) Technical Supplement of the Belfast Metropolitan Area Plan 2015 (Draft Plan) and **Figure 6.4.1**, there are a number of SLNCI's in the wider study area. All sites are located approximately 2km away from the immediate study area with the exception of Alexandra Park, which is situated approximately 500m away, and Waterworks Park, which is situated approximately 1200m away. Both Alexandra Park and Waterworks Park are classified as a Local Landscape Policy Area (LLPA); moreover Alexandra Park is classified as a Historic Park, Garden and Demesne.

Alexandra Park has been a public park since 1887. The land was bought by Belfast Corporation to establish a park in north Belfast. It contains a pond, semi-natural scrub complex, and a wooded glen. The Park has been owned and managed by Belfast City Council since 1888 and has public access.

Waterworks Park SLNCI is an inner city reservoir of local importance for water birds. It is an area of local conservation interest and area of local amenity importance. It contains two large water features; one a former reservoir, and the other part of a formal Victorian / Edwardian Park, based on a designated watercourse. The area is of recreation value in a high-density urban area and is an important part in the chain of the landscape linkage from Shore Road.

6.4.7.3 *Habitats*

TABLE 6.4.2: MAIN HABITAT TYPES RECORDED WITHIN THE STUDY AREA

Habitat Type	Approximate Area (m^2)
Bare ground	33,418
Broad-leaf plantation woodland	11,394
Scrub – dense / continuous	10,715
Amenity grassland	3,028
Introduced shrub	2,838
Scattered broad-leaf trees	2,150
Tall ruderal	831
Semi-improved neutral grassland	686
Scrub - scattered	465

The study area consists of a high-density urban mix of various land uses for commercial use, housing, and the western side of the Port of Belfast. ‘Natural habitats’ have virtually all been created and mainly date from landscaping following construction of the M3 and its various connecting slip-roads during the 1990s.

Bare ground comprises the largest habitat area (**Table 6.4.2**), and often occurs interspersed with sparse flora. Broad-leaf plantation woodland and introduced scrub, particularly along the M2 and M3 Motorway embankments (**Figure 6.4.2**), also make up sizeable areas. These trees, shrubs and small areas of amenity planting in the vicinity of the York Street junction are of low ecological value but of slightly greater value than an otherwise non-natural surrounding urban environment. Other habitats present within the study area include scattered trees within amenity grassland, tall ruderal, species-poor semi-improved grassland and scattered scrub.

6.4.7.3.1 ***Broad-Leaf Plantation Woodland***

Although the study area is dominated by an urban hard standing landscape, a number of parcels of woodland plantation occur, particularly in the middle of the study area, along the M2 motorway, along both the M2 Nelson Street off-slip and M2 York Street on-slip, and also under Dargan Bridge.

The majority of existing plantation woodland occurs on sloping earth banks, planted approximately 16 years ago during construction of the M3, around 1995. Dominant species include Alder (*Alnus sp.*) and Sycamore (*Acer pseudoplatanus*). Other species include Oak (*Quercus petraea*), Rowan (*Sorbus aucuparia*), Silver Birch (*Betula pendula*), Lime (*Tilia sp.),* Willow (*Salix sp.),* and Poplar (*Populus nigra*). Ground flora includes Ivy (*Hedera helix*), Bramble (*Rubus fruticosus agg.*)*,* Ribwort plantain (*Plantago lanceolata*), Greater plantain (*Plantago major*), Dog Rose (*Rosa canina agg*.), Bedstraw (*Galium avensi*), and Stinging Nettle (*Urtica dioica*), Common Bent (*Agrostis capillaris*), Creeping Meadow Grass (*Poa supina*) and other grass species.

6.4.7.3.2 ***Scrub***

Dense scrub comprises woody plants usually less than 5m tall, occasionally with a few scattered trees. It is prevalent within a number of areas, particularly along the edge of the Westlink, and adjacent to York Link and the M2 motorway. It consists of mainly of Privet (*Ligustrum sp*.), Dogwood (*Cornus alba*), Buddleia (*Buddleja davidii*), Elder (*Sambucus nigra*), Willow (*Salix sp*.), and Bramble.

Small parcels of introduced shrubs (ornamental planting) occur around the Yorkgate Railway Station and adjacent to retail units along Nelson Street. They consist of mainly shrubs and hedging including *inter alia* Cotoneaster (*Cotoneaster* sp.), and Laurel (*Prunus* sp.).

6.4.7.3.3 ***Scattered Scrub and Trees***

Scattered (ornamental) trees and scrub have also been planted as landscaping in stretches along York Street, Nelson Street and around Galway House car park. *Cotoneaster* and *Sorbus* are commonly occurring species.

6.4.7.3.4 ***Bare Ground***

Considerable areas of bare ground exist within the study area, occurring particularly under Dargan Bridge and where buildings or sites have been cleared. A wide variety of the usual array of derelict ground species occur sparsely within these areas and they provide limited wildlife value. Rosebay Willowherb (*Chamerion angustifolium*) and Buddleia are the most prevalent species of vegetation in these areas. Other common wasteland species include Creeping Thistle (*Cirsium arvense*), Creeping Buttercup (*Ranunculus repens*), Gorse (*Ulex europaeus*), Meadow Vetchling (*Lathyrus pratensis*), Mugwort (*Artemisia vulgaris*), Nipplewort (*Lapsana communis*), Coltsfoot (*Tussilago farfara*), Fat-hen (*Chenopodium album*), Black Medic (*Medicago lupulina*), Horsetail (*Equisetum*), Ribwort plantain (*Plantago lanceolata*), Greater plantain (*Plantago major*), Red Clover (*Trifolium pratense*), White Clover (*Trifolium repens*), Dandelion (*Taraxacum sp*.), Yarrow (*Achillea millefolium*), Common Couch (*Elytrigia repens*), Yorkshire Fog (*Holcus lanatus*), and False-oat grass (*Arrhenatherum elatius*).

6.4.7.3.5 ***Grasslands***

Most amenity grasslands comprise intensively managed swards of standard species, such as Perennial rye grass (*Lolium perenne*), Red fescue (*Festuca rubra*), and Sheep fescue (*Festuca ovina*). Herbs such as White clover, Dandelion, and Creeping buttercup are also present. The grass area adjacent to the M2 southbound off-slip at Nelson Street has a sward rich in herbs (Creeping thistle predominating as well as Mugwort (*Artemisia vulgaris*), and Gorse) and should be classified as semi-improved neutral grassland.

6.4.7.3.6 ***Watercourses***

There is one significant watercourse within the vicinity of the junction, the River Lagan. It drains a catchment of approximately 576km^2 in the southeast of the Province. The Lagan flows into Belfast Lough, to the east of the M2 motorway. The river is tidal at this point, and as such is not monitored for its biological or chemical quality. The river contains various ecologically significant habitats over its length, although all are upstream and none are in proximity to the immediate study area. The Mile Water, located at the north end of the site and flows under the M2 Motorway into the Herdman Channel is culverted throughout the entire study area.

6.4.7.3.7 ***Invasive Species***

A single plant of Japanese Knotweed (*Fallopia japonica*) was noted in derelict land behind Galway House. The Wildlife (Northern Ireland) Order 1985 (as amended) states that it is an offence to cause this species to grow in the wild. Waste containing Japanese knotweed should be disposed of in accordance with this Order.

6.4.7.4 *Protected Mammals*

During several site visits, an assessment was made of the likely occurrence of protected mammals such as Badger (*Meles meles*), Irish Hare (*Lepus timidus hibernicus*), and Red Squirrel (*Sciurus vulgaris*) all of which are protected at all times under Schedule 5 of the Wildlife (NI) Order 1985 (as amended). Otter (*lutra lutra*) are protected under the Conservation (Natural Habitats etc.) Regulations (Northern Ireland) 1995 (as amended). No evidence was found for any of the aforementioned species or any additional important species.

6.4.7.4.1 ***Bats***

Following a consultation request, a bat survey was undertaken to identify the level of bat activity in the area, despite the sub-optimal, built-up, urban nature of the environment.

Eight species of bats occur in Northern Ireland (**Table 6.4.3**) all of which are European Protected Species (EPS), protected through the Conservation (Natural Habitats etc.) Regulations (Northern Ireland) 1995 (as amended). Leisler's bat is a Belfast LBAP species.

It is also an offence to damage, destroy or obstruct access to any place that bats use for shelter or protection, whether bats are present or not, or to disturb a bat while it is occupying such a place; this applies even in houses and outbuildings. It is also illegal for anyone without a licence, to intentionally kill, injure or handle a bat of any species, to possess a bat, whether alive or dead, or to disturb a bat when roosting.

TABLE 6.4.3: BAT SPECIES OCCURRING WITHIN NORTHERN IRELAND

Species	Echolocation mean frequency Max Energy (kHz)	Preferred habitat type
Soprano pipistrelle (*Pipistrellus pygmaeus*)	55.5	Woodland edge & riparian
Common pipistrelle (*Pipistrellus pipistrellus)*	46.5	Woodland edge, parkland and hedgerows
Nathusius's pipistrelle (*Pipistrellus nathusii)*	40.7	Woodland edge & water
Daubenton's bat (*Myotis daubentonii*)	47.8	Watercourses, lakes, pond and riparian trees
Whiskered bat (*Myotis mystacinus*)	50.0	Parks, meadows, woodland & gardens
Natterer's bat (*Myotis nattereri*)	48.9	Relatively dense woodland, also over water
Leisler's bat (*Nyctalus leisleri*)	26.9	Above lakes, meadows and parkland
Brown long-eared bat (*Plecotus auritus*)	39.8	Dense habitats woodland, parkland & gardens

Bats can roost in buildings, bridges and mature trees with suitable cracks and crevices, and will use woodland edges and streams and waterbody shorelines as foraging habitat.

A bat survey was carried out on 22 August 2011 during which two species of Pipistrelle bats were detected. Commuting and foraging activity was noted throughout the site, particularly concentrated along the M2 Nelson Street off-slip and the North Queen Street Bridge area (**Figures 6.4.3A and 6.4.3B**). Further bat surveys would be part of the scope of the Stage 3 assessment of the Preferred Option.

6.4.7.5 *Breeding Birds*

No specific surveys were undertaken at this stage, although potential habitat was noted for breeding birds during the walkover surveys. It is anticipated that due to the nature of the study area, a number of urban bird species would be present, using the limited structures and the most dense areas of ornamental planting to nest in. A breeding bird survey would be required for Stage 3, along key stretches between April and June, with particular reference to notable habitats.

6.4.7.6 *Flora*

With reference to the Centre for Environmental Data and Recording (CEDaR) data sets, one Northern Ireland Priority Species has been previously recorded within the study area. A record of the plant Bristly Oxtongue (*Picris echioides)* at York Street came from 1974.

6.4.7.7 *Non-Native Invasive Species*

During the ecological surveys a single plant of Japanese Knotweed Fallopia japonica was located in waste ground adjacent to Galway House. The plant appeared relatively immature as only a single stalk was evident.

6.4.7.8 *Other Species*

No other species-specific surveys were undertaken at this stage, although evidence of other species of ecological value such as Northern Ireland Priority Species was gathered during the walkover surveys.

6.4.8 ***Assessment of Environmental Effects***

6.4.8.1 *Predicted Impact (Operational)*

6.4.8.1.1 ***Statutory Designated Sites***

With reference to **Figure 6.4.1**, no designated ecological sites would be directly affected by any of the interchange layout options. The closest is Inner Belfast Lough ASSI, approximately 1.5km northeast of the study area.

Consultation with Northern Ireland Environment Agency (NIEA) – Natural Heritage at Stage 1 indicated that a Habitat Regulations Assessment (HRA) under the terms of the Habitats Directive (Council Directive 92/43/EEC) should be undertaken to test the likely significance of the preliminary options on Belfast Lough SPA and Belfast Lough Open Water SPA.

The completed HRA confirmed that the proposed scheme would have no effect on the integrity of Belfast Lough SPA or Belfast Lough Open Water SPA. The assessment demonstrated that any adverse effects of the scheme would be too far away from the selection features within the designated sites to cause disturbance. Noise or vibration from the works would naturally attenuate to levels lower than the surrounding environment, and potential run off discharge into the River Lagan would contain sufficiently low and acceptable levels of contaminants. The selection features of wintering Redshank and Great Crested Grebe would be maintained in favourable condition, with no adverse impacts from the proposed scheme. The assessment was concluded after the first 'Screening Stage' (Test of Likely Significance). Subsequent consultation with NIEA and RSPB concurred with the conclusions of this assessment.

6.4.8.1.2 ***Sites of Local Nature Conservation Importance***

As no SLNCI's exist in the vicinity of the study area, there would be no impact on these locally designated sites. The closest is Alexandra Park SLNCI, approximately 500m northwest of the study area (**Figure 6.4.1**).

6.4.8.1.3 ***Habitat Loss***

None of the habitats within the study area shown in **Table 6.4.4** are considered to be ecologically valuable, however they do provide an element of 'natural' habitat within an otherwise urban environment. This would make them important only at a very local scale, as they provide limited opportunities for species to live and feed. The habitat loss associated with each of the options varies little, and the only sizeable differences relate to the area of amenity grassland and scattered broad-leaf trees.

TABLE 6.4.4: PREDICTED HABITAT LOSS WITH EACH SCHEME OPTION

Habitat Type	Total Area (m^2)	Habitat Loss (m^2) [% loss]			
		Option A	Option B	Option C	Option D
Bare ground	33,418	28,523 *(85)*	28,523 *(85)*	28,523 *(85)*	28,523 *(85)*
Scrub - dense	10,715	10,715 (100)	10,715 (100)	10,715 (100)	10,715 (100)
Broad-leaf plantation woodland	11,394	10,425 *(91)*	10,425 *(91)*	10,425 *(91)*	10,425 *(91)*
Amenity grassland	3,028	1,457*(48)*	3,028 *(100)*	1,457 *(48)*	3,028 *(100)*
Introduced shrub	2,838	195 (7)	195 (7)	195 (7)	195 (7)
Scattered broad-leaf trees	2,150	2,150 *(100)*	1,238 *(58)*	2,150 *(100)*	1,238 *(58)*
Tall ruderal	831	831 *(100)*	831*(100)*	831 *(100)*	831 *(100)*
Semi-improved neutral grassland	686	686 *(100)*	686 *(100)*	686 *(100)*	686 *(100)*
Scrub - scattered	465	None	None	None	None

The River Lagan/Belfast Lough intertidal zone would not be directly affected by any of the Interchange layout options. Option C would bring newly constructed links closest to the river, albeit at a distance of approximately 300m and buffered by industrial and the Port of Belfast land uses. The Mile Water is a culverted watercourse in the north of the study, which flows under the existing M2 Motorway to discharge into the Herdman Channel. It would not be affected by any of the new junction arrangement options and so no impact is anticipated.

Due to the nature of the proposed scheme at York Street, it is anticipated that pollution impacts from the large volume of traffic at the interchange (>60,000 AADT) could be significant. Some pollutant loading may occur from road drainage, but this aspect would be given further consideration at the next design stage when drainage design and traffic projections are more clearly defined.

TABLE 6.4.5: ASSESSMENT OF ECOLOGICAL EFFECTS

Option	Designations within 500m of Option	Baseline Ecology (within the direct footprint / potential for direct impact)	Potential Impact and significance
Option A	None	Broad-leaf plantation, scrub, semi-improved grassland and amenity grassland, scattered trees, bat foraging evidence.	Habitat loss, particularly broad-leaf plantation and dense scrub adjacent to the M2 Motorway, on bank slopes alongside both M2 and M3 off-slips and on-slips, and A12 Westlink. Loss of amenity grassland with scattered trees. Potential loss of foraging areas for bats and potential disturbance of breeding birds. There are no large tracts of semi-natural habitats. Option A would not impact on woodland / forest areas or TPOs. There would be no fragments of hedgerows. Area has only limited possibilities for wildlife. **Overall predicted impact: Slight Adverse**
Option B	None	Broad-leaf plantation, scrub, semi-improved grassland and amenity grassland, scattered trees, bat foraging evidence.	Habitat loss, particularly broad-leaf plantation and dense scrub adjacent to the M2 Motorway, on bank slopes alongside both M2 and M3 off-slips and on-slips, and A12 Westlink. Loss of amenity grassland with scattered trees. Potential loss of foraging areas for bats and potential disturbance of breeding birds. There are no large tracts of semi-natural habitats. Option B would not impact on woodland / forest areas or TPOs. There would be no fragments of hedgerows. Area has only limited possibilities for wildlife. **Overall predicted impact: Slight Adverse**
Option C	None	Broad-leaf plantation, scrub, semi-improved grassland and amenity grassland, scattered trees, bat foraging evidence.	Habitat loss, particularly broad-leaf plantation and dense scrub adjacent to the M2 Motorway, on bank slopes alongside both M2 and M3 off-slips and on-slips, and A12 Westlink. Loss of amenity grassland with scattered trees. Potential loss of foraging areas for bats and potential disturbance of breeding birds. There are no large tracts of semi-natural habitats. Option C would not impact on woodland / forest areas or TPOs. There would be no fragments of hedgerows. Area has only limited possibilities for wildlife. **Overall predicted impact: Slight Adverse**
Option D	None	Broad-leaf plantation, scrub, semi-improved grassland and amenity grassland, scattered trees, bat foraging evidence.	Habitat loss, particularly broad-leaf plantation and dense scrub adjacent to the M2 Motorway, on bank slopes alongside both M2 and M3 off-slips and on-slips, and A12 Westlink. Loss of amenity grassland with scattered trees. Potential loss of foraging areas for bats and potential disturbance of breeding birds. There are no large tracts of semi-natural habitats. Option D would not impact on woodland / forest areas or TPOs. There would be no fragments of hedgerows. Area has only limited possibilities for wildlife. **Overall predicted impact: Slight Adverse**

6.4.8.2 *Predicted Impacts (Construction)*

The study area exists within a busy urban environment, an area which is already subject to the usual noise, vibration and reduced air quality associated with the number of vehicle movements through the area each day. Species and habitats occurring within this environment are already accustomed to such disruption and disturbance and so are likely to be unaffected by any additional construction disruption.

The existing York Street junction is located approximately 350m west of the River Lagan, which is tidal at this point. Any construction-related pollution incidents could seriously impact the River Lagan and consequently Belfast Lough, which has a number of national and international designations.

Limited bird nesting opportunities exist in some of the areas of dense vegetation and structures. Bird-life is unlikely to be significantly affected during construction, provided vegetation clearance is undertaken outside the nesting season (March to September inclusive). The most sensitive time for birds is spring and early summer, during which incubation and feeding of dependant young usually occurs. To this end, it will be essential that an approach in line with current good practice is adopted and a breeding bird survey should be undertaken at Stage 3 to fully investigate the bird life within the study area.

The ecological value of the habitats on site is considered to be low, however, the loss of any vegetation during construction should be kept to a minimum as far as practicable, including for access purposes. Operations, such as site clearance, site traffic entering and exiting the works have the potential both to create and carry additional dust and dirt along the surrounding roads. This additional dust has the potential to reduce photosynthesis by smothering vegetation.

6.4.9 ***Mitigation and Enhancement Measures***

The construction contract for the preferred option should include measures and controls to minimise adverse effects on the local area during construction, such as emissions of dust and pollutants. For example, areas of the site can be dampened with water during dry periods to help reduce the amount of dust produced; possible provision of wheel-washing facilities at site accesses to keep construction site dirt and dust off public roads. Measures should be taken through careful planning and prevention measures to reduce the risk of accidental spillage/pollution incidents affecting the River Lagan.

6.4.9.1 *Protected Mammals*

Bats were the only protected species found within the site and were using it as a foraging location. A full investigation of the usage of the site by bats throughout their active season should be carried out during the Stage 3 Assessment.

Whilst no other protected species were found to be on site at this time, further investigation should be made at Stage 3 to update the existing survey results. The Phase 1 Habitat Survey should be updated as part of Stage 3 assessment.

6.4.9.2 *Potential Surveys Required*

It is recommended that an experienced ecologist be commissioned to verify the desktop assessment and conduct a full suite of habitat and species surveys for the final preferred interchange layout, as part of the Stage 3 Environmental Assessment. The assessment should identify all important sites of nature conservation interest which may potentially be affected.

The surveys required as part of the ecological assessment for the final choice of layout option should include:

- Plants and Habitats – an extended Phase 1 habitat survey is recommended between May and September, to include species lists and notable habitats and associated species;
- Bird survey – a breeding bird survey would be required along key stretches between April and June, with particular reference to notable habitats, using the BTO Breeding Bird/Common Bird Census methodology;
- Bat surveys – a series of three bat activity surveys carried out throughout the season May to September in line with NIEA survey guidelines; bat roost potential survey including any necessary emergence / re-entry survey at North Queen Street Bridge; and
- Protected mammals survey – A thorough check of the entire route is required for the presence of breeding mammals to include badger, otter and red squirrel, all of which are protected at all times.

6.4.10 *Summary and Conclusions*

- With regards to ecological impacts, all options are considered to carry a very similar minimal risk, considered to be Slight Adverse, and there is no difference between them.
- There are no designated sites of national or international ecological importance within the study area.
  - The closest designated sites are Belfast Inner Lough ASSI and Belfast Lough SPA, which is approximately 1.5km northeast of the York Street study area.
  - Several SLNCIs exist in the wider surroundings; the closest is Alexandra Park SLNCI (500m away). They would not be affected by any of the layout options.
- A Habitat Regulations Assessment (HRA) has concluded that the proposals would have no significant effect on the integrity of the Natura 2000 sites or their selection features.
- There are several small non-designated areas of planting in the vicinity of the existing junction. Although those areas are not considered ecologically valuable, any works to them should be carried out outside of the bird nesting season to avoid potential disturbance.
- Bat surveys have indicated activity primarily along the M2 Nelson Street off-slip and North Queen Street Bridge area. Bat roost surveys to be carried out. Further bat surveys would be part of the scope of the Stage 3.
- A single plant of Japanese Knotweed was identified during the ecological walkover survey at the back of Galway House at York Street.
- There are no significant woodland areas.

6.5 Landscape Effects

6.5.1 *Introduction*

The Design Manual for Roads and Bridges (DMRB) recognises that Landscape is an important national resource and that, while it is subject to change, the landscape is a resource of value to future generations.

This section of the report examines the scheme options' likely impact, not just on the views that people experience now and in the immediate future, but on the landscape as an entity in its own right.

The principal objective of this section is to assess the landscape and visual effects of the four Options (A to D) as part of the proposed York Street Interchange scheme.

6.5.2 *Methodology*

This assessment is concerned with the landscape and visual impacts of the four Options (A to D). The assessment is based on "*The Guidelines for the Landscape and Visual Assessment: Second Edition*" published by the Landscape Institute and the Institute of Environmental Management and Assessment (IEMA).

Regular site visits were undertaken to assess key features of the landscape and critical view points. The significance of the existing junction arrangement and visual dominance within the landscape were recorded. In addition, an assessment of the existing landscape character was undertaken. The terminology and criteria used in the assessment of the quality of the landscape character are defined in **Table 6.5.1**.

The quality of the landscape has been described and assessed (based on the *Guidelines for Landscape and Visual Assessment, Second Edition (2002*), edited by The Landscape Institute and Institute of Environmental Management and Assessment) as follows:

TABLE 6.5.1: CRITERIA USED IN THE ASSESSMENT OF THE QUALITY OF LANDSCAPE CHARACTER

Category	Criteria	Typical Example
Exceptional Landscape	• Strong landscape structure, characteristics and patterns • Very scenic and/or dramatic • Distinct features worthy of conservation • Sense of place • No detracting features.	Internationally or Nationally recognised e.g. all or a great part of World Heritage Sites, National Parks, AONB's.
High Quality Landscape	• Strong landscape structure, characteristics and patterns • Distinct features worthy of conservation • Sense of place • Occasional detracting features • Could be improved with appropriate management.	Nationally or Regionally recognised e.g. parts of National Parks, AONB's.
Attractive Landscape	• Recognisable landscape structure and patterns • Some features worthy of conservation • Sense of place • Some detracting features • Could be improved with appropriate management for land use and land cover.	Parkland landscape with distinct tree planting; Interesting topography.
Good Landscape	• Distinguishable landscape structure and patterns • Some features worthy of conservation • Some detracting features • Scope to improve.	Pleasant agricultural landscape but not particularly noteworthy.

TABLE 6.5.1: CRITERIA USED IN THE ASSESSMENT OF THE QUALITY OF LANDSCAPE CHARACTER		
Category	**Criteria**	**Typical Example**
Ordinary Landscape	• Weak landscape structure and patterns • Mixed land use evident • Land management • Frequent detracting features.	Rural areas with frequent one-off housing.
Poor Landscape	• A damaged landscape • Disturbed or derelict land • Detracting features dominate.	Poor quality industrial areas; Degraded landscape at the edge of a settlement.

Source: Guidelines for Landscape and Visual Assessment, 2nd Edition, 2002.

Desktop research was undertaken to establish any landscape designations present on or in close proximity to the study area. This process was in accordance with DMRB Volume 11, Section 3, Part 5, Chapter 9 (Stages in Landscape and Visual Impact Assessment – Stage 2), which stated that the following steps be undertaken:

- Conduct a landscape assessment of the area which would be affected by possible route options using the methodology described in Chapter 3 (Landscape Assessment Methodology).
- Check with the relevant statutory body and local planning authority that no new landscape areas have been designated.
- From information gathered during the landscape assessment, and by using maps, estimate in broad terms the number of properties which are likely to experience visual changes, employing the categories substantial, moderate and slight visual deterioration or improvement. A full on-site visual impact assessment survey will not generally be required at this stage.

An assessment was undertaken through analysis of photographs, desktop and site survey information. It should be noted that this assessment does not describe every effect of the proposed scheme options, only the main or likely significant effects on the environment which are required to inform the decision making authority. In addition, the assessment of visual impact is only indicative and further site surveys will be undertaken to specifically assess the visual impacts for individual properties during the Stage 3 assessment, following the selection of the Preferred Option.

6.5.2.1 *Assessing Significance of Effects*

The significance of the visual change is categorised in accordance with DMRB Volume 11, Section 3, Part 5, Chapter 4 (Visual Impact Assessment Methodology) which outlines the following scale:

- Substantial adverse or beneficial impact - where the scheme would cause a significant deterioration (or improvement) in the existing view;
- Moderate adverse or beneficial impact - where the scheme would cause a noticeable deterioration (or improvement) in the existing view;
- Slight adverse or beneficial impact - where the scheme would cause a barely perceptible deterioration (or improvement) in the existing view;
- No change - no discernable deterioration or improvement in the existing view.

These definitions are used to determine landscape or visual effects. These effects may be adverse (negative), neutral, or beneficial (positive). Neutral is defined as the proposed scheme would complement the scale, landform and pattern of the landscape and maintain the existing landscape quality. The assessment is largely based on objective criteria; however an element of subjective judgement is also involved. Thus, an understanding of both the landscape character and key landscape characteristics form the basis of an assessment of the visual impact.

6.5.3 *Regulatory/Policy Framework*

The hierarchy of strategies, policies and legislation operates to underpin the management of both the land and landscape. Some of these enable statutory designation at national level and others provide for local designations and appropriate management, with the aim of conserving and protecting the quality of the landscape.

6.5.3.1 *Regional Guidance*

6.5.3.1.1 ***Northern Ireland Landscape Character Assessment 2000 (NILCA)***

The Northern Ireland Landscape Character Assessment 2000 (NILCA) identified Areas of High Scenic Quality. These are defined as landscapes of regional or local importance for their scenic quality (i.e. important landscape resources in their own right, regardless of location or setting). They are characterised by visually pleasing patterns or combinations of landscape elements, and by their generally unspoilt character, free from major intrusion. In addition they may include significant sites or features of nature conservation, historic or cultural importance. Often they are visually prominent landscapes such as ridge tops, scarp slopes above settlements, and lough shores, and therefore many of these areas are particularly sensitive to change. The Areas of Scenic Quality identified in the NILCA are considered to be of regional significance and represent a second tier (below AONB's) in the hierarchy of landscape classifications.

6.5.3.2 *Local Policy*

6.5.3.2.1 ***PPS 2 – Planning and Nature Conservation***

This PPS sets out the Department of the Environments' land-use planning policies for the conservation of our natural heritage.

PPS 2 highlights the importance of Countryside Assessments as an integral part of the development plan making process. The Countryside Assessment will establish and evaluate the assets and resources of the countryside, for example, important landscapes or features of the landscape, significant woodland, wildlife habitats and archaeological and historic features. PPS 2 also notes that "*where practicable, development plans will identify on the plan proposals map all designated areas within which relevant nature conservation policies apply*".

PPS 2 also states that careful consideration will be given to the potential impact of proposed development on trees. Landowners and developers will be encouraged to retain existing trees, where practicable, and to plant additional trees.

6.5.3.2.2 ***PPS 6 - Planning, Archaeology and the Built Heritage***

Planning Policy Statement 6, Planning, Archaeology and the Built Heritage (PPS 6), states that development plans will, where appropriate, designate Local Landscape Policy Areas (LLPAs) and contain local policies and guidance to maintain the intrinsic environmental value and character of these areas. Local Landscape Policy Areas consist of those features and areas within and adjoining settlements considered to be of greatest amenity value, landscape quality or local significance and therefore worthy of protection from undesirable or damaging development.

LLPAs may include:

- archaeological sites and monuments and their surroundings
- listed and other locally important buildings and their surroundings
- river banks and shore lines and associated public access
- attractive vistas, localised hills and other areas of local amenity importance
- areas of local nature conservation importance; including areas of woodland and important tree groups.

6.5.3.2.3 ***Development Plans***

The adopted Development Plan for the study area is the Belfast Urban Area Plan (BUAP) 2001, published in December 1989; a date which precedes the formal adoption of the Regional Development Strategy (RDS). The Belfast Urban Area Plan is discussed further in Section 6.8. (Pedestrian, Cyclists, Equestrian & Community Effects).

6.5.3.2.4 ***Belfast Metropolitan Area Plan 2015 (Draft Plan, November 2004) – District Proposals Belfast***

The Belfast District Proposals consist of designations, polices, proposals and zonings specific to the administrative area of Belfast City Council. The purpose of the Plan is to inform the general public, Statutory Authorities, developers and other interested bodies of the policy framework and broad land use proposals which will be used to guide development up to the year 2015. It provides guidance on the amount and nature of development which can be expected and where it can best be located so as to create an overall environment that will enhance the quality of life for the people of the Belfast Metropolitan Area. Applicable for this assessment, the relevant Proposals and Policies are outlined below:

Policy ENV 3 Local Landscape Policy Areas

In designated Local Landscape Policy Areas (LLPAs), planning permission will not be granted for development that would be liable to adversely affect those features, or combination of features, that contribute to environmental quality, integrity or character.

Where riverbanks are included within LLPAs, planning permission will only be granted where access is provided to the river corridor as part of the development proposals.

Where proposals are within and/or adjoining a designated LLPA, a landscape buffer may be required to protect the environmental quality of the LLPA.

Policy COU 7 Areas of High Scenic Value

Planning permission will not be granted to development proposals that would adversely affect the quality, character and features of interest in Areas of High Scenic Value. Proposals for mineral working and waste disposal will not be acceptable.

6.5.4 *Baseline Conditions*

6.5.4.1 *Landscape Character*

This assessment of landscape character is the result of desktop and field survey work carried out for this scheme, and may be understood within the context of the Northern Ireland Landscape Character Assessment, Belfast/Lisburn (LCA No.97).

6.5.4.2 *Topography*

The development area for the Options for the York Street Interchange is bounded by:

- York Street, from the intersection with Great Patrick Street.
- The existing M2/M3, from the intersection with Corporation Street and Little Patrick Street as far north as Dock Street.
- Nelson Street.
- Cityside Retail Park.
- Clifton Street.
- Corporation Street.

The immediate study area is the urban city centre edge, between mixed areas of housing, commercial use, and the western side of the docks in the vicinity of Clarendon Dock. The study area is physically and visually confined and enclosed by these land uses, with the result that anticipated effects from the development would be relatively localised.

Plate 6.5.1 Aerial Photograph of Study Area

6.5.4.3 *Vegetation*

There is little relief from the structures and roads in the form of trees or open green space. The limited vegetation which is present, is located:

- the edge of the triangle created by the Westlink north and east, and York Street
- on the north and south side of the Westlink, at the junction with York Street
- between the current M3 and Docklands
- between the M3 and York Link, and on the Yorkgate Business Park site.

The vegetation appears not to be maintained and is a catch point for rubbish.

6.5.4.4 *Roads*

The existing York Street junction within the city of Belfast is crucial to the movement of traffic into, out of, and around the periphery of the city, as it links the A12 Westlink, the M2 Motorway, and the M3 Motorway. This is through a complex arrangement of signalised junctions that interface with the surface street network which includes York Street, York Link, Great George's Street and Nelson Street.

The area surrounding the existing junction is highly constrained by residential housing, commercial, retail and industrial properties, elevated rail infrastructure carried on the Dargan Bridge, and road infrastructure including the A12 Westlink, M2 Motorway, and the elevated M3 Motorway carried on the Lagan Bridge.

6.5.4.5 *Built Development*

The character of housing areas has been affected by the development of motorway extensions, which has resulted in isolating contiguous built areas, with community hearts such as local pubs, schools and shops being separated from their surrounding communities by motorway structures. Extensions of the motorway structures over the years have also created vertical barriers to views and privacy, by being located very close to or on the boundaries of properties, such as along the back gardens of Little George's Street. There is a disjointed urban character with pockets of housing in amongst commercial retail and office sites. All are separated from the city centre by the line of the Westlink and M3. The only visual and physical link from this area to the city that is not broken by the Lagan and Dargan bridges is York Street, which connects the existing city centre to the intersection of Dock Street and Brougham Street.

The vertical scale of the study area is also mixed and varies from 2-storey residential to the multi-storey Cityside Retail Park and Galway House. The docklands buildings also vary from single to multiple storeys, although tend to be no more than approximately 12m high (excluding church steeples). The existing Dargan Bridge railway line and M3 Lagan Bridge are the highest linear structures in the site, but are still considerably lower than both the Cityside Retail Park and Galway House. They are the current vertical limit of transport structures within the study area.

Important local buildings in the area, have value in that they are memorable, have local history, or are of a scale to integrate the area into the cityscape, and include:

- Cityside Retail Park - this red brick building is on the site of the former Gallaher's Tobacco factory
- The Sinclair Seamen's Presbyterian Church on Corporation Street
- Clarendon Dock building and the Harbour Office

- Belfast Head Post Office building (whilst not necessarily of great architectural merit, its design makes it distinctive)
- Clifton House and Gate Lodge (CC110 Clifton 1 LLPA).

The built character of the study area is generally of red brick terrace housing, pockets of newer housing in between motorway infrastructure, commercial retail use, a complex arrangement of motorway extensions, and derelict land between roads and under motorway flyovers where it is not otherwise being used for car parking. The derelict land is a mixture of grass, scattered rubbish, cracked asphalt and weed vegetation taking advantage of small amounts of water runoff and light from the gaps between the motorway decks above. Its condition indicates it is of little use to the city or local community in its current state, apart from its use for car parking. However, the derelict land is currently in a number of large parcels, which gives maximum opportunity for development and improvement.

6.5.4.6 *Future Development*

The baseline landscape character into which the scheme is sited could be materially altered by the introduction of additional built development. For information on planning applications within the study area, reference should be made to the Land Use section of this report (**Section 6.6**). A more detailed assessment of the impacts of future permitted development will be undertaken at Stage 3, once a Preferred Option has been selected.

6.5.4.7 *Recreation and Historical Features*

The recreation and community facilities within the study area are identified in **Section 6.8**. of this report. In addition, there are a range of cultural heritage assets, including Sinclair Seamen's Presbyterian Church, as discussed further in **Section 6.3**.

6.5.4.8 *Landscape Quality*

The York Street area is enclosed by red brick residential areas, the commercial edge of the high rise centre of the city, commercial retail development, the existing M3, and the buildings and yards adjacent to and part of the western docks. The quality of the environment within this urban district is increasingly degraded by traffic congestion, air pollution, litter, and a lack of accessible public open spaces.

The quality of this urban landscape as described is poor, due to the mixed land use and building use, differing scales of built fabric, and the presence of the Lagan and Dargan bridges. Extensive detracting features are the Lagan and Dargan bridges, derelict land, and inconsistency in architectural styles and scale.

LANDSCAPE QUALITY	POOR

6.5.4.9 *Important Views*

Potentially sensitive views are from areas and places close or adjacent to the site (**Figure 6.5.6**). These include:

- residential area bordered by current Westlink, as defined by Henry Street and North Queen Street
- the Lancaster (CC 097/13) Protected City Centre Housing Residential area, bordered by Great George's Street, York Street and North Queen Street
- Galway House

- Clarendon Dock public space and associated buildings
- travellers on the train and current M3
- Cityside Retail Park
- Lagan Weir
- Odyssey Arena
- Sinclair Seamen's Presbyterian Church
- views down York Street to and from the city centre
- the Obel tower – 28 storeys of apartments, office space and commercial use.

6.5.4.10 *Designations*

The study area is contained within the boundaries of Belfast City, as defined by the Northern Ireland Landscape Character Assessment LCA 97 – Belfast/Lisburn. Designations relating to the landscape are covered, for this area, by the Belfast Metropolitan Area Plan (BMAP) Draft 2015. The southern half of the study area is contained within one of the nine Belfast City Centre Character Areas. The character area is Designation CC018 (Lagan Side North and Docks Character Area). The draft BMAP describes it as:

'*the Laganside North and the Docks Character Area is disparate in character, yet represents one of the major areas of opportunity in Belfast City Centre, including The Waterfront, the Odyssey and the Clarendon Docks. This area runs from East Bridge Street, in the south of the area, to Dock Street, in the north, including the Abercorn Basin which lies beyond the BMAP proposed City Centre boundary. The area runs from Short Strand, in the east, to Carrick Hill/Great Patrick Street/Dunbar Link/Victoria Street, to the west. A high accessibility zone at Gamble Street and part of an accessibility zone at Central Street Station form part of this Character Area.*

Large scale physical features dominate this area, from the sweep of the River Lagan as it enters the docks, and the docks themselves, to the motorway and railway infrastructure. A diverse range of buildings and uses are found within the Laganside North and the Docks area including the Waterfront apartments and the Waterfront Hall.

The historic use of the area for industry and dock related activities is reflected in the general coarse grain of Laganside North and the Docks…..

In the area bounded by York Street, the M3 bridge, Queens Square and Dunbar Link, the Dunbar Link was originally built to ease the flow of traffic around the northern periphery of the City Centre. Along with the M2 and elevated M3 it has disconnected the docks and ferry terminals from the City Centre and the cathedral quarter in particular. It has also contributed to the widespread blight leaving many sites either vacant or under-used.'

Within draft BMAP Designation CC018 (Laganside North and Docks Character Area) are a number of designations:

- Development Opportunity Sites
- Protected City Centre Housing
- City Centre Gateway
- Area of Townscape Character
- Land zoned for housing.

The study area is immediately adjacent to five of the above designations: Development Opportunity Sites CC073 (Westlink/York Street); CC076 (Little York Street /Shipbuoy Street); CC080 (Corporation Street/Trafalgar Street); Cityside Retail Park a District Centre for retail under BMAP; and CC110 (Clifton 1 LLPA), as shown in **Figure 6.6.3** (Land Use Designations).

In addition to the designations under the draft BMAP, the study area is also located within the Belfast Lisburn Character Area (LCA No.97), which states that:

- The key characteristics include: *"Belfast and Lisburn lie within the lowland basin of the River Lagan which is enclosed by steep ridges and escarpments. Docks at head of Belfast Lough; principal industrial areas along the Lagan and new Laganside development focusing towards the river. Long red brick terraces and large red brick warehouses and industrial buildings are characteristic."*
- The landscape condition and sensitivity to change: *"The quality of the environment within the urban districts is increasingly degraded by traffic congestion, pollution, waste management problems and a lack of accessible public open spaces. Belfast also has a relatively high proportion of derelict land and there is much scope for continued regeneration."*
- Principles for accommodating new development: *"Scope for new building on derelict sites, with scope for innovative designs which may create new focal points and landmarks."*

6.5.4.11 *Protected Structures*

There are scheduled monuments and listed buildings within the study area. Additional information on these protected structures is contained in the Cultural Heritage section of this report (**Section 6.3**).

With respect to additional designations, it was established during the desktop research that there are no Tree Preservation Orders (TPO) confirmed for any trees within the study area.

6.5.5 ***Predicted Impacts***

The landscape and visual effects would generally be from all aspects of the scheme: the roadway structures; the supports for the roadway decks; signage gantries; parapets and safety barriers; and lighting columns. These would create a complicated mass of mixed visual patterns which would potentially fragment the node even more and could prevent future development and potential improvement of the site. Due to the confined nature of the site, landscape and visual effects would tend to be limited to the immediate area. The setting of buildings and roads would generally screen the proposed Scheme from wider views, including medium and long distance views.

For a detailed description of each option and link roads, reference should be made to **Section 3** of this report.

For the purposes of summarising the landscape and visual impacts of each of the proposed Options and Link roads, only the most significant impacts from the critical viewpoints are outlined. As part of the landscape and visual impact assessment process, 21 critical viewpoints were identified, and are indicated in **Figure 6.5.1**.

TABLE 6.5.2: LANDSCAPE AND VISUAL IMPACT ASSESSMENT

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option A – (Depressed Concept Design) The layout provides a grade-separated junction, but not a full interchange with Links at either existing ground level or in depressed sections (**Figure 6.5.2**)	**Link A** - M2 to Westlink		
	The proposed link road is initially an overbridge (minimum 7m above street level) with associated retaining walls. The link road then grades down to Corporation Street before passing under the existing built structures of the M3 and Railway Line. The link road is depressed 1.8m below ground level and would include retaining walls.	Substantial Adverse impact on landscape character. Although the overbridge can be largely absorbed alongside the existing built structures of the M3 and Railway Line, the depressed section would lead to partition and fragmentation of the open space and between adjacent sites. In addition, the depressed roadway would require parapets and high fences to prevent individuals from falling onto the roadway or throwing objects onto vehicles.	The proposed overbridge would be visually dominant. However, the visual dominance of the overbridge would be confined to the east side of the M3. Once elevation of the road is reduced to ground level, the visual dominance of the road is reduced to Slight Adverse, with the visually dominant features being the existing roadways with associated vehicles, lighting and signage.
	Link B - Westlink to M2		
	The proposed link road starts at the Westlink before grading down to a depressed roadway and passing under York Street (Link E) and proposed Link F, before grading back up to join the M2.	The proposed link road is immediately adjacent to the existing Westlink – M2 link road. While the route physically encroaches and fragments the open space, the impact would be Slight/Moderate Adverse, as it does not fundamentally alter the landscape character.	The visual impact of the link road would be a Slight Adverse, as it adds new elements. However they are in keeping with the existing features in this urban landscape.
	Link C - Westlink to M3		
	The proposed link road starts at the Westlink before grading down to a depressed roadway passing over Link A, before grading back up to join the M3.	The proposed link road follows the existing line for the Westlink – M3. The route physically fragments the space and alters the landscape character as it provides a physical boundary which restricts the movement of pedestrians and vehicles north and south through the junction. The addition of this link road to the scheme, when combined with Link A, results in a pocket of land which cannot be accessed by pedestrians or vehicles. This would have a Significant adverse impact on the landscape character, as at present all site surrounding the junction form part of this active urban landscape.	The visual impact of the link road would be Slight Adverse, as it adds new elements. However they are in keeping with existing features in this urban landscape. Importantly the visual impact of the inaccessible pocket of land identified could potentially be significant, dependent on the landscape mitigation measures chosen.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option A – (Depressed Concept Design) The layout provides a grade-separated junction, but not a full interchange with Links at either existing ground level or in depressed sections (**Figure 6.5.2**)	**Link D** - M3 to Westlink		
	This proposed link road follows the route of the existing road between York Street and the Westlink. The proposed road includes a change in level and therefore requires a new retaining wall and possible extension of an existing dwarf wall along Great George's Street.	The link road would have a Slight Adverse impact on the landscape character.	The visual impact of the road would be Slight Adverse. However, depending on the finish of the proposed wall and adjacent planting, the proposals could potentially improve and or reduce the visual impact of the existing and proposed roads for residents along Great George's Street.
	Link E - York Street (South) to York Street (North)		
	The proposed link road follows the route of the existing York Street (South) and York Street (North). The proposed road does however include a new overbridge and raising of York Street by approx 3m above the existing level.	The impact on landscape character would be Moderate Adverse, as it is a long established vehicle and pedestrian route. However, the elevation of the route and associated dwarf wall and bridge could potentially significantly alter the character, depending on design. For example, the bridge could facilitate greater pedestrian/vehicle permeability and movement between adjacent sites (either side of York Street than exists at present).	The visual impact would be Moderate Adverse, as this is a long established vehicle and pedestrian route. The overbridge would create a new visual element, the design of which could either lead to a deterioration or improvement of existing views, particularly from Cityside Retail Park and Galway House.
	Link F - York Street to M2		
	The proposed link road is immediately adjacent to the existing Westlink – M2 link road. The route initially grades down to the junction with York Street before rising to merge into the M2 and alignment adjacent to Link B. This proposal also involves the widening of the existing Dock Street Bridge.	This proposed link road would have a Moderate Adverse impact on landscape character as it encroaches onto the site of Galway House and involves widening of the bridge with associated removal of mature vegetation. It is important to note that replacement/mitigation planting and improvements to Dock Street Bridge upon its widening could potentially make a positive contribution to landscape character of this area.	The visual impact would be Moderate Adverse, particularly from Galway House and Cityside Retail Park. This would be more visually prominent in the short term, as the existing vegetation is removed to facilitate construction.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option A – (Depressed Concept Design) The layout provides a grade-separated junction, but not a full interchange with Links at either existing ground level or in depressed sections (**Figure 6.5.2**)	**Link G** - Westlink to York Street		
	The proposed link road follows the route of the existing road. However, the road drops in elevation as it approaches the junction with York Street. This proposal involves construction of a new retaining wall, typically 1.5m above existing level.	The proposal would have a Slight Adverse impact on landscape character, as there is already a retaining wall and road in this location.	The visual impact would be Neutral to Slight Adverse for the majority of viewpoints, with the exception of local houses that back immediately onto the road and which would experience an increase in the height of the retaining wall at the boundary of their property. The visual impact would be Moderate Adverse in this case.
	Link H - Corporation Street to Westlink		
	This proposed link road is a new route that links Corporation Street to the proposed Link A.	The proposed road would have a Slight Adverse impact on the existing urban landscape character.	The visual impact would be Slight Adverse, as roadways and car parks are dominant features on the existing views along Corporation Street. The proposed road would be slightly more visually prominent, due to its junction with Link A.
	Link I - Dock Street to M3		
	This proposed link road follows the existing route of Nelson Street. The road increases in elevation and includes an overbridge over Link A.	The impact on landscape character would be Slight, as the proposals reinforce the urban landscape setting which is characterised by roadways and the extensive number of vehicles. The closure of the existing off-slip provides an opportunity for mitigation which was otherwise not possible.	The visual impact would be Moderate Adverse, though could become an improvement depending on the nature of the mitigation.
	Link J - M3 to York Street		
	The proposed link road follows the existing route from the M3 to York Street. The existing road would be largely unchanged apart from additional traffic islands and road marking changes. The proposed link road would predominantly remain at existing level, although it would rise approx. 0.8m to join with the new levels on Link E. This level change would be supported by a dwarf retaining wall on the south side of the link road.	The impact on landscape character is only Slight Adverse, as the proposed route for the link road is the same as an existing roadway of similar scale.	The visual impact would be Slight Adverse, due to the introduction of the dwarf wall. Importantly, it is anticipated that only properties adjacent to the proposed link road would have their views impacted.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option B – (Elevated Concept Design) The layout provides a full interchange, with Links in both depressed corridors and on elevated overbridge structures. (**Figure 6.5.3**)	The proposed road link is an overbridge that rises over Dock Street to approx 9m high. It then rises further to 17.5m above street level over Dargan and Lagan bridges, before it drops down from an abutment (about 7m above existing) to tie into North Queen Street Bridge. Importantly, retaining structures are required to support the new alignment.	The scale and massing of the proposed link road with associated supporting columns would form a distinctive and new addition to this urban landscape. Although significant, the proposed link road would be in keeping with the character of the area, with the existing overbridges of the M3 and Dargan Bridge and their associated supporting columns. It is the scale and massing (i.e. largest span 90m and height 17.5m) which make it a distinguishing and significant feature that would Substantially affect the landscape character. Importantly, this proposed link road would not fragment the spaces underneath at street level as in Options A and C.	The visual impact of the road would be Substantial/Moderate Adverse, as it becomes a dominant feature in this landscape setting. The view at existing ground level would be impacted by the scale and massing of the link road and in particular the supporting columns. There would also be significant impacts to views from the adjacent multi-storey buildings e.g. Galway House, Cityside Retail Park and further away again The Royal Mail and The Obel buildings.
	Link B - Westlink to M2		
	The proposed link road starts at the Westlink, before grading down to a depressed roadway and passing under York Street (Link E) and the proposed Link F, before grading back up to join the M2.	The proposed link road is immediately adjacent to the existing Westlink – M2 link road. While the route physically encroaches and fragments the open space the impact would be Slight/Moderate Adverse, as it does not fundamentally alter the landscape character.	The visual impact of the link road would be Slight Adverse, as it adds new elements. However they are in keeping with the existing features in this urban landscape.
	Link C - Westlink to M3		
	The proposed link road starts at the Westlink before grading down to a depressed roadway and then grading back up to join the M3. The proposed link road follows the existing line for the Westlink – M3 and includes an overbridge.	The impact on the landscape character would be Moderate Adverse. Although this is a long established vehicle route the depressed roadway would physically fragment the space and alter the landscape character, as it provides a physical boundary which restricts the movement of pedestrians and vehicles north and south through the junction.	The visual impact of the link road would be Moderate Adverse, as it adds new elements. However they are in keeping with the existing features in this urban landscape.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option B – (Elevated Concept Design) The layout provides a full interchange, with Links in both depressed corridors and on elevated overbridge structures. (**Figure 6.5.3**)	**Link D** - M3 to Westlink		
	The proposed link road follows a new route from the M3 to the Westlink, which cuts through a potential development site. Rather than depressed roadway as in Options A and C, the link road is elevated by 1.2m with associated retaining walls and safety barriers. Importantly, the road includes the creation of an overbridge across York Street.	The impact on landscape character would be Substantial Adverse, as the proposed link road would form a new vertical element over York Street. The link road in this case is higher than with Option D, as York Street is also elevated in this option. The Substantial impact is due to the cumulative effect on landscape character from the creation of an overbridge across York Street. This link road creates an intensification of roadways which become a more dominant feature of the character in this urban landscape.	The visual impact would be Substantial Adverse, due to the height of the proposed overbridge. Views along York Street in both directions would be affected, in addition to the views from neighbouring properties both residential and commercial.
	Link E - York Street (South) to York Street (North)		
	The proposed link road follows the route of the existing York Street (South) and York Street (North). The proposed road does however include a new overbridge and the raising of York Street by approx 3m above the existing level.	The impact on landscape character would be Moderate Adverse, as this is a long established vehicle and pedestrian route. However, elevation of the route and associated dwarf wall and bridge could potentially significantly alter the character, depending on design. For example, the bridge could facilitate greater pedestrian/vehicle permeability and movement between adjacent sites (either side of York Street than exists at present).	The visual impact would be Moderate Adverse, as this is a long established vehicle and pedestrian route. The overbridge would create a new visual element, the design of which could either lead to a deterioration or improvement of existing views, particularly from Cityside Retail Park and Galway House.
	Link F - York Street to M2		
	The proposed link road is immediately adjacent to the existing Westlink – M2 link road. The route initially grades down to the junction with York Street before rising to merge into the M2 and alignment adjacent to Link B. This proposal also involves the widening of the existing Dock Street Bridge.	This proposed link road would have a Moderate Adverse impact on landscape character as it encroaches onto the site of Galway House and involves widening of the bridge with associated removal of mature vegetation. It is important to note that replacement/mitigation planting and improvements to Dock Street Bridge upon its widening could potentially make a positive contribution to the landscape character of this area.	The visual impact would be Moderate Adverse, particularly from Galway House and Cityside Retail Park. This would be more visually prominent in the short term, as the existing vegetation is removed to facilitate construction.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option B – (Elevated Concept Design) The layout provides a full interchange, with Links in both depressed corridors and on elevated overbridge structures. (**Figure 6.5.3**)	**Link G** - Westlink to York Street		
	The proposed link road follows the route of the existing road. However, the road drops in elevation as it approaches the junction with York Street. This proposal involves construction of a new retaining wall, typically 1.5m above existing level.	The proposal would have a Slight Adverse impact on the landscape character, as there is already a retaining wall and road in this location.	The visual impact would be Neutral to Slight Adverse for the majority of viewpoints, with the exception of local houses that back immediately onto the road and which would experience an increase in the height of the retaining wall at the boundary of their property. The visual impact would be Moderate Adverse in this case.
	Link H - Nelson Street to Westlink		
	This proposed link road provides a new route from Nelson Street to Link A. The link road includes a new overbridge (approx. 9m high) over Dock Street, with retaining walls on either side and realignment of the southbound lane on Nelson Street. The proposals also include the conversion of Garmoyle Street to a two-way street, which will include a change in the line markings, signalling and creation of small traffic islands.	The proposed road would have a Substantial Adverse impact on existing urban landscape character. The character of Dock Street, although an urban landscape, would become dominated by the presence of overbridges and associated supporting columns and retaining walls. It is important to note that the existing urban landscape in this area is not deemed to be of high landscape quality.	The visual impact would be Substantial Adverse, as all views along Dock Street are significantly altered. The overbridge becomes the dominant visual feature and restricts other mid and long distance views along Dock Street.
	Link I - Dock Street to M3		
	This proposed link road follows the existing route of Nelson Street. The road merges with Link C before joining the M3.	The impact on landscape character would be Slight Adverse, as the proposals reinforce the urban landscape setting which is characterised by roadways and the extensive number of vehicles. Closure of the existing off-slip provides an opportunity for mitigation which was otherwise not possible.	The visual impact would be Moderate Adverse, though could become an improvement depending on the nature of mitigation.
	Link J - M3 to York Street		
	The proposed link road follows the existing route of Great George's Street from the M3. This proposed route separates from Link D and grades down to the junction with Little York Street, before the road then rises to join York Street. The proposed link road includes the creation of a dwarf wall on the south side of the link.	The impact on landscape character would be only Slight Adverse, as the proposed route for the link road is the same as an existing roadway of similar scale.	The visual impact is deemed to be Slight Adverse, due to introduction of the dwarf wall. Importantly, it is anticipated that only properties adjacent to the proposed link road would have their views impacted.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option C – (Depressed Concept Design) The layout provides a full interchange, with Links at either ground level or in depressed sections. (**Figure 6.5.4**)	**Link A** - M2 to Westlink		
	The proposed link road is initially an overbridge (minimum 7m above street level) with associated retaining walls. The link road then grades down to Corporation Street before passing under the existing built structures of the M3 and Railway Line. The link road is depressed 1.8m below ground level and would include retaining walls.	This would Substantially impact on the landscape character. Although the overbridge can be absorbed alongside the existing built structures of the M3 and Railway Line, the depressed section would lead to partition and fragmentation of the open space and between adjacent sites. In addition, the depressed roadway would require parapets and high fences to prevent individuals from falling onto the roadway or throwing objects onto vehicles.	The proposed overbridge would be visually dominant. However, the visual dominance of the overbridge would be confined to the east side of the M3. Once elevation of the road is reduced to ground level, the visual dominance of the road is reduced to Slight Adverse, with the visually dominant features being the existing roadways with associated vehicles, lighting and signage.
	Link B - Westlink to M2		
	The proposed link road starts at the Westlink before grading down to a depressed roadway and passing under York Street (Link E) and proposed Link F, before grading back up to join the M2.	The proposed link road is immediately adjacent to the existing Westlink – M2 link road. While the route physically encroaches and fragments the open space, the impact would be Slight/Moderate Adverse, as it does not fundamentally alter the landscape character.	The visual impact of the link road would be Slight Adverse, as it adds new elements. However they are in keeping with the existing features in this urban landscape.
	Link C - Westlink to M3		
	The proposed link road starts at the Westlink before grading down to a depressed roadway passing over Link A, before grading back up to join the M3.	The proposed link road follows the existing line for the Westlink – M3. The route physically fragments the space and alters the landscape character as it provides a physical boundary which restricts the movement of pedestrians and vehicles north and south through the junction. The addition of this link road to the scheme, when combined with Link A, results in a pocket of land which cannot be accessed by pedestrians or vehicles. This would have a significant impact on the landscape character, as at present all site surrounding the junction form part of this active urban landscape.	The visual impact of the link road would be Slight Adverse, as it adds new elements. However they are in keeping with existing features in this urban landscape. Importantly the visual impact of the inaccessible pocket of land identified could potentially be significant, dependent on the landscape mitigation measures chosen.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option C – (Depressed Concept Design) The layout provides a full interchange, with Links at either ground level or in depressed sections. (**Figure 6.5.4**)	**Link D** - M3 to Westlink		
	The proposed link road follows a new route from the M3 to the Westlink, which cuts through a potential development site. The link is a depressed roadway with associated safety barriers and retaining walls. The link also includes a new retaining wall and possible extension of an existing dwarf wall along Great George's Street.	The impact on landscape character would be significant, as the proposed road physically encroaches and fragments the open space in addition to providing a physical boundary which restricts the movement of pedestrians and vehicles north and south through the junction.	The visual impact would be Moderate Adverse. However, depending on the finish of the proposed wall and adjacent planting, the proposals could potentially improve and/or reduce the visual impact of the existing and proposed roads for residents along Great George's Street.
	Link E - York Street (South) to York Street (North)		
	The proposed link road follows the route of the existing York Street (South) and York Street (North). The proposed road does however include a new overbridge and raising of York Street by approx 3m above the existing level.	The impact on landscape character would be Moderate Adverse, as it is a long established vehicle and pedestrian route. However, the elevation of the route and associated dwarf wall and bridge could potentially significantly alter the character, depending on design. For example, the bridge could facilitate greater pedestrian/vehicle permeability and movement between adjacent sites (either side of York Street than exists at present).	The visual impact would be Moderate Adverse, as this is a long established vehicle and pedestrian route. The overbridge would create a new visual element, the design of which could either lead to a deterioration or improvement of existing views, particularly from Cityside Retail Park and Galway House.
	Link F - York Street to M2		
	The proposed link road is immediately adjacent to the existing Westlink – M2 link road. The route initially grades down to the junction with York Street before rising to merge into the M2 and alignment adjacent to Link B. This proposal also involves the widening of the existing Dock Street Bridge.	This proposed link road would have a Moderate Adverse impact on landscape character as it encroaches onto the site of Galway House and involves widening of the bridge with associated removal of mature vegetation. It is important to note that replacement/mitigation planting and improvements to Dock Street Bridge upon its widening could potentially make a positive contribution to landscape character of this area.	The visual impact would be Moderate Adverse, particularly from Galway House and Cityside Retail Park. This would be more visually prominent in the short term, as the existing vegetation is removed to facilitate construction.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option C – (Depressed Concept Design) The layout provides a full interchange, with Links at either ground level or in depressed sections. (**Figure 6.5.4**)	**Link G** - Westlink to York Street		
	The proposed link road follows the route of the existing road. However, the road drops in elevation as it approaches the junction with York Street. This proposal involves construction of a new retaining wall, typically 1.5m above existing level.	The proposal would have a Slight Adverse impact on landscape character, as there is already a retaining wall and road in this location.	The visual impact would be Neutral to Slight Adverse for the majority of viewpoints, with the exception of local houses that back immediately onto the road and which would experience an increase in the height of the retaining wall at the boundary of their property. The visual impact would be Moderate Adverse in this case.
	Link H - Corporation Street to Westlink		
	This proposed link road is a new route that links Corporation Street to the proposed Link A.	The proposed road would have a Slight Adverse impact on the existing urban landscape character.	The visual impact would be Slight Adverse, as roadways and car parks are dominant features on the existing views along Corporation Street. The proposed road would be slightly more visually prominent, due to its junction with Link A.
	Link I - Dock Street to M3		
	This proposed link road follows the existing route of Nelson Street. The road increases in elevation and includes an overbridge over Link A.	The impact on landscape character would be Slight Adverse, as the proposals reinforce the urban landscape setting which is characterised by roadways and the extensive number of vehicles. The closure of the existing off-slip provides an opportunity for mitigation planting which was otherwise not possible.	The visual impact would be Moderate Adverse, though could become an improvement depending on the nature of the mitigation planting.
	Link J - M3 to York Street		
	The proposed link road follows the existing route of Great George's Street from the M3. This proposed route separates from Link D and grades down to the junction with Little York Street, before the road then rises to join York Street. The proposed link road includes the creation of a dwarf wall on the south side of the link.	The impact on landscape character would be Slight Adverse, as the proposed route for the link road is the same as an existing roadway of similar scale.	The visual impact would be Slight Adverse, due to the introduction of the dwarf wall. Importantly, it is anticipated that only properties adjacent to the proposed link road would have their views impacted.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option D – (Elevated Concept Design) The layout provides a grade separated junction, but not a full interchange, with links at either existing ground level or on elevated overbridge structures (**Figure 6.5.5**)	**Link A** - M2 to Westlink		
	The proposed road link is an overbridge that rises over Dock Street to approx 9m high. It then rises further to 17.5m above street level over Dargan and Lagan bridges, before it drops down from an abutment (about 7m above existing) to tie into North Queen Street Bridge. Importantly, retaining structures are required to support the new alignment.	The scale and massing of the proposed link road with associated supporting columns would form a distinctive and new addition to this urban landscape. Although significant, the proposed link road would be in keeping with the character of the area, with the existing overbridges of the M3 and Dargan Bridge and their associated supporting columns. It is the scale and massing (i.e. largest span 90m and height 17.5m) which make it a distinguishing and significant feature that would substantially affect the landscape character. Importantly, this proposed link road would not fragment the spaces underneath at street level, as in Options A and C.	The visual impact of the road would be a Substantial/Moderate Adverse, as it becomes a dominant feature in this landscape setting. The view at existing ground level would be impacted by the scale and massing of the link road and in particular the supporting columns. There would also be Significant impacts to views from the adjacent multi-storey buildings e.g. Galway House, Cityside Retail Park and further away again The Royal Mail and The Obel Buildings.
	Link B - Westlink to M2		
	This proposed link road starts at the Westlink, before rising up by 5.5m at an abutment onto an overbridge (approx. 18.5m high) across York Street, before grading down to join the existing M2.	The scale and massing of the proposed link road with associated supporting columns would form a distinctive and new addition to this urban landscape. Although significant, the proposed link road is in keeping with the character of the area, with the existing overbridges of the M3 and Dargan Bridge and their associated supporting columns. It is the scale and massing (i.e. 18.5m high) which makes it a distinguishing and significant feature that would substantially affect the landscape character.	The visual impact of the road would be Substantial Adverse, as it becomes a dominant feature in this landscape setting. The view at existing ground level would be impacted by the scale and massing of the link road and in particular the supporting columns. There would also be Significant impacts to views from the adjacent multi-storey buildings e.g. Galway House, Cityside Retail Park and further away again The Royal Mail and The Obel Buildings.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option D – (Elevated Concept Design) The layout provides a grade separated junction, but not a full interchange, with links at either existing ground level or on elevated overbridge structures (**Figure 6.5.5**)	**Link C** - Westlink to M3		
	The proposed link road follows the existing line for the Westlink – M3. The existing road would be largely unchanged, apart from additional traffic islands, line changes and signalling at junctions. The proposed link road would predominantly remain at existing levels. This link road would facilitate a new link to Corporation Street as well as access to the adjacent potential development site that at present is only accessible from Great George's Street.	The impact on landscape character would be Slight Adverse, as the proposed route for the link road is the same as an existing roadway of similar scale.	The visual impact would be Slight Adverse, due to the potential realignment of the junctions. It is anticipated that only properties adjacent to the proposed link road would have their views impacted.
	Link D - M3 to Westlink		
	The proposed link road follows a new route from the M3 to the Westlink, which cuts through a potential development site. Rather than depressed roadway as in Options A and C, the link road is elevated by 1.2m with associated retaining walls and safety barriers. Importantly, the road includes the creation of an overbridge across York Street.	The impact on landscape character would be Substantial Adverse, as the proposed link road would form a new vertical element over York Street. The substantial impact is due to the cumulative effect on landscape character from the creation of an overbridge across York Street. This link road creates an intensification of roadways which become a more dominant feature of the character in this urban landscape.	The visual impact would be Substantial Adverse, due to the height of the proposed overbridge. Views along York Street in both directions would be affected, in addition to the views from neighbouring properties both residential and commercial.
	Link E - York Street (South) to York Street (North)		
	The proposed link road follows the route of the existing York Street (South) and York Street (North). The proposed route maintains existing levels although it does include road widening, re-alignment, adjustments to signalling and line markings.	The impact on landscape character would be Slight Adverse, as this is a long established vehicle and pedestrian route.	The visual impact would be Slight Adverse, due to the potential realignment of the junctions. It is anticipated that only properties adjacent to the proposed link road would have their views impacted.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option D – (Elevated Concept Design) The layout provides a grade separated junction, but not a full interchange, with links at either existing ground level or on elevated overbridge structures (**Figure 6.5.5**)	**Link F** - York Street to M2		
	The proposed link road is immediately adjacent to the existing Westlink – M2 link road. The route initially grades down to the junction with York Street before rising to merge into the M2 and alignment adjacent to Link B. This proposal also involves the widening of the existing Dock Street Bridge.	This proposed link road would have a Moderate Adverse impact on landscape character as it encroaches onto the site of Galway House and involves widening of the bridge with associated removal of mature vegetation. It is important to note that replacement/mitigation planting and improvements to Dock Street Bridge upon its widening could potentially make a positive contribution to the landscape character of this area.	The visual impact would be Moderate Adverse, particularly from Galway House and Cityside Retail Park. This would be more visually prominent in the short term, as the existing vegetation is removed to facilitate construction.
	Link G - Westlink to York Street		
	The proposed link road follows the route of the existing road. However, the road drops in elevation as it approaches the junction with York Street. This proposal involves construction of a new retaining wall, maximum 5.4m above existing level.	The proposed road would have a Moderate Adverse impact on landscape character, as there is already a retaining wall and road in this location.	The visual impact would be Slight Adverse from the majority of viewpoints with the exception of local houses that back immediately onto the road and which would experience a substantial increase in the height of the retaining wall at the boundary of their property. The visual impact would be Substantial Adverse in this case.
	Link H - Nelson Street to Westlink		
	This proposed link road provides a new route from Nelson Street to Link A. The link road includes a new overbridge (approx. 9m high) over Dock Street, with retaining walls on either side and realignment of the southbound lane on Nelson Street. The proposals also include the conversion of Garmoyle Street to a two-way street, which will include a change in the line markings, signalling and creation of small traffic islands.	The proposed road would have a Substantial Adverse impact on existing urban landscape character. The character of Dock Street, although an urban landscape, would become dominated by the presence of overbridges and associated supporting columns and retaining walls. It is important to note that the existing urban landscape in this area is not deemed to be of high landscape quality.	The visual impact would be Substantial Adverse, as all views along Dock Street are significantly altered. The overbridge becomes the dominant visual feature and restricts other mid and long distance views along Dock Street.

Option	Link Road	Description of Landscape Impact	Statement of Visual Impact
Option D – (Elevated Concept Design) The layout provides a grade separated junction, but not a full interchange, with links at either existing ground level or on elevated overbridge structures (**Figure 6.5.5**)	**Link I** - Dock Street to M3		
	This proposed link road follows the existing route of Nelson Street. The road merges with Link C before joining the M3.	The impact on landscape character would be Slight Adverse, as the proposals reinforce the urban landscape setting which is characterised by roadways and the extensive number of vehicles. Closure of the existing off-slip provides an opportunity for mitigation which was otherwise not possible.	The visual impact would be Moderate Adverse, though could become an improvement depending on the nature of mitigation.
	Link J - M3 to York Street		
	The proposed link road follows the existing route of Great George's Street from the M3. This proposed route separates from Link D and grades down to the junction with Little York Street, before the road then joins York Street. The proposed link road includes the creation of a dwarf retaining wall on the south side of the link.	The impact on landscape character would be only Slight Adverse, as the proposed route for the link road is the same as an existing roadway of similar scale.	The visual impact would be Slight Adverse, due to the introduction of the dwarf retaining wall. Importantly, it is anticipated that only properties adjacent to the proposed link road would have their views impacted.

6.5.5.1 *Predicted Impacts from Key Sites and Landmarks.*

Further site surveys will be undertaken to specifically assess the visual impacts for individual properties during the Stage 3 assessment, following the selection of a preferred option. Therefore the following is an overview of the predicted impacts from key sites and landmarks within the study area, indicated on **Figure 6.5.6** (Location of Key Sites & Landmarks).

6.5.5.1.1 ***Zone 1: Odyssey, Lagan Weir and Belfast Head Post Office (0 residential units)***

Views to the proposed scheme area from the Odyssey, Lagan Weir, and to a degree the Belfast Head Post Office building, are largely screened by existing buildings and the existing M3 Lagan Bridge. Therefore, the visual impacts of any of the Options would be Neutral.

6.5.5.1.2 ***Zone 2: Obel Tower (approximately 280 residential units)***

Views towards the study area from the Obel Tower would be Neutral. Views from the lower floors would be screened by intervening buildings, particularly the Belfast Head Post Office. Views above this level would not be radically altered, as the scheme would form part of the existing complex urban fabric of this part of the city, and the roadways and structures when viewed from this distance and height would not dominate the view. The proposals would also be no higher than the existing Cityside Retail Park or Galway House and would not cut across views to the Belfast Hills or skyline.

6.5.5.1.3 ***Zone 3: North Queen Street/Henry Street Housing Area (approximately 130 residential units)***

All Options would have a negative impact on the housing areas bordered by North Queen Street and Henry Street, due to the additional roadways, especially where they are elevated and therefore affect views of the sky and distant hills.

Option A requires the north-bound section of Westlink to be raised to approximately the upper storey windows of the houses backing onto this road, for approximately half of its length along this shared boundary. This structure would reduce light available into these buildings, and reduce privacy. The impact would be Moderate Adverse.

Option B would have the same effect as Option A with regards to the north-bound carriageway of Westlink. The M2 to Westlink (Link A) flyover would additionally cut across views of the sky, views of the Holywood hills, and the city centre. The effect would be Substantial Adverse, as it would be detrimental to privacy and views of the larger landscape.

The effects of Option C would be very similar to those of Option A and the impact would be Moderate Adverse.

Option D would also be similar to Option B in terms of effects in that both the Westlink to M2 (Link E) and M2 to Westlink (Link A) flyover structures cut across views of the city centre, sky and Holywood hills. It differs from Option B and the remaining Options in that the Westlink to York Street (Link F) remains at its current level. Therefore, the impact would be Substantial Adverse.

6.5.5.1.4 ***Zone 4: Victoria Parade / North Queen Street Tower Blocks (approximately 200 residential units)***

Views towards the study area from the Tower Blocks would be Neutral to Slight Adverse. Views from the lower floors would be screened by adjacent housing developments and the existing Westlink with its associated boundary treatment. There would be some views available from the upper floors dependent on the orientation of the residential premises within the tower block. However, the scheme would only form a small part of the overall view of the existing complex urban fabric of this part of the city. There would be a negligible view of Options A & C due to the depressed concept designs. There would be a view of Options B & D due to the elevated overbridges. However, the roadways and structures when viewed from this distance and height would not dominate the view. The proposals would also be no higher than the existing Cityside Retail Park or Galway House.

6.5.5.1.5 ***Zone 5: Lancaster Street Housing (approximately 118 residential units)***

All Options would have a varying effect on the Lancaster housing area, due to the increase in the number of roadways, and the resulting support structures, parapets and fences that would be viewed from the houses. There would be some degree of benefit however for the Lancaster housing, in that the M3 to Westlink link would be realigned further away from the houses.

Option A would have little effect on this area, as the proposed York Street Bridge is relatively low. There would be a visual effect from the potential need for safety fencing along the depressed M2 to Westlink (Link A) which would add to the visual confusion of the site, therefore the impact would be Slight to Moderate Adverse.

The visual effects of Option B would be predominantly from the flyover, and the M2 to Westlink (Link A) being elevated. These structures cut across the views to the Cityside Retail Park, Galway House and sky. The support columns add additional confusion to the view, therefore the impact would be Substantial Adverse.

The effects of Option C would be from the potential safety fences and/or parapets on the depressed roads – M3 to Westlink (Link C), M2 to Westlink (Link A), and Westlink to M2 (Link E). The effects of the fences would partially screen views to the North Queen Street/Henry Street housing area, but this option would maintain views to Cityside Retail Park, Galway House and the sky, as all structures would be below the level of the current Lagan Bridge and Dargan Bridge. The impact would be Moderate Adverse.

The effects of Option D would be from the M2 to Westlink (Link A) and Westlink to M2 (Link E) which would cut across views to the North Queen Street/Henry Street housing area, Cityside Retail Park and Galway House. Both flyovers for M2 to Westlink (Link A) and Westlink to M2 (Link E) cut across sky views because they are at an elevation above that of the Lagan and Dargan bridges. The additional support columns would also further complicate and fragment the view. The impact would therefore be Substantial Adverse.

6.5.5.1.6 ***Zone 6: CC110 Clifton 1 LLPA Clifton House (approximately 13 residential units)***

The impacts on the LLPA of Clifton House would be largely Neutral to Slight Adverse for all Options. The majority of views from Clifton House to the study area are screened by intervening buildings. However, views from Clifton House of the elevated roadways of Options B and D, where they rise above the level of the existing Lagan and Dargan bridges, would be Slight to Moderate Adverse. These would be the only parts of Options B and D that are visible.

6.5.5.1.7 ***Zone 7: Galway House and Cityside Retail Park (0 residential units)***

From Galway House and Cityside Retail Park, Options A and C would have a Neutral impact, as both Options would require the elevation of York Street, but would not require any roadways to be elevated above the existing Lagan and Dargan bridges. Options B and D would have a Substantial Adverse impact, due to the elevated roadways which would partially screen views of the sky and possibly harbour and hills from the upper levels of both buildings. Option D may have the most severe effect, due to the reasonably close proximity of the Westlink to M2 (Link E) and M2 to Westlink (Link A) to Galway House and the loss of privacy, and views and the effects of the roadway and traffic at such high levels.

6.5.5.1.8 ***Zone 8: Docklands (approximately 250 residential units)***

The impact on the docklands of Options A and C would be Substantial Adverse, due to the elevated and depressed roadways bisecting the area. Although a large part of this area is currently derelict and used for vehicle storage/parking, it does have development potential with the opportunity to create a dual frontage to Corporation Street and extension of the docklands redevelopment. Options B and D would also be Substantial Adverse, in that it would add additional vertical and horizontal structures, however it would not fragment the docklands.

Impacts on views from the Clarendon Dock public space, historic Harbour Office and Sinclair Seamen's Church would be Substantial Adverse for Options B and D as both Options would cut across the view of the Belfast Hills, skyline, Cityside Retail Park and Galway House. As viewed from Clarendon Dock, Options B and D would be below the top of the Cityside Retail Park and Galway House. From the proximity of the Sinclair Seamen's Church, the views are similar as from Clarendon Dock.

6.5.5.1.9 ***Zone 9: Development Opportunity Sites (0 residential units)***

Options A and C would have a Substantial Adverse effect on the Development Opportunity Sites CC073 (Westlink/York Street), CC076 (Little York Street/Shipbuoy Street) and CC080 (Corporation Street/Trafalgar Street), as they would split all of the development sites into smaller parcels of land, of which some may be too small to develop. This would have a further negative impact on the cityscape by reducing the opportunity to develop the sites with large scale buildings, which would assist in integrating the motorway into the urban fabric.

6.5.5.1.10 ***Zone 10: Area bounded by York Street, Great George's Street, Great Patrick Street, Nelson Street (0 residential units)***

All Options would have a Substantial Adverse effect on views up and down York Street and on the cityscape, by introducing raised structures that introduce a further barrier separating this area from the city centre. Option D, while not requiring an overbridge on York Street, would still have a Substantial Adverse effect as the elevated M3 to Westlink (Link B), and flyovers for M2 to Westlink (Link A) and Westlink to M2 (Link E) would cut across this visual corridor.

6.5.6 *Mitigation and Enhancement Measures*

Mitigation is a term used to describe the measures that are employed to address environmental impacts. The purpose of mitigation is to avoid, reduce and where possible remedy or offset, any significant negative (adverse) effects on the environment arising from the proposed development. The following are a range of mitigation measures that should be considered as the design progresses.

6.5.6.1 *Avoidance Measures*

- Avoid the use of dominant road elements on the skyline. This will be particularly important where the proposed options include elevated link roads.
- Signage should be located sensitively so that it does not increase the visual impact, particularly to dwellings.
- Road lighting should be kept to essential locations only, as this will increase the visual impact of the road at night.
- Retention and enhancement of views from the road where appropriate.

6.5.6.2 *Reduction Measures*

- Minimise disturbance of existing vegetation and carry out proposed planting so as not to emphasise the intrusion of the road into the landscape, but rather to re-establish and reflect the landscape character of the area.

6.5.6.3 *Remediation Measures*

- Provide appropriate screening where the road would have a visual impact on adjacent properties or views. In selected locations where the visual impact is Substantial, immediate screening would be required, if feasible.
- Where possible and feasible, further consideration should be given at Stage 3 to the provision of off-site planting where it can reduce the visual impact of the road to properties.
- The boundary treatment for the road should be sensitive to the landscape character of the area, this is particularly important in the case of proposed retaining walls.
- Integration of parapets into the structure of the overbridges and other structures to create the impression of one simple structure.
- The overbridges should be designed to allow the road corridors and urban landscape to flow under the structures, in order to minimise its' visual prominence. For example, consideration should be given in the detailed design to minimise and strategically locate the bridge piers.
- The depressed roads could be roofed over to allow continuous views at ground level by minimising parapets and fencing and to facilitate redevelopment.

6.5.7 ***Summary and Conclusions***

The impacts of all Options would negatively affect both visual and cityscape aspects, as the York Street Interchange would become a dominant feature of the scene at this node. The landscape and visual aspects, however, are not one and the same. When assessing the Options from purely the visual impacts, it is evident that those Options that do not have elevated structures higher than the Lagan and Dargan bridges are preferable, as they would have the least visual impact and affect on views. This situation could be further improved if the depressed roadways are roofed over to remove the visual impacts of high security fencing and parapets. From this perspective, Options A and C are preferable, with Option A the better of the two.

The Options with the least effect on the landscape now and in the future are those that allow the largest intact parcels of land for future consolidation of the area and connection to the city centre. This is at odds with the Options that have the least visual impact, and the preferable options are those that tend to include elevated, flyover structures. Solely assessed on landscape impacts, Options B and D are preferable, with Option D having the most potential for future development of a scale that absorbs the interchange into the urban fabric.

6.6 Land Use

6.6.1 ***Introduction***

The assessment of land-take covers a wide range of land values and primary uses. Under guidelines laid down in the DMRB, the principal issues to be considered when assessing the effects of a proposed road scheme on land use are as follows:

- Demolition of private property and associated land-take
- Potential private land loss

- Effects on development land
- Potential loss of land used by the community
- Effects on agricultural land
- Effects on restoration proposals for abandoned waterways.

Land containing archaeological remains, historic buildings or gardens is dealt with in **Section 6.3 (**Cultural Heritage). Land of ecological importance is dealt with in **Section 6.4** (Ecology & Nature Conservation). In addition, **Section 6.5** (Landscape Effects) considers the contribution of all land affected by the scheme to the landscape or townscape and identifies designated areas, such as Areas of Outstanding Natural Beauty (AONB) and Local Landscape Policy Areas (LLPA).

6.6.2 *Methodology*

The principal objective at this secondary stage is to undertake sufficient assessment to give a clearer indication as to the potential land type losses and demolition required by each option under consideration, in order to assist in the selection of a preferred option.

6.6.2.1 *Demolition of Private Property and Private Land Loss*

Where properties need to be demolished for a scheme to be built, the environmental impact of their loss and associated land take should be included in the assessment, in accordance with the requirements of DMRB Volume 11, Section 3, Part 6, Chapter 2 (Demolition of Private Property and associated Land-take). Demolition can give rise to a range of other effects including loss of facilities, loss of attractive buildings or townscape, or the opening of views for other properties previously screened. The assessment also covers the effects of private land loss (i.e. gardens, driveways, open space, brownfield land, hardstanding etc), taken in part or in whole.

At this secondary stage, the options are sufficiently developed to allow an approximate estimate of properties at risk of demolition and where areas of private land would be lost to accommodate the various scheme options. Schedules (**Tables 6.6.4 & 6.6.5**) and a drawing (**Figure 6.6.1**) have been produced showing the range of properties which might need to be demolished, or from which land might need to be taken, for each option.

6.6.2.2 *Development Land and Planning Applications*

The environmental assessment takes account of, as far as practicable, future changes in land use due to new development which would likely occur in the absence of the scheme. Hence, in accordance with the requirements of DMRB Volume 11, Section 3, Part 6, Chapter 5 (Effects on Development Land), the steps taken were broadly similar with those undertaken at Stage 1, taking account of refinement to options and/or changes in development policies and plans.

For the effect of the scheme on development land, the Belfast Metropolitan Area Plan (BMAP) 2015 (Draft Plan) was inspected. In essence, the options were plotted on a map of land-use designations, identifying land-take from areas designated for potential future development and the degree of impact assessed. The same process was undertaken for planning applications, with Planning NI consulted to seek their ‘in-confidence’ views on the implications of the options on development proposals, plans and policies. This resulted in a broad assessment and statement of how each option might affect local planning applications and development designations, accompanied by relevant drawings (**Figures 6.6.2 & 6.6.3**).

6.6.2.3 *Community Land*

As required by DMRB Volume 11, Section 3, Part 6, Chapter 4 (Assessing the Loss of Land Used by the Community), Belfast City Council was again consulted to obtain information on the location and status of areas of land used by the public within the study area.

6.6.2.4 *Agricultural Land*

Typically, there are four main areas that are addressed in the assessment of effects on agricultural land. These are land-take, type of husbandry, severance and major accommodation works for access, water supply and drainage. In accordance with DMRB Volume 11, Section 3, Part 6, Chapter 10 (Stages in the Assessment of Effects on Agricultural Land), the main requirement at this secondary stage is to check that information on agricultural land quality and statutory areas designated for their agricultural importance obtained at Stage 1 is still valid.

6.6.2.5 *Waterways*

In terms of Waterway Restoration Projects (if any), it is essential to consider any waterways, formerly navigable watercourses or dry watercourses for which there are currently restoration proposals. The steps taken were to confirm that the information obtained at Stage 1 is still correct and consult with the relevant interested parties.

6.6.2.6 *Assessing the Significance of Effects*

With reference to DMRB Volume 11, Section 2, Part 5, Chapter 2 (Determining Significance of Environmental Effects), it is not sufficient to assess only the size and probability of possible impacts: their significance should also be assessed. The significance of the effect is formulated as a function of the receptor or resource's environmental value (or sensitivity) and the magnitude of project impact (change). In other words, significance criteria are used to report the effect of the impact. In terms of land use impacts, there may be a significant degree of ambiguity with regards to the non-monetary valuation of land and property, and the importance of its primary usage. Therefore significance criteria used to assess impacts is based on professional judgement and used loosely.

Firstly, to assess the overall significance of potential effects of the scheme options on land and property, an assessment has been made of the sensitivity of the resource and magnitude of potential impacts using the general criteria contained in **Tables 6.6.1 & 6.6.2** for guidance.

TABLE 6.6.1: ESTIMATING THE IMPORTANCES OF LAND USES

Importance	Criteria
High	Existing beneficial land uses (i.e. active property, private land associated with an active property, community lands and woodlands).
Medium	Areas designated for future usage with a developer interest (i.e. land-use planning policy designations contained within the BMAP (Draft Plan)), access lanes, farm outbuildings.
Low	Existing land uses of less beneficial nature (i.e. inactive property, private land associated with an inactive property) and without developer interest.

TABLE 6.6.2: ESTIMATING THE MAGNITUDE OF IMPACT ON AN ATTRIBUTE	
Importance	**Criteria**
Major	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements. Demolition of property. Land-take from property and/or severance which would preclude or significantly affect current or future use.
Moderate	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements. Land-take from property which would moderately affect current or future use.
Minor	Some measurable change in attribute's quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. Land-take from property which would slightly affect current or future use.
Negligible	Barely perceptible impact upon current or future use.

DMRB Volume 11, Section 3, Part 6 does not describe how the significance of effects should be scaled with regards to land-use. Therefore, **Table 6.6.3** outlines a suggested means of estimating the significance of potential effects, based upon the magnitude of impact and sensitivity of the receptor. Professional judgement and awareness of the relative balance of importance between sensitivity and magnitude allows the overall significance of impact to be assessed. The significance of impact is assessed with mitigation to define residual impacts.

TABLE 6.6.3: ESTIMATING THE SIGNIFICANCE OF POTENTIAL EFFECTS

IMPORTANCE OF ATTRIBUTE		MAGNITUDE OF IMPACT			
	High	Neutral	Moderate/Large	Large/Very Large	Very Large
	Medium	Neutral	Slight/Moderate	Moderate/Large	Large/ Very Large
	Low	Neutral	Slight	Moderate	Large
		Negligible	**Minor**	**Moderate**	**Major**

Source: DMRB 11.2.5.2 (Arriving at the Significance of Effect Categories - adapted)

6.6.3 ***Regulatory/Policy Framework***

New and improved roads are created by statute under the various provisions in The Roads (Northern Ireland) Order 1993 [as amended]. Before construction of a strategic road improvement can proceed, Roads Service must:

- make a Designation Order, identifying that part of the proposed road improvement which will become part of the Province's special road network
- make a Vesting Order, to compulsorily acquire the land required to construct the proposed road improvement
- prepare an Environmental Statement which predicts the environmental effects the proposed road improvement will have, and details the measures proposed to reduce or eliminate those effects.

The most relevant provision in terms of land use impacts within the Roads Order is contained within Part IX (Powers of Department in Relation to Land). With regards to the proposed scheme, the primary powers (subject to a range of conditions) include obtaining information on ownership of land, entry of land, acquisition of land (by agreement or compulsorily) for construction of the proposed scheme and associated works, resettlement of undertakings, and mitigation of adverse effects associated with road construction.

In terms of policy & plans, there is a hierarchy of planning policy and legislation in Northern Ireland, pertinent to the proposed scheme which is afforded differing weights when making planning decisions. The guiding principle that Planning NI observes in making decisions on planning applications is set out in PPS 1: General Principles. This states that development should be permitted, having regard to the Development Plan and all other material considerations, unless it would cause demonstrable harm to interests of acknowledged importance.

Other PPS relevant to the proposed scheme from a land use perspective include:

- PPS 4: Planning and Economic Development (November 2010)
- PPS 8: Open Space, Sport and Outdoor Recreation (February 2004)
- PPS 12: Housing in Settlements (July 2005)
- PPS 13: Transportation and Land Use (February 2005).

There are a large number of other Government strategies and policy documents that can, on occasion, be material to the consideration of particular development proposals. Examples of such documents include: the Northern Ireland Biodiversity Strategy; the Northern Ireland Waste Management Strategy; the Northern Ireland Landscape Character Assessment; and the River Conservation Strategy for Northern Ireland.

6.6.3.1 *Development Plans*

The adopted Development Plan for the study area is the Belfast Urban Area Plan (BUAP) 2001, published in December 1989; a date which precedes the formal adoption of the Regional Development Strategy (RDS). Whilst this plan remains a statutory instrument for its particular plan area, a new development plan has been prepared (Belfast Metropolitan Area Plan (BMAP) 2015), published in draft form in November 2004 in conformity with the RDS.

6.6.3.1.1 ***Belfast Urban Area Plan 2001***

Notwithstanding the advanced stage of BMAP 2015, the BUAP 2001 remains the ‘extant’ plan until final adoption of BMAP. It discusses general measures for the growth and expansion of Belfast. It notes that priority will be given to investment in strategic infrastructure. In particular, linkages to the City Centre and the M2 are specifically mentioned.

6.6.3.1.2 ***Belfast Metropolitan Area Plan 2015 (Draft Plan, November 2004)***

The BMAP is at an advanced stage of preparation, having undergone full Public Inquiry. The aim of the plan is to provide a planning framework which is in general conformity with the RDS in facilitating sustainable growth and a high quality of development in the Belfast Metropolitan Area throughout the Plan Period, whilst protecting and where appropriate, enhancing the natural and man-made environment of the plan area.

The Plan Strategy for the BMA consists of the following main elements:

- Strengthening the Metropolitan Area
- Promoting Urban Renewal
- Sustaining a Living, Working Countryside
- Enhancing Quality of Life

- Supporting Economic Development
- Promoting Equality of Opportunity
- Developing an Integrated Inclusive Transport System
- Protecting the Natural Environment.

The Plan Strategy, allocations, designations, policies, proposals and zoning of the Draft Plan are collectively referred to as the Plan Proposals. Part 3 of the plan deals with the Plan Area as a whole, and Part 4 deals specifically with District Proposals, setting out site-specific proposals for individual council areas.

6.6.3.1.3 ***Belfast Metropolitan Area Plan 2015 (Draft Plan, November 2004) – District Proposals Belfast***

The Belfast District Proposals consist of designations, polices, proposals and zonings specific to the administrative area of Belfast City Council.

The Plan Strategy for the Belfast District consists of the following main elements:

- Promoting Urban Renewal in the City
- Enhancing Quality of Life in the City
- Focus for Economic Development in the City
- Promoting Equality of Opportunity for All Sections of the City Population
- Protecting the City's Natural Environment
- Promote an integrated and inclusive Transport System consistent with the City's role as a major gateway to Northern Ireland and as the heart of the Regional Strategic Transport Network.

6.6.3.1.4 ***Belfast Metropolitan Transport Plan 2015 (BMTP)***

Prepared by DRD, the BMTP is a local non-statutory transport plan for the BMA, which takes forward the strategic initiatives of the RTS and sets out transport proposals for the BMA which people can expect to see implemented by 2015. The BMTP and draft BMAP are mutually supportive and integrated documents, with the former acting as a Technical Supplement to the latter in relation to transportation.

The overall development of the BMTP was based on GOMMMS, ensuring that a comprehensive range of solutions had been considered covering all modes of transport. It also ensured integration between transport and land use. The BMTP development was especially influenced by the guidance provided by the RDS and Regional Transportation Strategy (RTS) and enabling the generic multi-modal study process to be focused on the particular needs and special context of the BMA. An extensive consultation exercise was also undertaken, ensuring that the views of a wide range of stakeholders were taken into account in the development of the Plan. The consultation process built upon the extensive consultation exercise undertaken to support the RDS and RTS.

The BMTP identified a road hierarchy within the BMA, comprising the Strategic Highway Network linked to the wider RSTN in the RSTNTP and a Non-Strategic Highway Network. The Strategic Highway Network identified by the BMTP includes the A12 Westlink, M2 and M3, and a series of improvements are identified on the M1/Westlink and M2 routes to remove identified bottlenecks. With regards to the planned improvements to the M1/Westlink, the BMTP cautioned that:

"the improvements to the M1/Westlink will require further consideration to be given to improving the capacity and operation of the signalised junctions at York Street/Westlink and Nelson Street/York Link/Great George's Street."

6.6.4 ***Baseline Conditions***

6.6.4.1 *Existing Development*

Within the confines and immediate surrounds of the existing junction arrangement, there is very little built development. Whilst this land has been developed in the past, very little currently remains, other than a vehicle mechanics on Shipbuoy Street.

With regards to current land usage, surface level car parking, brownfield land, and amenity planting associated with the existing road network dominates. With reference to the BMAP (Draft) 2015, the area bounded by York Street, the elevated M3 Bridge, the M2, Queen's Square and Dunbar Link has disconnected the docks and ferry terminals from the City Centre and the Cathedral Quarter, contributing to widespread blight, leaving many sites either vacant or under used. The estimated importance of this land (from a land use perspective) is variable, however in the most part can be currently considered low, as there is little existing beneficial uses and little developer interest. The higher value land (i.e. of existing beneficial use) relates primarily to the surface level car parks (public and private).

Beyond the immediate surrounds of the existing junction arrangement, there is a distinct variation in land use and associated built development. To the west, high density residential housing occupies land north and south of the A12 Westlink. To the south, existing built development is dominated by commercial properties, becoming progressively more built-up away from the junction and closer to the City. The Obel building is located adjacent to the M3 motorway at Donegall Quay, and is currently the tallest residential building in Ireland. It has a mix of residential and office properties within it. To the east, built development is dominated by residential and mixed use office developments, primarily associated with the regeneration area at Clarendon Dock. To the north, built development is primarily dominated by commercial properties ribboning along York Street, most notably Cityside Mall at Yorkgate.

6.6.4.2 *Planning Applications*

Initial research of the new Planning NI 'Public Access for PLANNING' website was followed up with the provision of digital 'red line' planning data from Planning NI, up to February 2012. The 'red line' associated with a planning application forms the outer most boundary of the potential development site; it is not indicative of the proposed site layout. Subsequent checks of the Planning NI 'Public Access for PLANNING' website for newly submitted planning applications also took place, in order to keep abreast of current development proposals.

This data confirmed that historically, a significant number of planning applications have been submitted within the area, though very few of these are currently extant. Those which are currently extant, very few of significance are located with the confines of the existing junction arrangement. In essence, the majority of these are advertisement applications (i.e. hoardings and display panels) and thus contribute little to development of the area.

In the surrounds of the existing junction arrangement, there are however a number of significant extant planning applications with some sizeable developments being proposed. These include a new University of Ulster Campus in Belfast City Centre and a range of social/private housing developments and mixed use developments, the majority of which propose to make use of vacant brownfield land within the study area.

Any application which has been Refused, Dismissed, Withdrawn or Lapsed has not been considered within this assessment, though those applications which have been approved via appeal to the Planning Appeals Commission (PAC) have been considered. Only those deemed to be of significance to the wider development of the study area and directly affected by any of the options under consideration have been illustrated on **Figure 6.6.2**.

6.6.4.3 *Development Land*

The Stage 2 assessment reviewed policy frameworks and broad land use proposals contained within the BUAP 2001 and BMAP (Draft) 2015, which are used to guide development. As noted earlier, the BUAP remains a material planning consideration (even though it has passed its notional end date) until such a time that it has been superseded wholly or in part by the adoption of the BMAP. Nevertheless, these plan proposals sit alongside, but do not supersede, prevailing regional planning policy as set out in the RDS and PPSs (except where specifically indicated in the plan).

The planning framework associated with the BUAP 2001 provided land use and planning policy support for the regeneration and renewal of Belfast City, though there is no specific development zonations located within the study area. The lack of zonation affords flexibility in the type of potential development proposals that could be accommodated within the study area.

With reference to the BMAP (Draft) 2015 district proposals for Belfast, the designations, policies, proposals and zonings for individual locations within Belfast City are categorised by the following areas (all of which fall within the study area):

- Belfast City Centre
- Belfast Harbour Area
- The Arterial Routes
- Outer Belfast City.

The study area is essentially located on the northern fringe of the designated City Centre (CC), the southeastern fringe of North Belfast (NB), the southwestern fringe of the Belfast Harbour Area (BHA), with the York Street/York Road/Shore Road Arterial Route (AR) passing through in a north/south orientation. As such, there are a variety of zonations/designations contained therein. Typical zonations of significance within the immediate study area include Development Opportunity Sites, which are sites greater than 0.1 hectare (ha) in size, within the City Centre and normally vacant, derelict, or currently used for surface level car parking (**Figure 6.6.3**). These include:

- **Zoning CC 073** at West Link/York Street (0.38ha). Site is located within a wedge of land located between the A12 Westlink and York Street, and currently comprises surface level car parking operated by Roads Service.
- **Zoning CC 074** at Great George's Street/York Street (0.14ha). Site is located on the corner of York Street at the junction with Great George's Street, and currently comprises surface level car parking.
- **Zoning CC 076** at Little York Street/Shipbuoy Street (0.9ha). Site is surrounded by Great George's Street, Nelson Street, York Link and York Street. The site currently comprises surface level car parking, operated by Roads Service, and a vehicle mechanics workshop.
- **Zoning CC 077** at Great George's Street/Nelson Street/Great Patrick Street/York Street (1.65ha). This site currently comprises warehousing, vacant and underused buildings and private surface level car parking.
- **Zoning CC 078** at Great Patrick Street/Little Patrick Street (0.38ha). Site currently comprises commercial warehousing and surface level car parking for warehouse customers.

- **Zoning CC 080** at Corporation Street/Trafalgar Street (1.72ha). This site currently comprises vacant land in use for storing building materials.
- **Zoning CC 082** at Tomb Street (0.69ha)**.** This site, underneath the M3 flyover, currently comprises surface level car parking operated by Roads Service.

Of those Development Opportunity Sites that are in use (in part or in whole) as surface car parks, under policy framework proposals contained within BMAP, planning permission (under the Planning (Northern Ireland) Order 1991) would typically be granted, provided that all existing car spaces are replaced, either on site or in an appropriate location in the vicinity of the site, and that the spaces are reserved for short stay use only.

A number of protected city centre housing areas on the fringe of the City Centre area are also located within the immediate study area. Within these areas, any development that results in a change of use from housing (i.e. commercial) would normally be resisted (**Figure 6.6.3**). These include:

- **Zoning CC 097/12** (Clifton).
- **Zoning CC 097/13** (Lancaster).

On the southeastern periphery of North Belfast, a District Centre for retailing (BT 017/6) has been zoned at Yorkgate (**Figure 6.6.3**). Such centres provide shoppers in Belfast with convenience and choice in areas beyond the City Centre. It is recognised however, that the City Centre is under-performing as a Regional Centre, with many out-of-town centres over-trading, and subsequently attracting trade away from the City Centre. In order to redress this imbalance, boundaries are delineated for all of the District Centres.

Located to the immediate northeast of the M2/M3 motorways is the Belfast Harbour Area (BHA 08); a major area (540 ha) of existing employment/industry (**Figure 6.6.3**). Also within the BHA, and in close proximity to the existing junction, are three areas zoned for housing. These include:

- **Zoning NB 04/01** at 15 Prince's Dock Street (0.14 ha).
- **Zoning NB 04/05** at James Clow Mill, between St. Joseph's and Short Street (0.32 ha).
- **Zoning NB 05/06** at 61 Dock Street (0.16ha).

All of these zoned housing areas have been or are currently being developed.

6.6.4.4 *Community Land*

There are no areas of community land in the immediate vicinity of the existing junction arrangement. The closest area of community land is the Bridges Urban Sports Park (**Figure 6.8.1**), located under the M3 flyover at the junction of Little Patrick Street and Corporation Street. The park provides facilities for skateboarding, in-line skating, Parkour and BMXing. It also includes a capsule bowl and street complex, complete with handrails, hips, quarter pipes, grind boxes and hubbas. This is a Belfast City Council maintained facility, partly funded by the European Union Programme for Peace and Reconciliation.

6.6.4.5 *Agricultural Land*

As the study area is located within a highly urbanised environment, no land is currently in agricultural usage.

6.6.4.6 *Woodland Areas*

The only areas of woodland within the study area are parcels of maturing amenity planting, associated with the existing road network. Most of the amenity woodland planting can be found from York Link, extending along the western M2 Motorway embankment, through to Dock Street and along the M2 eastern embankment through to the Duncrue Street off-slip. Small parcels of amenity woodland can also be found adjacent to the M3 on-slip embankment at Nelson Street, and adjacent to the A12 Westlink southbound and northbound carriageway embankments.

With regards to Tree Preservation Orders (TPO's), Planning NI have confirmed that there none are currently in place within the study area.

6.6.4.7 *Waterway Restoration Schemes*

The Lagan Canal formerly connected Belfast (at Stranmillis) to Lough Neagh, however currently is in a state of partial disrepair, partial abandonment and partial restoration. Proposals for full restoration are currently being considered, after the establishment of the Lagan Canal Restoration Trust (LCRT) and the Lagan River Project, following a report commissioned by various agencies, including Belfast, Castlereagh, Craigavon and Lisburn Councils, the Department of Culture, Arts & Leisure (DCAL), the Inland Waterways Association of Ireland, and the Ulster Waterways Group. In the long term, plans are being considered to open the Lagan Corridor as far as Lough Neagh, where it would link up with the Shannon and Erne Waterway, via the Ulster Canal (which is also in need of restoration), facilitating connection of Belfast, Dublin and Limerick via waterway (Belfast City Council, January 2012 [online]).

6.6.5 ***Predicted Impacts***

6.6.5.1 *Operation*

6.6.5.1.1 ***Demolition of Private Property and Associated Land-take***

Whilst the proposed scheme is located on the northern fringe of the City Centre, the nature of the built environment which surrounds the existing junction is such that very little demolition of property would be expected to accommodate any of the options under consideration. As noted earlier, the built environment is characterised by areas of land which are vacant, derelict, or currently used for surface level car parking. Nevertheless, due to the complexity of providing grade-separation whilst attempting to achieve current design standards, there would inevitably be cases where properties would be at risk of demolition.

A detailed scheduled of properties at risk of demolition with the options under consideration is contained within **Table 6.6.4** below and **Figure 6.6.1**. This table contains information on property types potentially affected by respective options, location and reason for expected loss.

TABLE 6.6.4: POTENTIAL DEMOLITION / PARTIAL REMOVAL OF PROPERTIES FOR EACH OPTION				
Ref No.	**Options**	**Property Type**	**Location**	**Reason for Loss**
D1	**A & C**	Government	Driver & Vehicle Agency (DVA), Road Transport Licensing Division 148 to 158 Corporation Street	M2 – Westlink (Link A)
D1	**B & D**	Government (outbuilding)	Driver & Vehicle Agency (DVA) , Road Transport Licensing Division 148 to 158 Corporation Street	M2 – Westlink (Link A)
D2	**A & C**	Government	Roads Service – Eastern Division Section Office, Corporation Street	M2 – Westlink (Link A)
D3	**A & C**	Commercial	Focus Security Solutions 130-132 Corporation Street	M2 – Westlink (Link A)

With reference to **Table 6.6.4**, and **Figure 6.6.1** all properties at risk of demolition are located between Corporation Street and Nelson Street and would be lost to accommodate the link between the M2 and Westlink (Link A) with all four scheme layout options. No other modification to the existing road network with any of the options under consideration is expected to result in demolition of property.

Options A & **C** would result in the same three properties being at risk of demolition, with expected impacts being identical due to the coincident alignment taken by Link A between the M2 and Westlink with these two options. Demolition is expected as the alignment taken by Link A is largely determined by the need to avoid bridge piers under the M3 Lagan Bridge and Dargan Rail Bridge (which cannot be repositioned) whilst attempting to achieve minimum design standards. In terms of current usage, two of the properties are government buildings and the other commercial. The government buildings are currently in use by the DVA as part of the Road Transport Licensing Division, and by DRD Roads Service as their Eastern Division Section Office. The commercial property is in use by Focus Security Solutions, which provides professional fire alarms and fire extinguishing equipment to the Northern Ireland market.

Options B & **D** would also result in a property being at risk of demolition, though the overall impact would be minor in comparison to **Options A** & **C**. At the DVA facility on Corporation Street, Link A (which is coincident between these options) would directly affect an outbuilding used to house services/utility apparatus. Even though the associated private land loss would be significant (as discussed below), no further demolition of property would be expected.

As noted earlier, a commercial property (Kirk Automobile Engineer) is located within the centre of the existing junction arrangement. It would therefore be reasonably assumed that this property may be at risk of demolition. Nevertheless at this stage, it can be accommodated in its current location and access maintained with all options under consideration.

6.6.5.1.2 *Potential Private Land Loss*

As noted earlier in **Sub-Section 6.6.4.1**, land use within the immediate study area is characterised by surface level car parking, brownfield land, and amenity planting associated with the existing road network. As such, there would inevitably be cases where, whilst there would be no actual building demolition, swathes of private land would be affected.

Amenity planting associated with the existing road network is not considered in the assessment of private land loss, as it is an integral part of the existing road network for softening and screening. The impact upon amenity planting is instead considered within **Section 6.4** (Ecology & Nature Conservation) and **Section 6.5** (Landscape Effects).

A detailed schedule of properties/areas predicted to experience private land loss with any of the four options under consideration is contained within **Table 6.6.5** below and shown on **Figure 6.6.1**. This schedule contains information on type of loss associated with each option, location, predicted impact and magnitude of that expected impact.

It must be noted that DRD Roads Service currently owns the majority of private land that would be affected by the proposed scheme. However, this is not prejudicial to the overall assessment, as it focuses specifically on loss (not ownership) and impacts associated with these losses in terms of current usage.

TABLE 6.6.5: SCHEDULE OF PROPERTIES / AREAS PREDICTED TO EXPERIENCE PRIVATE LAND LOSS

Ref No	Option (s)	Type of Loss	Location	Predicted Impact	Magnitude
PL 1	**A/B/C**	Grassed Area	Between Molyneaux Street & York Street	Land lost to accommodate partial realignment of Link G (Westlink to York Street).	Negligible
PL 2	**All**	Existing Vehicular Access / Hardstanding / Parking	Yorkgate Business Park Galway House, York Street	Land lost to accommodate realignment of Link F (York Street to M2) and new vehicular access from York Street.	Minor
PL 3	**All**	Brownfield Land	Between York Street & M2 (opposite Cityside Mall)	Land lost to accommodate realignment of Link F (York Street to M2).	Minor
PL 4	**All**	Existing Vehicular Access / Hardstanding	Cityside Mall, York Street	Land lost to accommodate slight modification of existing access.	Negligible
PL 5	**B/D**	Weighbridge Turning Area (Hardstanding) & Vehicular Access	DVA Weighbridge, Garmoyle Street	Land lost from weighbridge turning area to accommodate partial realignment of Nelson Street, severing the existing access from Dock Street.	Minor
PL 6	**A/C**	Hardstanding / Surface Level Car Parking	DVA / Roads Service (Eastern Division Section Office), Corporation Street	In addition to the demolition of property, land would be lost to accommodate Link A (M2 to Westlink). As a depressed link, this would result in the severance of this parcel.	Moderate
PL 6	**B/D**			Land would be lost to accommodate bridge piers associated with elevated Link A (M2 to Westlink). As land would be accessible under this link, no severance would be experienced and existing usage largely maintained.	Minor
PL 7	**A/C**	Brownfield Land	Between Nelson Street and Corporation Street (opposite main entrance to Clarendon Dock)	Land lost to accommodate Link A (M2 to Westlink) and Link C (Westlink to M3). Land would be severed into two largely equally sized parcels east and west of Link A.	Moderate
PL 7	**B**			Loss of land from north western and south western corners of the parcel to accommodate Link A (M2 to Westlink) and Link C (Westlink to M3) respectively. No severance would be experienced.	Negligible
PL 7	**D**			Loss of land from north western corner of the parcel to accommodate Link A (M2 to Westlink). Land would also be lost to accommodate a link to Corporation Street from York Link/Nelson Street, resulting in severance of the parcel.	Minor

TABLE 6.6.5: SCHEDULE OF PROPERTIES / AREAS PREDICTED TO EXPERIENCE PRIVATE LAND LOSS

Ref No	Option (s)	Type of Loss	Location	Predicted Impact	Magnitude
PL 8	**A/B/C**	Brownfield Land	Between M3, Nelson Street and Corporation Street (opposite Sinclair Seamen's Church)	Loss of land from north western corner of the parcel to accommodate Link C (Westlink to M3). No severance would be experienced.	Negligible
PL 9	**B/C**	Surface Level Car Parking	Under M3 Flyover, between Nelson Street and Corporation Street	Loss of majority of parking area to accommodate a link between Shipbuoy Street and Corporation Street.	Major
PL 10	**C**	Brownfield Land	Between Great George's Street, Little York Street & Shipbuoy Street	Loss of land from southwestern corner of the parcel to accommodate Link D (M3 to Westlink). No severance would be experienced.	Moderate
PL 11	**A**	Northside Park & Ride / Surface Level Car Parking	Between Great George's Street, York Street & York Link	Loss of land to accommodate Link A (M2 to Westlink). As a depressed link, this would result in the severance of this parcel. Land would also be lost to accommodate Link C (Westlink to M3).	Major
PL 11	**B**			Land would be lost to accommodate bridge piers associated with elevated Link A (M2 to Westlink). As land would be accessible under this link, no severance would be experienced. Land would also be lost to accommodate Link C (Westlink to M3).	Moderate
PL 11	**C**			Loss of land to accommodate Link A (M2 to Westlink). As a depressed link, this would result in the severance of this parcel. Land would also be lost to accommodate Link C (Westlink to M3) and Link D (M3 to Westlink).	Major
PL 11	**D**			Land would be lost to accommodate bridge piers associated with elevated Link A (M2 to Westlink). As land would be accessible under this link, no severance would be experienced.	Minor
PL 12	**A/B/C**	Surface Level Car Parking	Between Westlink southbound and northbound carriageways and York Street	Majority of land would be lost to accommodate Link A (M2 to Westlink), Link B (Westlink to M2), Link C (Westlink to M3) and Link D (M3 to Westlink). Land would be severed into multiple parcels.	Major
PL 12	**D**			Majority of land would be lost to accommodate Link A (M2 to Westlink), Link B (Westlink to M2) and Link D (M3 to Westlink). Land would be severed into multiple parcels.	Major

TABLE 6.6.6: TOTAL NUMBER OF PRIVATE LAND PARCELS AFFECTED & MAGNITUDE OF IMPACT EXPERIENCED

Option	Negligible	Minor	Moderate	Major	TOTAL
A	3	2	2	2	**9**
B	4	4	1	2	**11**
C	3	2	3	3	**11**
D	1	6	0	1	**8**

In terms of providing an overall quantitative summary of magnitude of impact associated with each of the options under consideration, with reference to **Table 6.6.6**, it is evident that **Option C** would affect the highest number of individual private land parcels (eleven) and have the greatest magnitude of impact, with up to three parcels being subject to major adverse impacts (i.e. land take that would preclude or significantly affect current use).

Conversely, **Option D** would affect the lowest number of private land parcels (eight) and have the least magnitude of impact, with only one area of private land being subject to major adverse impacts.

Option B would also affect the highest number of private land parcels (eleven), though only two of these parcels would be subject to major adverse impacts. **Option A** would only affect nine private land parcels, with two of these parcels also being subject to major adverse impacts.

6.6.5.1.3 *Potential Effect on Planning Applications*

The assessment of potential effects on planning applications focuses specifically on direct physical impact upon proposed development sites, in order to establish whether any of the options under consideration would preclude or restrict development potential. With reference to **Figure 6.6.2** and **Table 6.6.7**, it is expected at this stage that only three applications of any particular significance would experience direct impacts associated with the scheme options. The small number of applications directly affected can be linked to existing landownership in the area. As Roads Service already owns the majority of land affected by the proposed scheme, understandably very few applications would therefore be directly affected.

TABLE 6.6.7: SCHEDULE OF PLANNING APPLICATIONS DIRECTLY AFFECTED BY SCHEME OPTIONS				
App. Ref. Decision & Date	**Option(s)**	**Development Proposal & Location**	**Predicted Impact**	**Magnitude**
Z/2010/1580/F Pending	**A/B/C**	Surface car park with pay kiosk on lands opposite 66 Corporation Street	Slight encroachment into periphery of site to accommodate partial realignment of Link I (Dock Street to M3)	Negligible
Z/2008/1795/F Approved 31/08/2010	**A/B/C**	Erection of 10-storey building at 161-165 York Street (opposite Cityside Mall)	Slight encroachment into periphery of site to accommodate Link F (York Street to M2) and associated widening of M2.	Negligible
	D		Slight encroachment into periphery of site to accommodate Link B (Westlink to M2) and associated widening of M2.	
Z/2007/1370/F Approved 13/02/2009	**A/B/C**	Erection of apartment blocks comprising 183 dwellings on lands opposite 66 Corporation Street	Slight encroachment into periphery of site to accommodate partial realignment of Link I (Dock Street to M3)	Negligible

The land-take from any of the planning applications within **Table 6.6.7** is likely to have a barely perceptible impact on the viability of these sites to accommodate the proposed development. Even though the predicted impacts would be Negligible, it is evident that **Option D** would minimise the potential for direct physical impact on planning applications of any of the options under consideration. All other options would be largely equal in terms of impact.

A number of advertisement applications (hoardings/display panels) would also be directly affected by the options under consideration, however as these do not contribute to the development of the area, impacts upon these is not considered particularly significant and post scheme construction, it would be expected that there would be scope for some of the applications to be accommodated adjacent to the proposed road layout.

As the existing road network would be extensively modified to accommodate any of the options under consideration, indirect impacts would be experienced throughout the wider road network, in terms of traffic redistribution and access amendments. With the extensive separation of local and strategic traffic and associated freer flowing traffic conditions, it would be expected that this would be of benefit to the majority of applications with regards to their transport assessments. There would however, be cases where traffic redistribution would cause greater pressure on local routes (i.e. Corporation Street), which may have adversely affected transport assessments associated with these applications. It is worth noting at this stage that as a statutory consultee to Planning NI, Roads Service has been informing a number of applicants that plans are underway to undertake major road improvement works at York Street, which would affect local traffic movements in the area and that this may/would affect the application site. The applications that would experience the greatest affect associated with these changes are those for the more sizeable developments including:

- **Z/2012/0361/F** – New University of Ulster Campus in the City Centre at Interpoint, York Street
- **Z/2012/0352/O** – Apartment development (217 units) within site bounded by Little York Street, Great George's Street and Nelson Street
- **Z/2011/0737/O** – Social housing development on a vacant site at Nelson Street, bounded by Great George's Street to north, Little York Street to west, Nelson Street to east, and other lands adjacent to Little Patrick Street to south
- **Z/2010/1006/O** – Mixed use development including a maximum of 120 residential units with associated amenity space and surface parking; a hotel; class B1 offices; small scale retail and retail services; cafe/restaurants; and multi-storey car parking, plus associated works including basement car parking; ancillary service area; open space; and related infrastructure improvements within lands bounded by the River Lagan to the east, Corporation Street to the west, Dock Street and Corry Link to the north, and the elevated M3 Cross Harbour Bridge/Motorway to the south
- **Z/2008/0824/F** – Construction of 238 1-bed and 2-bed apartments, with 200 parking spaces on ground and first floor levels, with elevated landscaped central courtyard in a site bounded by Little York Street, Great George's Street and Nelson Street
- **Z/2007/2502/F** – Proposed mixed use development, comprising ground floor retail units and 46 apartments over seven storeys between Brougham Street and York Street.

This issue of traffic redistribution and access to these proposed development sites will be considered in detail at Stage 3.

6.6.5.1.4 *Potential Loss of Development Land*

In terms of potential loss of development land, three zoned areas would be affected by each of the options under consideration; however the magnitude of impact would vary. As contained within BMAP (Draft) 2015 district proposals for Belfast, and illustrated on **Figure 6.6.3**, all sites potentially affected are zoned as Development Opportunity Sites. As noted earlier, these sites generally compromise lands which are under-utilised or vacant. New development within these sites might provide a mix of new uses, could promote the vitality and viability of the urban area, or could enhance the cityscape. This could be achieved, for example by closing frontage gaps or by replacing unattractive features. According to BMAP, such development within the City could enhance shopping frontages, encourage pedestrian movement and so assist commercial growth.

The predicted impact upon these sites with each option is detailed within **Table 6.6.8**, along with an estimation of area lost from these sites and associated magnitude of expected impact.

TABLE 6.6.8: SCHEDULE OF PREDICTED IMPACTS UPON DEVELOPMENT LAND

Option (s)	Zoned Land	Predicted Impact	Area Lost (ha)	Magnitude
A/C	**CC 080** Corporation Street / Trafalgar Street (1.72ha)	Loss of land to accommodate Link A (M2 to Westlink) and Link C (Westlink to M3). Land would be severed into two largely equally sized parcels east and west of Link A.	0.67	Moderate
B		Loss of land from north western and south western corners of the parcel to accommodate Link A (M2 to Westlink) and Link C (Westlink to M3) respectively. No severance would be experienced.	0.13	Negligible
D		Loss of land from north western corner of the parcel to accommodate Link A (M2 to Westlink). Land would also be lost to accommodate a link to Corporation Street from York Link/Nelson Street, resulting in severance of the parcel.	0.13	Minor
A	**CC 076** Little York Street / Shipbuoy Street (0.9ha)	Loss of land to accommodate Link A (M2 to Westlink). As a depressed link, this would result in the severance of this parcel. Land would also be lost to accommodate Link C (Westlink to M3).	0.37	Moderate
B		Land would be lost to accommodate bridge piers associated with elevated Link A (M2 to Westlink). As land would be accessible under this link, no severance would be experienced. Land would also be lost to accommodate Link C (Westlink to M3).	0.45	Moderate
C		Loss of land to accommodate Link A (M2 to Westlink). As a depressed link, this would result in the severance of this parcel. Land would also be lost to accommodate Link C (Westlink to M3) and Link D (M3 to Westlink).	0.56	Moderate
D		Land would be lost to accommodate bridge piers associated with elevated Link A (M2 to Westlink). As land would be accessible under this link, no severance would be experienced.	0.21	Minor
A/B/C	**CC 073** West Link / York Street (0.38ha)	Land would be lost to accommodate Link A (M2 to Westlink), Link B (Westlink to M2), Link C (Westlink to M3) and Link D (M3 to Westlink). Land would be severed into multiple parcels.	0.38	Major
D		Land would be lost to accommodate Link A (M2 to Westlink), Link B (Westlink to M2) and Link D (M3 to Westlink). Land would be severed into multiple parcels.	0.24	Major

With reference to **Table 6.6.8**, it is evident that all options have impacts in terms of land loss and severance upon areas designated for future development. Whilst comparatively the difference in the amount of land lost between options is not significant, **Option C** would have the greatest overall impact. In essence, this option would preclude any meaningful development taking place within zoned area CC 073 and would significantly affect the potential future development of CC 076. Indeed, it is worth noting that all options would likely preclude any meaningful development taking place within zoned area CC 073.

Option D, and to lesser extent **Option B,** would have the least degree of impact upon areas of land zoned for future development.

With reference to **Figure 6.6.3**, all options would directly encroach into the Belfast Harbour Major Area of Existing Employment and as noted earlier in the assessment of properties at risk of demolition and private land loss, would either result in the loss of properties currently providing employment (**Options A** & **C**) or result in significant loss of land which may possibly impact upon the future viability of these properties as employment locations (**Options B** & **D**).

With reference to **Figure 6.6.3**, there would be no direct impact upon any other areas zoned within BMAP 2015 (i.e. Protected City Centre Housing Areas, District Centre, or Land Zoned for Housing).

6.6.5.1.5 ***Potential Loss of Community Land***

No community land would be lost to any of the options under consideration.

6.6.5.1.6 ***Potential Agricultural Land Loss and Field Severance***

No agricultural land would be lost to any of the options under consideration.

6.6.5.1.7 ***Potential Loss of Woodland Areas***

Pockets of maturing amenity woodland planting associated with the existing road network would be lost to all of the options under consideration, though this has little bearing on the assessment of land use impacts. As noted earlier, the assessment of these losses is considered further under Section 6.4 (Ecology & Nature Conservation) and Section 6.5 (Landscape Effects).

It is confidently assumed at this stage that no TPO's would be directly affected by any of the options under consideration.

6.6.5.1.8 ***Waterway Restoration Schemes***

As there would be no modification to the M3 Lagan Bridge or Dargan Rail Bridge over the Belfast Harbour Area, there would be no direct impact upon the proposal to reopen the Lagan Navigation and open up the Lagan Corridor between Belfast and Lough Neagh.

6.6.5.2 *Construction*

Construction of any of the scheme layout options would have temporary land use impacts. The main impact would be the temporary loss of land to accommodate the site compound(s) and stockpile locations which are likely to be quite sizeable considering the scale of infrastructural works required to construct the proposed scheme. The impact of this however is unlikely to be significant, considering the large number of vacant brownfield sites located within the study area, which could easily accommodate both. In terms of differences in the temporary land requirements between options, there would be variation in the type and volume of materials required to construct elevated and depressed elements, and variation in the amount of excess material excavated from the site. However, it is envisaged at this stage that surrounding land availability would be more than sufficient to accommodate the construction of any interchange arrangement.

Considering the complexity of providing full or partial grade-separation, there may also be temporary loss of land to accommodate road diversions through site in order to facilitate the continued through movement of traffic. Again, this issue would not be exclusive to any particular option under consideration.

6.6.6 *Mitigation and Enhancement Measures*

6.6.6.1 *Operation*

In terms of mitigation & enhancement measures, land take and severance would be minimised where technically feasible. In particular, the minimisation of land parcel severance with depressed options (i.e. Options A & C) has the potential to be developed further in the scheme design if such an option were to be preferred. Whilst some sections of depressed links would be capped/covered as part of the scheme design, there is scope for further sections to be capped, however this would be developer led and at this stage is not considered part of the current design. Nevertheless, extended capping of depressed links has the potential to minimise severance, though costs of doing so to a private developer may be prohibitive.

Whilst the demolition of property (i.e. DVA, Roads Service and Focus Security buildings at Corporation Street) is a major adverse impact associated with Options A & C, their loss does provide the opportunity to provide exchange land to compensate for the loss of land from Development Opportunity Sites. The loss of the outbuilding at the DVA property can be mitigated with the replacement of this building.

Irrespective of which option is selected, where land would be lost and subject to compulsory purchase, compensation would be made in accordance with the statutory requirements for land acquired under the draft Vesting Order for the proposed scheme.

6.6.6.2 *Construction*

Specifically in relation to the impacts on land use during construction, the following mitigation measures would be incorporated:

- As far as possible, construction compounds would be located in areas that would cause the least disturbance to existing land uses
- all land used for temporary construction works, and outside the area to be developed for the road, would be reinstated on completion.

6.6.7 *Residual Impacts*

As noted previously, it is not sufficient to assess the size and probability of potential impacts; their significance should also be assessed. The level of significance is to be assigned after consideration of any proposed mitigation (i.e. significance is assigned with mitigation in place allowing for the positive contribution of all mitigation that is proposed). It is therefore the residual impacts associated with the proposed scheme that are most reflective of what the overall predicted impact would be upon land use during the operation and construction phase.

6.6.7.1 *Significance of Potential Effects (Operation)*

6.6.7.1.1 *Demolition of Private Property and Associated Land Take*

The loss of any property is considered significant; however as the commercial & government properties (DVA, Roads Service – Eastern Division Section Office & Focus Security Solutions) affected by **Options A** & **C** provide employment, they are of existing beneficial use and thus the significance of their loss would be **Large Adverse**.

As it is likely that loss of the outbuilding at the DVA with **Options B** & **D** could be mitigated, the significance of effect would be considered **Neutral**.

6.6.7.1.2 ***Potential Private Land Loss***

The existing importance of private land uses affected by any of the options would generally be low, considering that the main beneficial land use is surface level car parking. As such, the significance of effect would mainly be **Slight** to **Moderate Adverse.** Nevertheless, based upon the amount of land that would be lost and severance created, **Option C** would have the greatest significance of effect, and **Option D** the least.

6.6.7.1.3 ***Potential Effect of Planning Applications***

As the impact upon planning applications associated with each option under consideration would be Negligible, the significance of effect would be **Neutral**.

6.6.7.1.4 ***Potential Loss of Development Land***

The importance of Development Opportunity Sites affected by the proposed scheme is generally low, considering the current overall lack of developer interest. **Option C** would have the most significant effect, with two sites experiencing **Large Adverse** effects and one site experiencing **Moderate Adverse** effects. **Option D** would have the least significant impact, with one site experiencing **Large Adverse** effects and two sites experiencing **Slight Adverse** effects.

It must be noted that the significance of effect should not solely be related to loss of land and severance. Development of these lands would be developer led, thus those options which have less physical impact and minimise severance, would not necessarily guarantee that these sites would remain viable or attractive for development.

6.6.7.1.5 ***Potential Loss of Community Land***

As no community land would be affected with any of the options, the significance of effect would be **Neutral**.

6.6.7.1.6 ***Potential Agricultural Land Loss and Field Severance***

As no agricultural land would be affected with any of the options, the significance of effect would be **Neutral**.

6.6.7.1.7 ***Potential Loss of Woodland Areas***

Amenity woodland planting lost to the proposed scheme would be replaced where it is feasibly possible and appropriate. As such, the significance of effect would likely be **Neutral** with all options.

6.6.7.1.8 ***Waterway Restoration Schemes***

As no waterway restoration schemes would be affected with any of the options, the significance of effect would be **Neutral**.

6.6.7.2 *Significance of Potential Effects (Construction)*

As vacant brownfield land would likely be used during construction for compounds and stockpiling, no existing beneficial uses would be affected, and thus the significance of effect for any of the options under consideration would be **Neutral.**

6.6.8 *Summary and Conclusions*

- It is clearly evident that in terms of physical impact upon existing and future land uses **Option C,** and to a lesser extent **Option A,** would have the greatest adverse effects.
- From a Land Use perspective **Option D** would be preferred, with **Option B** having the next least adverse effects.

6.7 Noise and Vibration

6.7.1 *Introduction*

The sources of noise from traffic can be separated into two components. The first is generated by the engine exhaust system and transmission and is the dominant source when traffic is not freely flowing, particularly from heavy vehicles which contribute a significant proportion of low frequency noise. Noise levels will vary primarily according to engine speed rather than vehicle speed. The second noise source component is generated from the interaction of tyres with the road surface and is the dominant noise source under free flow traffic conditions at moderate to high road speeds and contributes a significant proportion of high frequency noise. Noise levels will vary depending on vehicle speed, the road surface and whether the surface is wet or dry.

The noise from a stream of traffic at a reception point at any one instant is an aggregation of noise from each of many vehicles at various distances. Among factors which influence a basic traffic noise level are traffic flow, speed, composition (percentage Heavy Duty Vehicles (HDV's)), road gradient and road surface characteristics.

Noise annoyance is described by the World Health Organisation (WHO) as *'a feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them'*. It can affect people in houses, the street or even during recreational activities. People are now known to be more sensitive to abrupt changes in traffic noise than research had previously suggested. New information suggests that human hearing is sensitive at the 1dB(A) level. This is equivalent to a 25% increase or a 20% decrease in traffic flow. This sensitivity to new schemes is an effect that can last for a number of years and will vary according to the sensitivity of hearing of the individual. There are also reported correlations between noise exposure and sleep disturbance, which can be significant, even at low noise levels.

Vibration can also occasionally be caused by traffic movement. Vibration is a low frequency disturbance producing physical movement in buildings and their occupants. It is the rolling of wheels on the road surface when passing over irregularities in the road that causes vibration.

Vibration is usually measured in terms of Peak Particle Velocities (PPVs) and is the maximum speed of movement (measured in mm/s) of a point in the ground during passage of vibration. Vibration can be problematic because of:

- its ability to affect precision tasks (for example in hospitals)
- possible architectural damage, which affects the building and the occupants.

A copy of the technical Noise Report, prepared in relation to the scheme options is included at **Appendix G** of this report.

6.7.2 ***Methodology***

6.7.2.1 *Study Area*

The procedure for the assessment of noise and vibration impacts from road schemes is split into three phases, as set out in the DMRB:

- Scoping to determine whether the project has the potential to cause a change to the receiving environment which could result in noise and vibration impacts, and to determine the likely extent of any assessment and to identify sensitive receptors
- 'Simple' assessment of noise and vibration impacts at dwellings and other sensitive receptors
- 'Detailed' assessment of noise and vibration impacts at dwellings and other sensitive receptors.

Based on the nature of the proposed interchange layout options, which consist of the construction of significant new roads, the assessment has proceeded straight to the 'Detailed' stage.

At the Detailed assessment stage, the study area for a traffic noise impact assessment is defined in the DMRB as follows:

a) The study area must include the proposed development and all surrounding existing roads that are predicted to be subject to a change in traffic noise level of 1 dB(A) or more on Scheme opening, or 3 dB or more in the long term, as a result of the proposed Scheme. These road links are defined as significant links and are identified by analysis of the provided traffic data.

b) The study area of the detailed quantitative assessment of noise impacts is defined as a corridor 600m either side of the proposed Scheme, and a set of corridors 600m either side of all significant links within 1 km of the proposed Scheme.

c) For dwellings and other sensitive receptors that are within 1 km of the proposed Scheme, but more than 600m from a significant link, a qualitative assessment of the noise and vibration impacts should be undertaken.

d) For significant links which are outside the 1 km boundary from the proposed Scheme, an assessment should be undertaken by estimating the 'Calculation of Road Traffic Noise' (CRTN) Basic Noise Level on these roads (the traffic noise level at 10 m) with and without the proposed Scheme. A count of the number of dwellings and other sensitive receptors within 50 m of these links should be undertaken.

6.7.2.2 *Prediction and Assessment Methodology*

6.7.2.2.1 ***Noise***

The operational traffic noise assessment has been undertaken following the methodology as described in the November 2011 version of the Design Manual for Roads and Bridges (DMRB) Vol. 11, Section 3, Part 7. The assessment considers both changes in absolute noise levels and the effect on residents in terms of annoyance.

Noise from a flow of road traffic is generated by both vehicles' engines and the interaction of tyres with the road surface. The traffic noise level at a receptor, such as an observer at the roadside or residents within a property, is influenced by a number of factors including traffic flow, speed, composition (% HGV), gradient, type of road surface, distance from the road and the presence of any obstructions between the road and the receptor.

Noise from a stream of traffic is not constant; therefore, to assess the noise impact a single figure estimate of the overall noise level is necessary. The index adopted by the Government in the CRTN to assess traffic noise is the $L_{A10,18h}$. This value is determined by taking the highest 10% of noise readings in each of the eighteen 1-hour periods between 06:00 and 00:00 (midnight), and then calculating the arithmetic mean. A reasonably good correlation has been shown to exist between this index and residents' perception of traffic noise over a wide range of exposures.

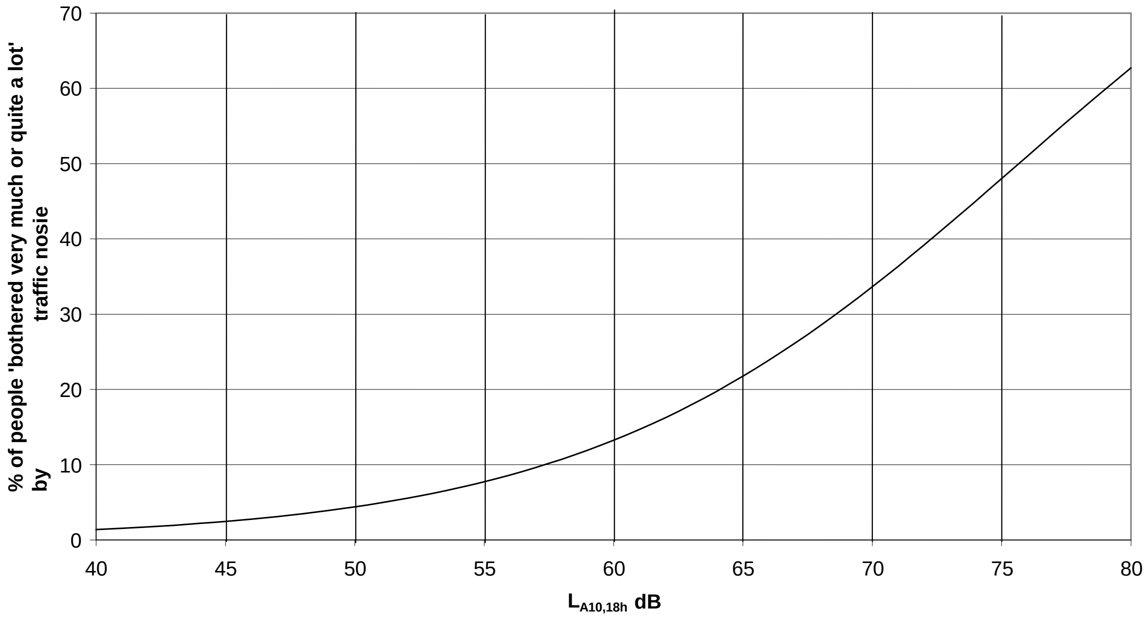
CRTN provides the standard methodology for predicting the $L_{A10,18h}$ road traffic noise level. Noise levels are predicted at a point 1 m measured horizontally externally from the façade of the building.

The DMRB also requires an assessment of night time traffic noise levels ($L_{night,outside}$), a parameter which is not predicted by the standard CRTN methodology. Three methods of estimating $L_{night,outside}$ are outlined in the DMRB. Method 1 uses individual 1-hour traffic data over the night-time (23:00-07:00); Method 2 uses 8-hour average night time traffic; and Method 3 estimates the $L_{night,outside}$ from the $L_{A10,18h}$ traffic noise level. The façade level predicted by CRTN must be reduced by 2.5 dB to give the free-field $L_{night,outside}$ level.

Once the 18-hour traffic noise level has been predicted, it can be used to provide an indication of the likely annoyance to residents caused by traffic noise. Individuals vary widely in their response to the same level of traffic noise. However, the average or community response from a large number of people to the same level of traffic noise is fairly stable, therefore, a community average degree of bother caused by traffic noise can be related to the long-term steady state noise level.

The DMRB illustrates the relationship between the steady state traffic noise level and the estimated annoyance experienced, expressed as the percentage of people 'bothered very much or quite a lot' is illustrated in **Plate 6.7.1** (taken from DMRB). This shows, for example, that approximately 13% of all residents would be 'bothered very much or quite a lot' at a façade road traffic noise level of 60 dB $L_{A10,18h}$.

Plate 6.7.1: Estimation of Traffic Noise Nuisance - Steady State



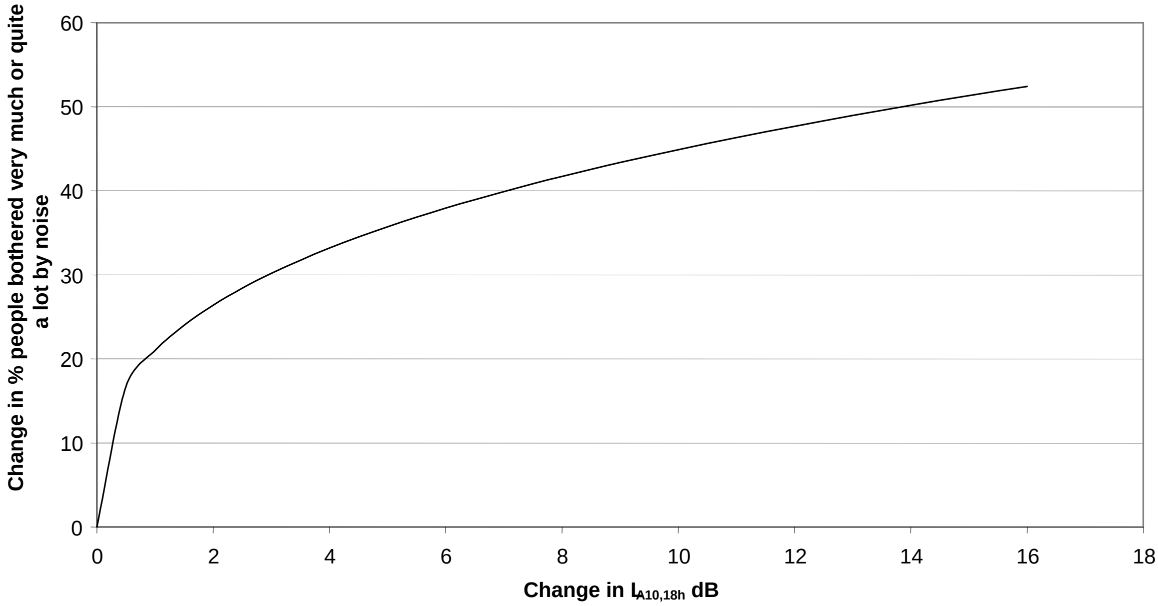
Source: DMRB 11.3.7, Annex 6, pp. A6/1

In addition, research has shown that people are more sensitive to abrupt changes in traffic noise, for example following the opening of a new road, than would be predicted from the steady state relationship between traffic noise and nuisance (described above). These effects last for a number of years, however, in the longer term the perceived noise nuisance tends towards the steady state level due to familiarisation. The percentage change in the traffic noise nuisance due to an abrupt change in the traffic noise is illustrated in **Plate 6.7.2** (taken from DMRB).

Plate 6.7.2 shows, for example, that with an abrupt (and permanent) increase of 10 dB(A) there would be a net change of 45% of residents 'bothered very much or quite a lot' by road traffic noise. If the initial noise level was 60 dB $L_{A10,18h}$ (with 13% people already bothered) then there would be a total of 58% bothered immediately after an increase to 70 dB $L_{A10,18h}$. This would eventually diminish in the long term, due to familiarisation to become approximately 34% bothered (**Plate 6.7.1**).

The objective of the assessment, as set out in the DMRB, is to gain an overall appreciation of the noise and vibration climate, both with (Do-Something) and without (Do-Minimum) the proposed development. These conditions are assessed for the baseline year (the assumed year of opening) and the future assessment year (15 years after opening).

Plate 6.7.2: Estimation of Traffic Noise Nuisance - Immediate Change in % people 'bothered very much or quite a lot' by traffic noise



Source: DMRB 11.3.7, Annex 6, pp. A6/1

The DMRB outlines the steps to be carried out at the 'Detailed' assessment stage:

a) Identify the study area, as discussed above, and predict 18-hour (06:00-00:00) and night-time (23:00-07:00) traffic noise levels at all residential properties within 600m of the proposed Scheme and/or significant links. Predictions are required for the Do-Minimum and Do-Something scenarios in the assumed year of opening and 15 years after opening.

b) Carry out the following comparisons for each property in order to identify the number of properties which undergo an increase or decrease in traffic noise levels and annoyance:

- the Do-Minimum scenario in the baseline year against the Do-Minimum scenario in the future assessment year (long term);
- the Do-Minimum scenario in the baseline year against the Do-Something scenario in the baseline year (short term); and
- the Do-Minimum scenario in the baseline year against the Do-Something scenario in the future assessment year (long term).

For night time traffic noise levels, only the two long term comparisons are required and only properties where the $L_{night,outside}$ level is 55 dB(A) or greater in any of the compared scenarios, need to be considered.

Obviously different façades of the same property can experience different changes in traffic noise level. DMRB requires that each of the above comparisons of traffic noise levels are based on the façade which experiences the worst case change (i.e. the largest increase, or, if all façades undergo a decrease, the smallest decrease).

Additionally, DMRB requires that the above comparisons of annoyance use the highest levels of annoyance in the first 15 years. For properties which experience an increase in noise due to the proposed development, the greatest annoyance is likely to be immediately after opening (**Plate 6.7.2**), for properties which experience a decrease (and also in the Do-Minimum comparison) the greatest annoyance is the steady state level of annoyance in the long term (**Plate 6.7.1**);

c) Assess the impact on sensitive receptors, other than residential properties, within the 600m study area. This is based on 18-hour (06:00-00:00) traffic noise levels and considers the same three comparisons as outlined above for residential properties. Other sensitive receptors considered include hospitals, schools, community facilities (such as places of worship) designated ecological areas (Areas of Outstanding Natural Beauty (AONB), National Parks, Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Areas of Special Scientific Interest (ASSI)), Scheduled Ancient Monuments (SAM) and Public Rights of Way (PRoW);

d) Complete a qualitative assessment of sensitive receptors which are within 1 km of the proposed development but more than 600m from the proposed development and significant links; and

e) For significant links which are outside the 1 km boundary from the proposed Scheme, complete an assessment by estimating the Calculation of Road Traffic Noise (CRTN) Basic Noise Level on these roads (the traffic noise level at 10 m) with and without the proposed development. A count of the number of dwellings and other sensitive receptors within 50 m of these links should be undertaken. No significant links have been identified beyond 1km from the proposed development and therefore this step is not required for this assessment.

The DMRB provides two classifications for the magnitude of the noise impact of a proposed scheme, as shown in **Tables 6.7.1 and 6.7.2**.

Table 6.7.1 relates to the short term changes in noise levels and **Table 6.7.2** relates to the long term changes in noise levels.

TABLE 6.7.1: CLASSIFICATION OF MAGNITUDE OF OPERATIONAL TRAFFIC NOISE IMPACTS SHORT TERM

Noise Change dB(A)	Magnitude of Impact
0	No Change
0.1-0.9	Negligible
1.0-2.9	Minor
3.0-4.9	Moderate
5+	Major

Source: DMRB 11.3.7.3, Table 3.1, pp. 3/5

TABLE 6.7.2: CLASSIFICATION OF MAGNITUDE OF OPERATIONAL TRAFFIC NOISE IMPACTS LONG TERM

Noise Change dB(A)	Magnitude of Impact
0	No Change
0.1-2.9	Negligible
3.0-4.9	Minor
5.0-9.9	Moderate
10+	Major

Source: DMRB 11.3.7.3, Table 3.2, pp. 3/5

6.7.2.2.2 ***Vibration***

Traffic vibration can be transmitted through the air or through the ground. Airborne vibration is produced by the engines and exhausts of road vehicles, with dominant frequencies typically in the range 50 - 100 Hz. Ground borne vibration is produced by the interaction of the vehicle tyres and the road surface with dominant frequencies typically in the range 8 - 20 Hz. The passage of vehicles over irregularities in the road surface can be a source of ground borne vibration.

Traffic vibration can potentially have an effect on buildings and cause disturbance to occupiers. DMRB reports that extensive research on a wide range of buildings has found no evidence of traffic induced ground borne vibration being a source of significant damage to buildings. DMRB also reports that there is no evidence that exposure to airborne vibration causes even minor damage.

Airborne vibration is noticed by occupiers more often than ground borne vibration as it may result in detectable vibrations in building elements such as windows and doors.

DMRB states that perceptible vibration only occurs in rare cases and identifies that the normal use of a building, such as closing doors and operating domestic appliances can generate similar levels of vibration to that from traffic.

DMRB states in A1.35 that “where appropriate, an assessment of traffic induced vibration nuisance should be undertaken”. Given the relatively small changes in noise levels within the study area resulting from the implementation of the scheme options and the relationship between noise changes and nuisance for airborne vibration (significantly less than for noise), it is considered that an assessment of airborne vibration nuisance is not appropriate.

Therefore, a quantitative assessment of operational vibration impacts, in terms of annoyance to occupiers or impacts at any other receptors has been scoped out of this assessment.

6.7.2.3 *Model Input Data, Assumptions and Limitations*

A model of the York Street Interchange and the surrounding area was developed in SoundPLAN v7.0; a sophisticated noise modelling software package which implements a range of calculation methodologies including CRTN.

The following scenarios were implemented in the model:

- Do-Minimum (2020)
- Do-Minimum (2034)

- Option A (2020)
- Option A (2034)
- Option B (2020)
- Option B (2034)
- Option C (2020)
- Option C (2034)
- Option D (2020)
- Option D (2034).

The following datasets were provided for incorporation in the model:

- OS base mapping dataset
- Road traffic datasets for the above scenarios (18-hour AAWT flow, %HDV, average speed)
- Topographical survey dataset
- 3D design strings for each of the 4 options
- DTM dataset.

Additional information was provided for the existing road surfacing and the proposed road surfacing for the four layout options.

The spatial extent of the road traffic datasets was limited. Consequently, it was not possible to follow exactly the DMRB guidance on the size of the study area. The study area for the 'Detailed' calculation of noise levels was restricted to a buffer 400m from the interchange options. Considering the nature of the options and the extent of affected road links resulting from their implementation, this is not considered to be a significant restriction. There were no significant road links outside of this 400m buffer.

The model was employed to calculate façade noise levels at a height of 4 metres above ground level to all residential properties, and all non-residential sensitive properties, within the 400m buffer for each of the ten scenarios listed above. There were 37 non-residential sensitive properties within the study area, consisting of:

- 9 churches
- 4 schools / colleges
- 2 hospitals / nursing centres
- 13 community halls
- 2 advice centres
- 2 surgeries
- 1 hostel
- 1 care home
- 3 nurseries.

Figure 6.7.1 shows the study area, residential properties and non-residential properties, with non-residential sensitive properties highlighted.

Additionally, the model was employed to calculate noise level contours across the 400m buffer area at a height of 4 metres above ground level for each of the ten scenarios.

The calculated façade noise levels were processed according to the methodology in DMRB to provide the tables of results as required.

6.7.3 *Regulatory/Policy Framework*

With reference to DMRB 11.3.7.1, there are two main areas of current legislation pertinent to the assessment of the proposed scheme in relation to noise and vibration impacts. The first of these is legislation which provides a means to redress the adverse impacts of noise and vibration attributable to vehicular activity during the operational phase on both land and people. The second area of legislation provides a means to redress the adverse impacts of transient noise and vibration generated during the construction phase.

6.7.3.1 *The Land Acquisition and Compensation (Northern Ireland) Order 1973*

Part II of the Order (Compensation for Depreciation Caused by Use of Public Works) provides a means by which compensation can be paid to owners of land and property which has experienced a loss of value caused by the use of public works such as new and improved roads. Noise and vibration are two of the issues that would be considered under any such claim for compensation. Under the Order, Notice should be published one year after the opening of the road and claim period is for 2 years after the date of publication of the Notice, although there is a facility for allowing consideration of likely extent of claims during detailed design, following the completion of statutory processes.

6.7.3.2 *The Noise Insulation Regulations (Northern Ireland) 1995*

The noise impact of traffic noise is assessed with reference to the Noise Insulation Regulations (Northern Ireland) 1995. These regulations seek to determine the impact of noise from any new or altered road, in relation to the noise sensitive receivers. In respect of road traffic noise, properties may qualify for an offer of noise insulation under the Regulations if all four of the following conditions are satisfied:

- the property must be within 300 metres of the nearest point on the carriageway of the road after construction
- the façade noise level due to road traffic on any highway (the ‘relevant’ noise level) for the design year, or for any intervening year if noisier, must equal or exceed 68 dB $L_{A10,18h}$ (the ‘specified’ level), with levels of 67.5 dB $L_{A10,18h}$ rounded upwards
- the ‘relevant’ noise level for the design year, or for any intervening year if noisier, must be at least 1 dB $L_{A10,18h}$ higher than the pre-construction year road traffic noise level
- noise from the new or altered road must contribute at least 1 dB $L_{A10,18h}$ to the ‘relevant’ noise level.

Roads Service has a duty under these Regulations to offer insulation for residential properties with respect to a new road, and discretionary powers in relation to altered roads. Various discretionary powers are also available in relation to façades or parts of façades contiguous with the qualifying façade. Roads Service also has discretionary powers to reduce the impact of construction noise. The Regulations apply to habitable rooms and so precludes bathrooms, toilets, halls and usually kitchens.

Some residential buildings are not eligible under the Regulations. These include clearance areas and any building which was first occupied after the ‘relevant date’ (the date a new road was first opened to public traffic or an altered road was opened following completion of the alteration). Buildings for which a Condition was attached to their planning permission requiring insulation against traffic noise are also not eligible. Furthermore, the Regulations do not apply to any buildings for which a planning application was lodged with Planning NI or which was constructed after the date of publication of the Department's proposal to construct a road, altered road or additional carriageway as indicated:

i) in a draft Order referred to in a notice published in accordance with Paragraph 1 of Schedule 8 to the Roads (Northern Ireland) Order 1993 or an Order made under Articles 4(1), 14(1) or 15(1) of that Order: or

ii) in a development plan or draft development plan published in accordance with Part III of the Planning (Northern Ireland) Order 1991.

Additionally, where works for the construction of the proposed scheme are expected to cause noise impacts at a level which in the opinion of the Department for Regional Development (DRD) would seriously affect, for a substantial period of time, the enjoyment of an eligible building, the Department has discretionary powers to provide noise insulation to reduce the impact of construction noise.

6.7.4 *Predicted Impacts and Significant Effects*

6.7.4.1 *Do-Minimum Scenario*

Table 6.7.3 shows the long term traffic noise changes if the scheme did not go ahead. Of the 1707 residential properties in the study area, all would experience 'Negligible' daytime noise increases.

For the night time period, 214 residential properties would experience 'Negligible' noise increases. It should be noted that only the 214 residential properties with noise levels at or above 55 dB $L_{night,outside}$ in either of the Do-Minimum scenarios are included in the table, as required by DMRB.

For the non-residential receptors within the study area, all 37 would experience 'Negligible' noise increases.

TABLE 6.7.3: LONG TERM TRAFFIC NOISE CHANGES (DO MINIMUM 2020 TO DO MINIMUM 2034)

Change in noise level		Daytime		Night-time
		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1707	37	214
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	0	0	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	0	0	0
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

6.7.4.2 *Do-Something Option A Scenario*

Table 6.7.4 shows the short term traffic noise changes resulting from the implementation of Option A. For the daytime period, 1180 properties would experience 'Negligible' noise increases, 16 would experience 'Minor' noise increases, 381 would experience 'No Change', 129 would experience 'Negligible' noise decreases, and 1 would experience a 'Minor' noise decrease.

For the non-residential receptors within the study area, 34 would experience 'Negligible' noise increases, and 3 would experience 'Minor' noise increases.

TABLE 6.7.4: SHORT TERM TRAFFIC NOISE CHANGES (OPTION A: DO MINIMUM 2020 TO DO SOMETHING 2020)

Change in noise level		Daytime	
		Number of dwellings	Number of other sensitive receptors
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1–0.9	1180	34
	1.0–2.9	16	3
	3.0–4.9	0	0
	5+	0	0
No Change	0	381	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1–0.9	129	0
	1.0–2.9	1	0
	3.0–4.9	0	0
	5+	0	0

Table 6.7.5 shows the long term traffic noise changes resulting from Option A. For the daytime period, 1655 properties would experience 'Negligible' noise increases, 8 would experience 'No Change' and 44 would experience 'Negligible' noise decreases.

For the non-residential receptors within the study area, all 37 would experience 'Negligible' noise increases.

For the night time period, 144 residential properties would experience 'Negligible' noise increases. It is noted that only the 144 residential properties with noise levels at or above 55 dB $L_{night,outside}$ in either the Do-Minimum or Do-Something scenario are included in the table, as required by DMRB.

TABLE 6.7.5: LONG TERM TRAFFIC NOISE CHANGES (OPTION A: DO MINIMUM 2020 TO DO SOMETHING 2034)

Change in noise level		Daytime		Night-time
		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1655	37	144
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	8	0	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	44	0	1
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

Table 6.7.6 shows the traffic noise nuisance changes, with and without Option A in place. For the Do-Minimum 2020 to Do-Minimum 2034 calculations, the changes in nuisance are calculated using long term nuisance statistics. For the Do-Minimum 2020 to Do-Something 2034 calculations, the changes in nuisance are calculated for the worst-case situation in the first 15 years after opening of the scheme, using short term and/or long term nuisance statistics.

TABLE 6.7.6: LONG TERM TRAFFIC NOISE NUISANCE CHANGES (OPTION A)

Change in nuisance level		Number of dwellings	
		Do-Minimum	Do-Something
Increase in nuisance level	<10%	1707	727
	10 <20%	0	908
	20<30%	0	23
	30<40%	0	0
	>40%	0	0
No Change	0 %	0	0
Decrease in nuisance level	<10%	0	49
	10 <20%	0	0
	20<30%	0	0
	30<40%	0	0
	>40%	0	0

6.7.4.3 *Do-Something Option B Scenario*

Table 6.7.7 shows the short term traffic noise changes resulting from the implementation of Option B. For the daytime period, 1309 properties would experience 'Negligible' noise increases, 43 would experience 'Minor' noise increases, 244 would experience 'No Change', 97 would experience 'Negligible' noise decreases, and 14 would experience 'Minor' noise decreases.

For the non-residential receptors within the study area, 31 would experience 'Negligible' noise increases and 6 would experience 'Minor' noise increases.

TABLE 6.7.7: SHORT TERM TRAFFIC NOISE CHANGES (OPTION B: DO MINIMUM 2020 TO DO SOMETHING 2020)

Change in noise level		Daytime	
		Number of dwellings	Number of other sensitive receptors
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1–0.9	1309	31
	1.0–2.9	43	6
	3.0–4.9	0	0
	5+	0	0
No Change	0	244	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1–0.9	97	0
	1.0–2.9	14	0
	3.0–4.9	0	0
	5+	0	0

Table 6.7.8 shows the long term traffic noise changes resulting from Option B. For the daytime period, 1650 would experience ‘Negligible’ noise increases, 11 would experience ‘No Change’ and 46 would experience ‘Negligible’ noise decreases.

For the non-residential receptors within the study area, all 37 would experience ‘Negligible’ noise increases.

For the night time period, 145 residential properties would experience ‘Negligible’ noise increases. It is noted that only the 145 residential properties with noise levels at or above 55 dB $L_{night,outside}$ in either the Do-Minimum or Do-Something scenario are included in the table, as required by DMRB.

TABLE 6.7.8: LONG TERM TRAFFIC NOISE CHANGES (OPTION B: DO MINIMUM 2020 TO DO SOMETHING 2034)

Change in noise level		Daytime		Night-time
		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1650	37	145
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	11	0	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	46	0	0
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

Table 6.7.9 shows the traffic noise nuisance changes, with and without Option B in place. For the Do-Minimum 2020 to Do-Minimum 2034 calculations, the changes in nuisance are calculated using long term nuisance statistics. For the Do-Minimum 2020 to Do-Something 2034 calculations, the changes in nuisance are calculated for the worst-case situation in the first 15 years after opening of the scheme using short term and/or long term nuisance statistics.

TABLE 6.7.9: LONG TERM TRAFFIC NOISE NUISANCE CHANGES (OPTION B)			
Change in nuisance level		Number of dwellings	
		Do-Minimum	Do-Something
Increase in nuisance level	<10%	1707	524
	10 <20%	0	1071
	20<30%	0	60
	30<40%	0	0
	>40%	0	0
No Change	0 %	0	0
Decrease in nuisance level	<10%	0	52
	10 <20%	0	0
	20<30%	0	0
	30<40%	0	0
	>40%	0	0

6.7.4.4 *Do-Something Option C Scenario*

Table 6.7.10 shows the short term traffic noise changes resulting from the implementation of Option C. For the daytime period, 1261 properties would experience ‘Negligible’ noise increases, 41 would experience ‘Minor’ noise increases, 318 would experience ‘No Change’, 86 would experience ‘Negligible’ noise decreases, and 1 would experience a ‘Minor’ noise decrease.

For the non-residential receptors within the study area, 31 would experience ‘Negligible’ noise increases and 6 would experience ‘Minor’ noise increases.

TABLE 6.7.10: SHORT TERM TRAFFIC NOISE CHANGES (OPTION C: DO MINIMUM 2020 TO DO SOMETHING 2020)

Change in noise level		Daytime	
		Number of dwellings	Number of other sensitive receptors
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1–0.9	1261	31
	1.0–2.9	41	6
	3.0–4.9	0	0
	5+	0	0
No Change	0	318	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1–0.9	86	0
	1.0–2.9	1	0
	3.0–4.9	0	0
	5+	0	0

Table 6.7.11 shows the long term traffic noise changes resulting from Option C. For the daytime period, 1674 properties would experience ‘Negligible’ noise increases, 13 would experience ‘No Change’ and 20 would experience ‘Negligible’ noise decreases.

For the non-residential receptors within the study area, all 37 would experience ‘Negligible’ noise increases.

For the night time period, 144 residential properties would experience ‘Negligible’ noise increases. It is noted that only the 144 residential properties with noise levels at or above 55 dB $L_{night,outside}$ in either the Do-Minimum or Do-Something scenario are included in the table, as required by DMRB.

TABLE 6.7.11: LONG TERM TRAFFIC NOISE CHANGES (OPTION C: DO MINIMUM 2020 TO DO SOMETHING 2034)

Change in noise level		Daytime		Night-time
		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1674	37	144
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	13	0	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	20	0	0
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

Table 6.7.12 shows the traffic noise nuisance changes, with and without Option C in place. For the Do Minimum 2020 to Do-Minimum 2034 calculations, the changes in nuisance are calculated using long term nuisance statistics. For the Do-Minimum 2020 to Do-Something 2034 calculations, the changes in nuisance are calculated for the worst-case situation in the first 15 years after opening of the scheme using short term and/or long term nuisance statistics.

TABLE 6.7.12: LONG TERM TRAFFIC NOISE NUISANCE CHANGES (OPTION C)

Change in nuisance level		Number of dwellings	
		Do-Minimum	Do-Something
Increase in nuisance level	<10%	1707	641
	10 <20%	0	993
	20<30%	0	48
	30<40%	0	0
	>40%	0	0
No Change	0 %	0	0
Decrease in nuisance level	<10%	0	25
	10 <20%	0	0
	20<30%	0	0
	30<40%	0	0
	>40%	0	0

6.7.4.5 *Do-Something Option D Scenario*

Table 6.7.13 shows the short term traffic noise changes resulting from the implementation of Option D. For the daytime period, 1235 properties would experience ‘Negligible’ noise increases, 368 would experience ‘Minor’ noise increases, 15 would experience ‘Moderate’ noise increases, 31 would experience ‘No Change’, 50 would experience ‘Negligible’ noise decreases, and 8 would experience ‘minor’ noise decreases.

For the non-residential receptors within the study area, 30 would experience ‘Negligible’ noise increases and 7 would experience ‘Minor’ noise increases.

TABLE 6.7.10: SHORT TERM TRAFFIC NOISE CHANGES (OPTION D: DO MINIMUM 2020 TO DO SOMETHING 2020)

Change in noise level		Daytime	
		Number of dwellings	Number of other sensitive receptors
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1–0.9	1235	30
	1.0–2.9	368	7
	3.0–4.9	15	0
	5+	0	0
No Change	0	31	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1–0.9	50	0
	1.0–2.9	8	0
	3.0–4.9	0	0
	5+	0	0

Table 6.7.14 shows the long term traffic noise changes resulting from Option D. For the daytime period, 1661 properties would experience 'Negligible' noise increases, 20 would experience 'minor' noise increases, 5 would experience 'No Change' and 21 would experience 'Negligible' noise decreases.

For the non-residential receptors within the study area, 34 would experience 'Negligible' noise increases and 3 would experience 'Minor' noise increases.

For the night time period, 105 residential properties would experience 'Negligible' noise increases. It is noted that only the 105 residential properties with noise levels at or above 55 dB $L_{night,outside}$ in either the Do-Minimum or Do-Something scenario are included in the table, as required by DMRB.

TABLE 6.7.14: LONG TERM TRAFFIC NOISE CHANGES (OPTION D: DO MINIMUM 2020 TO DO SOMETHING 2034)

Change in noise level		Daytime		Night-time
		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1661	34	105
	3.0-4.9	20	3	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	5	0	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	21	0	0
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

Table 6.7.15 shows the traffic noise nuisance changes, with and without Option D in place. For the Do-Minimum 2020 to Do-Minimum 2034 calculations, the changes in nuisance are calculated using long term nuisance statistics. For the Do-Minimum 2020 to Do-Something 2034 calculations, the changes in nuisance are calculated for the worst-case situation in the first 15 years after opening of the scheme, using short term and/or long term nuisance statistics.

TABLE 6.7.15: LONG TERM TRAFFIC NOISE NUISANCE CHANGES (OPTION D)

Change in nuisance level		Number of dwellings	
		Do-Minimum	Do-Something
Increase in nuisance level	<10%	1707	107
	10 <20%	0	1140
	20<30%	0	421
	30<40%	0	15
	>40%	0	0
No Change	0 %	0	0
Decrease in nuisance level	<10%	0	24
	10 <20%	0	0
	20<30%	0	0
	30<40%	0	0
	>40%	0	0

6.7.4.6 *Option Comparison*

Overall, there is little difference between the options in terms of noise changes. On balance, Option D would be slightly more adverse than the other three options. Ranking of the options from most favourable to least favourable results in:

1) Option B
2) Option A
3) Option C
4) Option D.

6.7.4.7 *Noise Level Difference Contours*

As required by DMRB, noise level difference contour plots were derived for the four options.

Figure 6.7.2 shows the long term noise level difference contours (Do-Minimum 2034 minus Do-Minimum 2020). Noise changes across the study area are less than 1 dB.

Figures 6.7.3-6.7.6 show the short term noise level difference contours (Do-Something 2020 minus Do-Minimum 2020) for Option A, Option B, Option C and Option D. It is evident that larger noise changes are generally confined to the area in close proximity to each option, with some wider areas subject to noise increases of between 1 and 3 dB.

Figures 6.7.7-6.7.10 show the long term noise level difference contours (Do-Something 2034 minus Do-Minimum 2020) for Option A, Option B, Option C and Option D. As for **Figures 6.7.3 - 6.7.6**, larger noise changes are generally confined to the area in close proximity to each option. The wider areas subject to noise increases of between 1 and 3 dB are enlarged when compared to the short term difference contours for the same option.

6.7.4.8 *Qualification under the Noise Insulation Regulations (Northern Ireland) 1995*

Noise levels to all façades of all residential properties within 300 metres of the four options were calculated. The resultant noise levels were processed to ascertain whether the three criteria for possible qualification under the Noise Insulation Regulations (Northern Ireland) 1995 were satisfied at any property.

It was concluded that no residential properties are likely to qualify for any of the four options.

6.7.5 ***Construction Impacts***

All four scheme layout options have the potential to result in significant noise and vibration impacts during construction, with 1707 residential properties and 37 sensitive non-residential properties within 400m of the option footprints.

Option A and Option C require less construction of elevated sections of roadway than Options B and D, with slightly more tunnelling works. This would likely have consequences in terms of the relative amounts of piling works, and consequent high noise levels, required for the four options.

A range of good site practices would be adopted in order to mitigate construction phase noise and vibration. It is assumed that the contractor will follow best practicable means to reduce the noise and vibration impacts on the local community, including:

- fixed and semi-fixed ancillary plant such as generators, compressors, wood chippers etc which can be located away from receptors to be positioned so as to cause minimum noise disturbance. If necessary, acoustic barriers or enclosures to be provided for specific items of fixed plant.

- all plant used on site will comply with the EC Directive on Noise Emissions for Outdoor Equipment, where applicable.
- selection of inherently quiet plant where appropriate. All major compressors to be 'sound reduced' models fitted with properly lined and sealed acoustic covers which are kept closed whenever the machines are in use, and all ancillary pneumatic percussive tools to be fitted with mufflers or silencers of the type recommended by the manufacturers.
- all plant used on site will be regularly maintained, paying particular attention to the integrity of silencers and acoustic enclosures.
- machines in intermittent use to be shut down in the intervening periods between work or throttled down to a minimum.
- drop heights of materials from lorries and other plant will be kept to a minimum.
- adherence to the codes of practice for construction working and piling given in British Standard BS 5228 and the guidance given therein for minimising noise and vibration emissions from the site.

In addition, the contractor will be subject to agreed working hours. For any works outside these hours, such as any night time works required to construct some aspects of the chosen option, it is likely that prior agreement will be required.

It is strongly recommended that local residents are kept informed and provided with a contact name and number for any queries or complaints. In particular residents should be notified in advance of any night time works.

A preliminary ranking of the options for construction noise and vibration effects, from most favourable to least favourable, results in:

1) Option A

2) Option C

3) Option B

4) Option D.

6.7.6 ***Mitigation and Enhancement Measures***

6.7.6.1 *Operation*

The introduction of any scheme option would result in changes in the number of vehicles on the surrounding road network. As presented in the preceding tables, the changes in flow and distance would cause the noise levels at a number of properties to change.

Following the Noise Insulation Guidelines, if a property is exposed to a noise impact level greater than 68 dB $L_{A10,\,18hr}$, and is subject to an increase of more than 1 dB with the scheme, then the property is eligible for Noise Insulation. At this stage, no residential properties have been predicted to qualify for mitigation under these guidelines.

If deemed appropriate, the use of a low noise road surface on the scheme can mitigate any noise impact by circa 3- 5 dB. The determination of any additional mitigation specification can be completed at the pre-construction phase.

6.7.6.2 *Construction*

A range of good site practices would be adopted in order to mitigate construction phase noise and vibration. It is assumed that the appointed Contractor would follow best practicable means to reduce the noise and vibration impacts on the local community, including:

- fixed and semi-fixed ancillary plant such as generators, compressors, wood chippers etc, which can be located away from receptors, to be positioned so as to cause minimum noise disturbance. If necessary, acoustic barriers or enclosures to be provided for specific items of fixed plant
- all plant used on site will comply with the EC Directive on Noise Emissions for Outdoor Equipment, where applicable
- selection of inherently quiet plant where appropriate. All major compressors to be 'sound reduced' models, fitted with properly lined and sealed acoustic covers which are kept closed whenever the machines are in use, and all ancillary pneumatic percussive tools to be fitted with mufflers or silencers of the type recommended by the manufacturers
- all plant used on site will be regularly maintained, paying particular attention to the integrity of silencers and acoustic enclosures
- machines in intermittent use to be shut down in the intervening periods between work or throttled down to a minimum
- drop heights of materials from lorries and other plant will be kept to a minimum;
- adherence to the codes of practice for construction working and piling, given in British Standard BS 5228 and the guidance given therein for minimising noise and vibration emissions from the site.

In addition, the Contractor would be subject to agreed working hours. For any works outside these hours, such as any night time works required to construct some aspects of the chosen option, it is likely that prior agreement would be required.

It is strongly recommended that local residents are kept informed and provided with a contact name and number for any queries or complaints. In particular, residents should be notified in advance of any night time works.

6.7.7 ***Summary and Conclusions***

A noise assessment for the four approved layout options for York Street Interchange has been carried out. The assessment has followed the guidelines provided in the November 2011 version of the Design Manual for Roads and Bridges (DMRB) Vol. 11, Section 3, Part 7.

The study area for the 'Detailed' calculation of noise levels was restricted to a buffer 400m from the interchange options. Considering the nature of the options and the extent of affected road links resulting from their implementation, this is not considered to be a significant restriction. There were no significant road links outside of this 400m buffer.

Overall, there is little difference between the options in terms of noise changes. On balance, Option D is slightly more adverse than Options A, B or C. Ranking of the options from most favourable to least favourable results in:

1) Option B

2) Option A

3) Option C

4) Option D.

Initial calculations indicate that no properties are likely to qualify for insulation under the Noise Insulation Regulations (Northern Ireland) 1995 for any of the four options.

Ranking of the options from most favourable to least favourable for construction noise and vibration effects results in:

1) Option A

2) Option C

3) Option B

4) Option D.

6.8 Pedestrians, Cyclists, Equestrians and Community Effects

6.8.1 *Introduction*

This section addresses the impact that the options under consideration would have on journeys which people make in the vicinity of the interchange as Non-Motorised Users (NMU's) such as pedestrians, cyclists or equestrians. In addition, the impact on local vehicle movements in relation to accessing community facilities is also considered. Essentially there are three main aspects addressed in this section: changes in journey length and times; changes in amenity; and changes in community severance.

The impact on journey length considers how the scheme might affect the duration or distance of journeys made by pedestrians and others as a result of the disruption to pedestrian routes and Public Rights of Way (PRoW).

Amenity is defined as the relative pleasantness of a journey. It is therefore concerned with changes in the degree and duration of people's exposure to traffic, in terms of fear/safety, noise, dirt and air quality, and the impact of the road itself; primarily any visual intrusion associated with the scheme and its structures.

Community severance is defined as the separation of residents from facilities and services they use within their community, caused by new or improved roads, or by changes in traffic flows. In addition, community severance may sometimes be caused by demolition of a community facility, or loss of land used by members of the public. Aged people, disabled and children are particularly vulnerable to disruption of their travel patterns.

6.8.2 *Methodology*

The objective at this secondary stage is to undertake sufficient assessment to identify the routes used by pedestrians and others, the community facilities and the effects upon these two categories to be taken into account in developing and refining the preferred option.

In accordance with the requirements of DMRB Volume 11, Section 3, Part 8, Chapter 9, (Stages in the Assessment of Impacts on Pedestrians, Other Travellers and Communities), the steps taken include:

- identification and assessment of the existing usage of community facilities and routes used by pedestrians and others which might be affected by any of the options
- an assessment of any changes in the safety and amenity value of routes used by pedestrians and others, which might be affected by any of the options

- where journey lengths would be increased, or where journey amenity would be reduced, an assessment of the likely changes in community severance
- where cyclists will be significantly affected, obtain the views of Sustrans on the implications of the various options under consideration.

6.8.2.1 *Assessing the Significance of Effects*

With reference to DMRB Volume 11, Section 2, Part 5, Chapter 2, it is not sufficient to assess only the size and probability of possible impacts; their significance should also be assessed. The significance of the effect is formulated as a function of the receptor or resource's environmental value (or sensitivity) and the magnitude of project impact (change). In other words, significance criteria are used to report the effect of the impact.

In terms of pedestrians, cyclists, equestrians and community effects, these should be assessed firstly in terms of the sensitivity and value of the receptor (e.g. High, Medium or Low), and secondly in terms of magnitude of impact (e.g. Major, Moderate, Minor or Negligible). The sensitivity and value of receptors that may be affected by any of the options is based on professional judgement, considering general usage and type. The scales adopted for the magnitude of impact are contained in **Table 6.8.1** below:

TABLE 6.8.1: ESTIMATING THE MAGNITUDE OF IMPACT ON AN ATTRIBUTE

Magnitude	Criteria
Major	Loss of community resource / NMU provision and/or quality and integrity of community resource / NMU provision. Large scale or major improvement to community resource / NMU provision quality; extensive restoration or enhancement.
Moderate	Loss of community resource / NMU provision, but not adversely affecting quality and integrity. Benefit to, or addition of, key characteristics of community resource, features or elements.
Minor	Some measurable change in attributes of community resource / NMU provision, quality or integrity. Minor benefit or addition to a community resource / NMU provision.
Negligible	No perceptible change to community baseline conditions.

DMRB Volume 11, Section 3, Part 8, does not describe how the significance of effects should be scaled with regards to pedestrians, cyclists, equestrians and community impacts. Therefore, **Table 6.8.2** outlines a suggested means of estimating the significance of potential effects, based upon the magnitude of impact and sensitivity of the receptor. Professional judgement and awareness of the relative balance of importance between sensitivity and magnitude allows the overall significance of impact to be assessed. The significance of impact is assessed with mitigation (where known) to define residual impacts.

TABLE 6.8.2: ESTIMATING THE SIGNIFICANCE OF POTENTIAL EFFECTS

IMPORTANCE OF ATTRIBUTE					
	High	Neutral	Moderate/Large	Large/Very Large	Very Large
	Medium	Neutral	Slight/Moderate	Moderate/Large	Large/ Very Large
	Low	Neutral	Slight	Moderate	Large
		Negligible	**Minor**	**Moderate**	**Major**
		MAGNITUDE OF IMPACT			

Source: DMRB 11.2.5.2 (Arriving at the Significance of Effect Categories - adapted)

6.8.3 ***Regulatory/Policy Framework***

Belfast City Council has the primary responsibility for provision of public open space facilities within the study area. Their statutory powers to provide for and facilitate recreation are considerable, ranging from leisure and tourism promotion, acquisition of land for recreational use and provision of facilities, to securing public access to the countryside.

6.8.3.1 *Access to the Countryside (NI) Order 1983*

The Access to the Countryside (NI) Order 1983 came into force in Northern Ireland in March 1984. Belfast City Council has a mandatory, statutory duty *'to assert, protect and keep open and free from obstruction any public right of way'.*

Public Rights of Way may be asserted as one of the following, depending on their historic use:

- Public footpath: Right of passage on foot only.
- Bridleway: Right of passage on foot and by horse.
- Cartway/Carriageway: Paths open to all traffic.

They are also given discretionary powers to repair and maintain Rights of Way, to create, divert or close public paths, and to make access agreements or Orders to open land.

6.8.3.2 *PPS 3: Access, Movement and Parking (Revised)*

This Planning Policy Statement (PPS) sets out planning policies for vehicular and pedestrian access, transport assessment, the protection of transport routes and parking. It forms an important element in the integration of transport and land use planning. It sets out a number of policies in relation to the provision of new accesses onto public roads and embodies the Government's commitments to the provision of a modern, safe and sustainable transport system.

The main objectives of this PPS are to:

- promote road safety, in particular, for pedestrians, cyclists and other vulnerable road users;
- restrict the number of new accesses and control the level of use of existing accesses onto Protected Routes
- make efficient use of road space within the context of promoting modal shift to more sustainable forms of transport
- ensure that new development offers a realistic choice of access by walking, cycling and public transport

- ensure the needs of people with disabilities and others whose mobility is impaired, are taken into account in relation to accessibility to buildings and parking provision
- promote the provision of adequate facilities for cyclists in new development
- promote parking policies that will assist in reducing reliance on the private car and help tackle growing congestion
- protect routes required for new transport schemes including disused transport routes with potential for future reuse.

6.8.3.3 *PPS 8: Open Space, Sport and Outdoor Recreation*

This PPS sets out planning policies for the protection of open space, the provision of new areas of open space in association with residential development and the use of land for sport and outdoor recreation, and advises on the treatment of these issues in development plans. It embodies the Government's commitment to sustainable development, to the promotion of a more active and healthy lifestyle, and to the conservation of biodiversity.

Open space, for the purposes of this Statement, is defined as all open space of public value. The definition includes not just outdoor sports facilities, parks and gardens, amenity green space and children's play areas, but also natural and semi-natural urban green spaces, allotments, cemeteries, green corridors, and civic spaces. It includes not just land, but also inland bodies of water that offer important opportunities for sport and outdoor recreation and which can also act as a visual amenity.

The main objectives of this PPS are to:

- safeguard existing open space and sites identified for future such provision
- ensure that areas of open space are provided as an integral part of new residential development and that appropriate arrangements are made for their management and maintenance in perpetuity
- facilitate appropriate outdoor recreational activities in the countryside
- ensure that new open space areas and sporting facilities are convenient and accessible for all sections of society, particularly children, the elderly and those with disabilities
- achieve high standards of siting, design and landscaping for all new open space areas and sporting facilities
- ensure that the provision of new open space areas and sporting facilities is in keeping with the principles of environmental conservation, and helps sustain and enhance biodiversity.

6.8.4 ***Baseline Conditions***

6.8.4.1 *Local Vehicle Movements (Existing Road Network)*

As identified in the Belfast Metropolitan Transport Plan (BMTP) 2015, the Belfast Metropolitan Area (BMA) is typical of most large urban areas, comprising a set of radial road links that converge on a central hub, represented by the City Centre. The BMA occupies a strategic position on several Key Transport Corridors (KTC) including:

- Eastern Seaboard KTC
- North Western KTC
- Northern KTC
- South Western KTC.

As such, the city acts as a central ‘hub’ on the traffic network, with a series of Motorway and A-Class roads radiating from the city including:

- M1 to Dungannon
- M2 to Randalstown
- M3 to Sydenham
- A12 Westlink
- A2 to Carrickfergus
- A2 to Bangor
- A20 to Newtownards
- A24 to Ballynahinch/Newcastle
- A52 to Crumlin.

Vehicle movements through and in the vicinity of the York Street area are discussed below in general terms. Information regarding the characteristics and layout of each stretch of road which conveys strategic and/or local vehicle movements through the junction (referred to as ‘Links’) is described in detail within **Section 2.1.1**.

For strategic vehicle movements, the existing road layout at York Street provides access to the A12 Westlink, M2 and M3, as well as the City Centre, North Belfast and the Docklands. Access to the Westlink provides links towards Lisburn, Craigavon, Newry and cross-border to Dublin. The M2 provides links to the north and northwest of the Province, including Larne, Belfast International Airport, Coleraine and Londonderry. The M3 provides links to East Belfast, Sydenham Bypass, George Best Belfast City Airport, Holywood and Bangor. The existing links between the Westlink and the M2/M3 are at-grade, intersecting with the local city road network through signal controlled priority junctions. The M2 to M3 Lagan Bridge connection (and *vice versa*) is the only strategic link within the existing junction arrangement that is currently grade-separated from the local city road network.

For local vehicle movements, the existing road layout at York Street is a signalised gyratory system, with northbound movements accommodated by one-way running along the York Street arterial route, eastbound movements accommodated by one-way running along York Link, southbound movements accommodated by one-way running along Nelson Street, and westbound movements accommodated by one-way running along Great George’s Street. Local movements through the signalised gyratory system occur in direct interaction with strategic movements through four at-grade, heavily trafficked signal controlled junctions. Any movement in the system involves negotiating a minimum of two signal controlled junctions and merging with and/or giving way to strategic traffic on a priority basis.

With reference to the BMTP 2015, one of the key transport problems of the BMA, and Belfast in particular, is the multifunctional role (as described above) of many of the links forming the road network. Whilst the main radial road links form key axes for movement between the city’s suburbs and its central core, they also serve local movements within the suburban area. Consequently, it is evident that conflicts exist between the needs of local and strategic traffic (particularly on this part of the city road network).

6.8.4.2 *Community Facilities*

For the purposes of assessment, the term ‘community facility’ ranges from health and social services, to education, arts, culture and religious facilities. It also includes facilities for leisure and social purposes, including centres, meeting places and halls. Essentially this definition includes:

- Leisure and culture facilities (including arts, entertainment and built sports facilities)
- Community centres and meeting places (including places of worship, libraries)
- Facilities for children (from nursery provision to youth clubs)
- Education (including adult education)
- Social Services
- Healthcare facilities
- Service-orientated businesses (i.e. locally based shops)
- Public transport facilities.

As the study area is located within Belfast, on the northern periphery of the City Centre, it is generally accepted that principal facilities which the local community (i.e. City, Docklands and North Belfast) would be travelling to on a regular basis are not only located within the environs of the immediate study area, but also throughout the wider Metropolitan area and City Centre, a number of which have been shown on **Figure 6.8.1**.

Within the centre of the study area itself, community facilities include DRD Roads Service surface level car parks (including Northside Park & Ride) and Jack Kirk Automobile Engineer.

On the east side of the study area (i.e. the Docklands), community facilities include Sinclair Seamen's Presbyterian Church, Stella Maris Emergency Hostel, the Greek Consulate, Flying Angel Seafarers Centre, Dockers' Club, St Joseph's Church, Harbour Commissioners and a number of public houses and retail units.

On the south side of the study area (North City Centre), community facilities include the Children's Law Centre and University of Ulster on York Street, *Bunscoil Mhic Reachtain* (Irish Language School) on Lancaster Street, Frederick Street Nursery School, Lancaster Street Community Garden, Bridges Urban Sports Park (adjacent to the M3 flyover), DRD Roads Service surface level car parks and a number of retail units. A variety of religious and social facilities can also be found within the locale, including Donegall Street Congregational Church, St Kevin's Community Hall, St Patrick's Parish Centre, St Patrick's Church, and Friends Meeting House.

On the west side of the study area, community facilities include The Mater Hospital, Clifton House Conference Centre, Clifton Street Surgery, Clifton Nursing Home, St Malachy's College, Indian Community Centre, Belfast Orange Hall, The Hopelink Centre, and a range of retail units.

On the north side of the study area, a variety of community facilities ribbon along York Street, including Cityside Retail Park (which contains a cinema, gym, fast food outlet, bingo hall, supermarket and a number of other retail units), Yorkgate Train Station, and St Paul's Church & Hall. On North Queen Street, facilities include North Queen Street Community Centre, North Belfast Family Centre, North Queen Street Play Centre, and a number of retail units.

It is important to emphasise that the range community facilities detailed above is not exhaustive. It is recognised that the potential exists for other facilities (not identified above) to provide important services to the local community surrounding the study area.

6.8.4.3 *Public Transport*

In terms of public transport provision, the study area is well connected to rail and bus services.

6.8.4.3.1 ***Public Rail Network***

Even though the Belfast to Larne/Londonderry railway line is conveyed through the centre of the study area via Dargan Bridge (carrying it over York Street junction), there are no halts or stations within the immediate study area. The closest connection is Yorkgate Railway Station on York Street, which serves North Belfast and is located on the very northern periphery of the study area. The high level Dargan Bridge (which was constructed in 1993 and runs immediately adjacent to the M3 Lagan Bridge) connects Yorkgate to the rest of the rail network at Belfast Central.

From Monday to Friday, there is a half-hourly Larne Line service, with the outbound terminus alternating between Carrickfergus and Larne Harbour. All inbound Larne Line services terminate at Belfast Central, except for some peak-time services which continue through to Great Victoria Street.

Larne Line services on Saturday are much the same, except that all inbound trains terminate at Great Victoria Street rather than Belfast Central, except for a few early morning or late night services which terminate at Belfast Central. On Sundays, the service runs every hour and a half each way between Larne Harbour and Great Victoria Street.

Weekday services on the Belfast - Londonderry Line also call at Yorkgate on a bi-hourly basis. Most Londonderry Line trains run from Waterside Station to Great Victoria Street and *vice versa*, however some outbound services run to Portrush instead, and some early morning inbound services only run to Belfast Central. Some extra services run to and from Ballymena at peak times.

On Saturdays, there are a slightly reduced number of trains, however the Londonderry Line service remains largely similar. On Sundays, only five Londonderry Line trains run in each direction, terminating at Waterside Station or Great Victoria Street respectively.

6.8.4.3.2 ***Public Bus Network***

A range of public bus services serve and pass through the study area. In terms of network connection in and around the study area itself, there are a range of bus stops including; at Cityside Retail Park, Northside Park & Ride, Brougham Street, York Street, Nelson Street and Corporation Street. The stops are connected to the Translink Metro Network, which provides one bus service for all of Belfast. The network is made up of 12 high-frequency corridors along the main arterial roads into the City Centre and additional services operating throughout the Greater Belfast area.

The York Street arterial route is served primarily by Metro Service 2, which connects the City Centre to Rathcoole, Monkstown, Fairview Road, Glengormley and Carnmoney. The outbound route from the City Centre passes along York Street, though the inbound route utilises Nelson Street (where York Street is one-way) as part of the signalised gyratory system.

Metro Services 13 & 14 between the City Centre and Newtownabbey/Glenville/Hyde park also pass through the study area, however as a city express, do not provide a stop-on-request service other than at Interpoint on York Street. The outbound route from the City Centre passes along York Street and onto the M2 (via York Link). The inbound route departs the M2 at Duncrue Street, accessing the city via Nelson Street/Dunbar Link/York Street.

Metro Services 61 & 64 connects the City Centre with the Greater North Belfast area, both of which provide a stop-on-request service to the bus stops along the city road network. Service 61 follows the same outward and inward route via Dunbar Link, Corporation Street, Dock Street and Brougham Street. Service 64 follows the exact same route as Service 2 through the study area, though deviates off York Street at Brougham Street.

Metro Service 96 connects the City Centre with Duncrue Street/Docklands, though only the inbound service provides a stop-on-request service to the bus stops along the city road network. Outbound, the route taken is via Dunbar Link/York Street/Dock Street/Garmoyle Street. Inbound, the route taken is via Nelson Street/Dunbar Link/York Street.

The study area is not directly connected to the Ulsterbus or Express Goldline Network, though these services (i.e. the Airport Express (300), Maiden City Flyer (212)) pass through the existing York Street junction as part of their planned routes. Essentially York Street junction forms a hub point for the north and north-westbound Ulsterbus and Express Goldline services to and from Europa and Laganside Bus Centres, with a variety of routes taken through the junction arrangement. The majority of outbound services utilise York Street or Westlink when accessing the M2. No Ulsterbus services use the bus lane on Corporation Street from Clarendon Dock to Dock Street (only Metro Services). Inbound from the M2, Express services (i.e. 212, 218, 219, 220, 222, 256 & 300) all use the bus lane on Duncrue Street and into the city via Nelson Street.

Bus service efficiency throughout the study area for Metro, Ulsterbus and Goldline is enhanced by way of dedicated bus lanes including lanes on Duncrue Street, Nelson Street, Corporation Street/Garmoyle Street and at Northside Park & Ride (York Link). These allow for increased journey time reliability.

Located within the centre of the existing junction arrangement (between York Street, York Link and Great George's Street) is Northside Park & Ride, which provides flexibus connection to the City Centre approximately every 15 mins (from 7.40am to 6.25pm). The Park & Ride allows congestion to be reduced into the City Centre by giving a viable, more sustainable alternative to using the car. The bus provides a stop-on-request service at the University of Ulster, Castle Court, Donegall Place, Chichester Street, Victoria Street and Transport House (Monday to Saturday). It takes a looped route around the signalised gyratory system via York Street, York Link, Nelson Street and Great Patrick Street (Dunbar Link). The Park & Ride provides 394 car parking spaces (including provision for disabled patrons) for £3 per day and is well used.

6.8.4.3.3 ***Public Transport Network Development Proposals***

In terms of future development of the rail network within the study area, Translink are considering the feasibility of providing a new station at Gamble Street to serve the proposed Greater Belfast Development at the University of Ulster (scheduled for opening 2018) and likely associated influx of people to the area. To facilitate the new rail halt, twin tracks would be required between Yorkgate and Gamble Street (the line is currently only single track). As such, significant modification of Dargan Bridge would be required to accommodate these changes.

The Belfast Metropolitan Transport Plan (BMTP) 2015 outlines a number of initiatives aimed at improving public transport throughout the City, though it must be noted that the BMTP is a local non-statutory transport plan. It has been framed with a long term strategy in line with the Regional Development Strategy (RDS).

The BMTP identifies problems with public transport provision in the BMA, including: -

- Traffic levels on some roads
- The impact of traffic on the environment and quality of life
- Road safety
- The deteriorating quality of public transport provision
- A public transport system that does not meet people's travel needs

- Limited integration between modes
- Limited provision for walking and cycling.

The BMTP states that there '*is a clear need to substantially improve the quality of public transport services in delivering a modern integrated transport system for the BMA, especially in terms of journey ambience, frequency and reliability and in a way that extends travel choices for all sections of the community*.'

The BMTP prioritises several key points in terms of rail transport, including, improvement of access to and facilities at rail stations, increasing service frequencies by up to 50%, and provision of new or re-located stations.

Improvements to bus services suggested by the BMTP include the implementation of an extensive Quality Bus Corridor (QBC) network with:

- bus priority measures
- service frequency improvements of up to 50% compared to existing levels
- modern high quality low floor buses
- improved bus stop facilities including real time passenger information plus improved access to bus stops
- bus lane enforcement cameras
- QBCs implemented on 14 sets of routes including Belfast - Antrim corridor (MTC A) on two routes; Antrim Road, and using the M2 (City Express), in the vicinity of York Street junction.

On the strategic road network, the BMTP prioritises bus measures which should be implemented on the M2 in the Antrim Corridor (MTC A) between Fortwilliam and York Street, and on the Sandyknowes on-slip southbound to supplement that already on the M1 in the Lisburn Corridor (MTC B) between Stockman's Lane and Broadway junction.

The improvements prioritised with the BMTP are supportive of those contained within the RDS, which identifies:

- the improvement of facilities and access to stations as a means of increasing the catchment area for rail services
- substantially improved service frequencies of up to 100% on all routes
- providing new stations at key locations as a means of increasing the catchment area for rail, providing new interchange opportunities, and supporting development and regeneration initiatives.

6.8.4.4 *Pedestrian Facilities*

The existing network of footways allows for relatively unrestricted pedestrian movements throughout the study area. The only sections of road connected to York Street junction that do not have footway provision are the A12 Westlink and M2/M3 Motorways. Whilst pedestrians are typically allowed access onto A-class roads, in the case of Westlink, access is strictly prohibited.

The existing network of footways essentially facilitates access between the City, North Belfast and the Docklands (**Figure 6.8.2**). With regards to pedestrian movements, the main issue in terms of hindrance is direct interaction with local and strategic traffic; as such a range of dedicated pedestrian crossing points (controlled and uncontrolled) are located throughout the study area (**Figure 6.8.2**).

Based on initial survey work, it is evident that pedestrian movements in the vicinity of the junction are significant. A simple survey to examine existing movements was undertaken during the assessment of Preliminary Options at Stage 1 at two counting locations. It involved observing pedestrians traversing main routes, noting direction of travel and if crossing movements took place. Station A was located within the DRD Roads Service (Northside Park & Ride) car park, and Station B was located within Galway House car park. Overall, a total of 3694 movements were observed, (2003 at Station A and 1691 at Station B). The most popular route for pedestrians, observed from Station A, was along York Street (in both directions), with a total of 1640 people using the footway on the west side of the road. At Station B, the most popular route was from York Street to/from Cityside Retail Park, with 983 people using the route. Also from observations during the survey, many pedestrians used one of the three car parks located in the immediate vicinity of the existing junction.

To validate the survey work undertaken at Stage 1, a more detailed NMU survey was undertaken during Stage 2 on 21 and 22 April 2010 to observe and record movements throughout the wider study area.

Again, the survey counts (based on 12-hour flows) indicated that movements along York Street were the most popular, with approximately 1300 pedestrians observed at the Great George's Street junction (making it the most heavily used crossing within the study area). Movements along York Street are facilitated by footways on either side of the road, though movements predominantly occur along the western footway (for numerous reasons). The footways are intersected in quick succession by strategic road junctions at the termination point of both the southbound and northbound Westlink carriageways. Although crossing movements are controlled, as these junctions facilitate the convergence of M2/M3/Westlink strategic and other local traffic, they are very heavily congested.

The survey also recorded movements on the majority of other footways within the study area, though in no instance were the number of users recorded close to those recorded at York Street. Of these footways, recorded movements along Corporation Street were quite significant, with up to 500 pedestrians observed in the vicinity of the M3 flyover.

Community Greenways are green space networks, which enhance the existing open space provision by linking areas together. Greenways have recreational, ecological and aesthetic roles and offer pedestrians the opportunity to walk from one area to another via pleasant green surroundings. With reference to BMAP (Draft) 2015 and **Figure 6.8.1**, Carr's Glen/Waterworks and North Belfast/South Belfast/Lagan Valley Regional Park Community Greenways are aligned along the northern and eastern periphery of the study area respectively. Within the study area, Carr's Glen/Waterworks Community Greenway essentially commences at the Dock Street/Garmoyle Street junction, passing under the M2 (via Dock Street) before veering northwards along York Street. At the Dock Street/Garmoyle Street junction, it connects directly into the North Belfast/South Belfast/Lagan Valley Regional Park Community Greenway, which is aligned in a north/south orientation along Corporation Street, Garmoyle Street, Whitla Street and Duncrue Street.

6.8.4.5 *Cyclist Facilities*

Dedicated cycling provision throughout the existing study area is limited. None of the existing road network currently has adjacent cycling lane provision, thus cycling journeys made through the existing junction arrangement are on-road and in direct interaction with local and strategic traffic.

With reference to Sustrans [online] and **Figure 6.8.1**, National Cycle Network (NCN) Route 93 is aligned along the eastern periphery of the study area. This route is aligned along Garmoyle Street, Dock Street, Princes Dock Street, Clarendon Road and Donegall Quay. BMAP (Draft) 2015 also contains proposals to connect several on-road and traffic-free local routes to NCN

Route 93. Local on-road routes west of the River Lagan would run along Royal Avenue, Castle Street, Castle Place and High Street to link in with Donegall Quay.

In addition to that noted above under pedestrian facilities, Community Greenways also act as a cycle network, allowing cyclists to have a safer journey with less surrounding noise and pollution.

The NMU survey undertaken on 21 and 22 April 2010 also observed and recorded cyclist movements throughout the wider study area. This survey identified that of all the existing routes (i.e. York Street, Nelson Street, and Corporation Street) connecting North Belfast and the Docklands to the City Centre, the highest movements were recorded along Corporation Street. This would not at all be unexpected considering the proximity to NCN Route 93, availability of the road to two-way movements, and the comparatively low traffic volume. At the Corporation Street/Dock Street junction, approximately 112 cyclists were recorded moving in both directions. Cyclist movements were also recorded on York Street (particularly northbound) and none were recorded on Nelson Street.

6.8.4.6 *Equestrian Facilities*

As would be expected, no known equestrian facilities are located within the vicinity of the York Street area. Furthermore, no equestrian activity has been observed on the local city road network.

6.8.5 ***Predicted Impacts***

6.8.5.1 *Operation*

6.8.5.1.1 ***Local Vehicle Movements (Proposed Road Network)***

The options under consideration either provide full or partial grade-separation of the strategic links between the A12 Westlink and M2 Motorway (Links A & B), and between the A12 Westlink and M3 Motorway (Links C & D). Whilst the benefits of these changes are obvious for the strategic road user, local vehicle movements (i.e. users of the local network of city roads) would also experience benefits, due to the reduction in strategic traffic interaction, leading to freer flowing conditions through junctions (which are currently at-grade, signalised, heavily trafficked and congested).

Due to the confined nature of the proposed scheme area and requirement to meet minimum road design standards, the intersection of some other key links would however be modified, realigned, diverted and/or permanently stopped-up. As the York Street area forms a northern gateway to the City, significant volumes of traffic merge and diverge at this point from a wide variety of links. Hence, the potential for beneficial and adverse impacts on vehicle movements (both strategic and local) to and from community facilities would vary between options.

As set out in the BMTP 2015, strategic improvements would directly facilitate improvements to the local road network by eliminating or reducing through traffic interaction. However, vehicles coming off at York Street Interchange would continue to interact with local traffic and possibly along different sections of road (when compared to existing conditions) due to changes in road layout. The strategic network would be enhanced such that it could safely and efficiently cater for longer-distance movements of people and freight to, from and between different parts of the BMA, particularly locations of regional importance such as the City Centre, Regional Gateways, and potential strategic development and employment locations; and support the reduction of traffic and impact of traffic on the non-strategic highway network, particularly in built up areas.

The description of the principal changes to local vehicle movements associated with the proposed improvements to York Street Interchange is discussed below on a link-by-link basis. These options are described in further detail in **Sections 3.3.2 to 3.3.5**.

Option A presents the first of two depressed concept designs. The layout provides a grade separated junction, but not a full interchange, with Links at either existing ground level or in depressed sections. A general arrangement for Option A is included as **Drawing S105296-R-SK-A-000**, with profiles of the various links also included as **Drawings S105296-R-SK-A-100 to 101 inclusive** and cross-sections at key locations further included on **Drawings S105296-R-SK-A-200 to 205 inclusive**. For the purposes of describing the principal roadworks required, the convention set out in **Table 3.3.2** has been adopted to describe the various links within the proposed layout.

Option B presents the first of two elevated concept designs. The layout provides a full interchange, with Links in both depressed corridors and on elevated overbridge structures. A plan of the proposed layout is included as **Drawing S105296-R-SK-B-000** with profiles of the various links also included as **Drawings S105296-R-SK-B-100 to 101 inclusive** and cross-sections at key locations further included on **Drawings S105296-R-SK-B-200 to 207 inclusive**. For the purposes of describing the principal roadworks required, the convention set out in **Table 3.3.4** has been adopted to describe the various links within the proposed layout.

Option C presents the second of two depressed concept designs. The layout provides a full interchange, with Links at either existing ground level or in depressed sections. A plan of the proposed layout is included as **Drawing S105296-R-SK-C-000**, with profiles of the various links also included as **Drawings S105296-R-SK-C-100 to 101 inclusive** and cross-sections at key locations further included on **Drawings S105296-R-SK-C-200 to 206 inclusive**. For the purposes of describing the principal roadworks required, the convention set out in **Table 3.3.6** has been adopted to describe the various links within the proposed layout.

Option D presents the second of two elevated concept designs. The layout provides a grade separated junction, but not a full interchange, with Links at either existing ground level or on elevated overbridge structures. A plan of the proposed layout is included as **Drawing S105296-R-SK-D-000**, with profiles of the various links also included as **Drawings S105296-R-SK-D-100 to 101 inclusive** and cross-sections at key locations further included on **Drawings S105296-R-SK-D-200 to 206** inclusive. For the purposes of describing the principal roadworks required, the convention set out in **Table 3.3.7** has been adopted to describe the various links within the proposed layout.

Link A (M2 to Westlink)

For all options under consideration, Link A would be fully grade-separated between the M2 and Westlink, which in terms of local vehicle movements would have significant benefits, as there would no longer be any direct interaction with strategic through traffic within the interchange through signalised junction arrangements. The benefits of these changes in terms of local vehicle movements would be most keenly felt along York Street. In terms of accessibility to this link however, modification of the route to be taken by local vehicle users from the Docklands area would be required with all options.

Link A with Options A & C would incorporate elevated and depressed sections between the M2 and Westlink, and would have a much more sweeping horizontal alignment than Options B & D, aligning this link much closer to Corporation Street. Under existing conditions, the community within the Docklands area is connected to the Westlink via Nelson Street (which with all options would only facilitate connection to the M3, severing this existing route). With Options A & C, a direct connection from Corporation Street to Link A would be provided, which would result in minimal change in the required distance to travel over existing conditions and would be through a much improved highway environment.

Options B & D however would not be able to provide the connection to Corporation Street. Instead Garmoyle Street and Whitla Street would be modified to allow two-way running, facilitating a connection from Dock Street to Nelson Street via a signalised junction. Nelson Street (north of Dock Street) would be modified to facilitate direct connection to Link A, however this would result in the cessation of two-way running along this road (only the citybound bus lane would remain). In essence Options A & C would result in the least change to the existing road environment, minimising increases in distance travelled, creation of new severance, and reduction in journey amenity.

All Options would sever an existing route for the M2 and local docklands traffic to the City Centre and Great George's Street via Nelson Street. The primary route however for local traffic to the City Centre from the Docklands is Corporation Street, thus this change in road layout is unlikely to have a significant impact upon vehicle movements (particularly in terms of redistribution) however for Great George's Street bound traffic (from the docklands and the M2), the route taken would be altered significantly, though similarly with all options.

Link B (Westlink to M2) & Link C (Westlink to M3)

For all options under consideration, Link B would be fully grade-separated between the Westlink and M2, which in terms of local vehicle movements has significant benefits, as there would no longer be any direct interaction with strategic through traffic within the interchange through signalised junction arrangements. Again, the benefits of these changes in terms of local vehicle movements would be most keenly felt along York Street and largely equal amongst options considered. With all options, the at-grade connection to York Street from Westlink would be maintained. However, due to the configuration of Option D, the on-slip and merge lane from Clifton Street to the Westlink, and the diverge and off-slip from the Westlink to York Street (and onwards to M3), would be in such close proximity that they would be below minimum design standards. Consequently, Clifton Street on-slip would be stopped-up, severing a link for local traffic from Crumlin Road direction to the strategic road network. As a result, York Street, M2 & M3 bound traffic would instead continue across the Westlink (via Clifton Street) on to Frederick Street and then York Street, increasing journey length, time, traffic loading and number of signalised junctions encountered. Implications of this would be far ranging, but probably none more significant than limiting the choice and ease of route for emergency services from The Mater Hospital, potentially affecting response times.

Link C would be fully grade-separated between the Westlink and M3 for all options, except Option D. Again, the benefits of grade-separation in terms of local vehicle movements would be most keenly felt on York Street, with the cessation of direct local and strategic traffic interaction through signalised junction arrangements. However, grade-separation with Options A, B & C would sever the link from York Street to M3 (via York Link). There would be a variety of alternative routes available to access the M3 from York Street, however all would increase journey length, time, traffic loading and number of signalised junctions encountered.

With Option D, the arrangement of Link C would largely be similar to existing conditions (i.e. would cross York Street and Nelson Street (at-grade) via signalised priority junction arrangements, following the alignment of York Link). Whilst this arrangement would continue to be restrictive in terms of local through movements along York Street, it would have the benefit of maintaining connection to the M3 from York Street and facilitating a new local connection to Corporation Street, providing a degree of relief of severance to the Clarendon Dock area (but not to the wider Docklands Area, as the movements along Corporation Street, north of Clarendon Dock would remain to be bus only).

Link D (M3 to Westlink)

Link D would be fully grade-separated between the M3 and Westlink for all options except Option A, which again in terms of local vehicle movements would have significant benefits, most notably with regards to through movements on York Street.

With Option A, the layout of Link D would largely be similar to existing (i.e. would cross Nelson Street and York Street (at-grade) via signalised priority junctions, following the alignment of Great George's Street). Whilst this arrangement would continue to be restrictive in terms of local through movements along York Street, it would allow M3 traffic to continue to utilise Nelson Street into the city centre (which would be stopped-up with all other options). With the other options, City Centre bound traffic from the M3 would have to continue along Great George's Street to North Queen Street, passing along the periphery of a City Centre housing area at Lancaster Street, increasing the degree of community severance and reduction in amenity, due to increased traffic exposure. The impact on Great George's Street between York Street and North Queen Street would however be offset by the inability of the M2 to Westlink traffic to use this street as a rat-run.

Link E (York Street South to York Street North)

As discussed above, local movements along York Street would be significantly benefited by grade-separation of the strategic links between the Westlink and M2/M3 Motorways. Hence, Options B & C would provide the greatest benefit as all strategic links across York Street would be grade-separated. Whilst the number of signalised priority junctions along York Street would be the same with all options, and the same as existing conditions, the reduction in local and strategic traffic interaction and overall traffic volume would result in prioritised movements from York Street (south) to York Street (north), reducing existing severance. With Options A & D, movements along York Street would be less prioritised with continued at-grade junctions with Link D (Option A) and Link C (Option D). Consequently all options would result in reduced community severance, due to the minimisation of local and strategic traffic interaction, but to a lesser extent with Options A & D.

With regards to amenity (i.e. the relative pleasantness of a journey), there would be distinct variations between options. As noted above, Options B & C would provide full grade-separation of strategic links, however in the case of Option B, this would result in negative amenity impacts. As Links A & D with this option would be elevated above York Street, local users would be subject to a significant visual intrusion associated with the flyovers and associated structures (i.e. bridge piers). As the strategic links would pass under York Street with Option C, no visual intrusion would occur and thus the impact upon amenity in this regard would be beneficial. As Links A, B & D would be elevated above York Street with Option D, the visual intrusion and associated amenity impacts would be major.

Link F (York Street to M2)

The community severance and amenity impacts discussed above for Link E would be similar to those experienced on Link F, though specifically with regards to the connection to M2, there would be a variation between options.

From York Street (south) Options A, B & C would provide direct, unhindered access to the M2 from York Street, however with Option D, road users would still have to give way to strategic traffic from Westlink to M3, via a signal controlled priority junction.

From York Street (north), the connection to M2 would be maintained with all options and a turning circle provided for non-motorway traffic.

Link G (Westlink to York Street)

Although modification and partial realignment would be required to the existing junction arrangement, all options would maintain the connection from Westlink to York Street.

Link H (Nelson Street to Westlink)

With all options, Nelson Street would only provide connection to the M3, thus severing the existing link to Westlink (for strategic traffic) and to Great George's Street/North Queen Street (for local traffic). With all options, Nelson Street traffic (from North Belfast and the Docklands) would instead use Corporation Street/Dunbar Link/York Street, or alternatively Brougham Street/North Queen Street when accessing the Westlink. The latter would be the more likely route for Docklands traffic and either route for North Belfast traffic. Nevertheless, this would increase traffic loading on the wider local road network, increasing severance and reducing amenity, though the impacts are likely to be similar with all options.

Link I (Dock Street to M3)

As noted above, Nelson Street would provide dedicated access from Dock Street to the M3 with all options. With the cessation of access to Westlink from this road, and the stopping-up of the existing M2 to Nelson Street junction, the volume of traffic using this road would be significantly reduced, reducing severance and improving amenity over existing conditions, though the impacts are likely to be similar with all options.

Link J (M3 to York Street)

With regards to local and strategic vehicle movements from the M3 to York Street, Option A would be least preferred, as traffic would still encounter signal controlled priority junctions on Nelson Street and York Street. With all other options, this would be reduced to only one junction at York Street, reducing severance and improving amenity.

6.8.5.1.2 ***Community Facilities***

Direct impact upon community facilities with any of the options under consideration would be minimal. As discussed above, the main impact would be changes in accessibility and associated severance and amenity impacts with modification to the existing road network. Apart from the restriction in access from Nelson Street to the wider road network, with any of the options, accessibility to community facilities and existing severance is likely to be improved. However there would be variation in amenity impacts (i.e. relative pleasantness of journey taken) with elevated links versus depressed links. Nevertheless, one community facility (Northside Park & Ride) would be lost to accommodate the proposed scheme with all scheme options.

There would be varying degrees of direct impact upon Northside Park & Ride. Option C would likely result in the complete loss of this facility to accommodate depressed links between the M2/M3 and Westlink, however Option D would only require a small degree of land loss to accommodate bridge piers associated with Link A. As noted earlier, the purpose of the facility is to provide Flexibus connection to the City Centre, to reduce congestion and offer a more sustainable mode of transportation. As such, it requires good connection to the city road network to make it attractive to road users. In essence, for those options where this facility could remain, the proposed access would be so convoluted that it is unlikely to remain viable at this location, even if direct impact is minimal. Where land loss is minimal (i.e. Option D), the Park & Ride facility would remain viable as a surface level car park only.

The Strategic Review of Park & Ride (published by DRD - Transportation Policy Division, March 2011), has in fact stated that the Northside Park & Ride site would cease to operate as a Park & Ride facility in the long term; it may, more appropriately, operate as a short-stay provision, notwithstanding the BMTP proposals on parking provision, and it would be subject to the implementation of Park & Ride facilities at Sandyknowes and Templepatrick.

6.8.5.1.3 ***Public Transport***

Public Rail Network

Existing rail infrastructure and provision of services would not be directly affected by any of the options under consideration. There would also be no change in terms of accessibility to Yorkgate Station.

The scheme option designs also take cognisance of the potential for improvements to Dargan Bridge (i.e. expanding to twin tracks) and the feasibility of providing a new station at Gamble Street. Hence, there would be no direct impact upon these proposals with any of the options under consideration.

Public Bus Network

Outbound Metro Service 2 (along York Street) would benefit significantly from grade-separation of strategic links between the Westlink and M2/M3 Motorways, due to the reduction in strategic traffic interaction. Connectivity would not be directly affected, as no stop-on-request bus stops serviced by this route would be lost. The route taken by the inbound service would be subject to change due to the severance of the Nelson Street connection to Great George's Street, though this impact would be common to all options. The existing stop-on-request bus stops along this road would also be lost. By way of access to the City Centre, this service would instead follow a route be via Corporation Street, which is unlikely to have any bearing on future service provision.

Outbound Metro Services 13 & 14 (between the City Centre and Newtownabbey / Glenville / Hydepark) would also equally benefit from the changes to York Street (as discussed above). In terms of connection to the M2 however, Options A, B & C would provide direct, unhindered access from York Street. With Option D, the service would still have to give way to strategic traffic from Westlink to M3, via a signal controlled priority junction. The inbound route would also be affected by the changes to Nelson Street, and again the alternative route to the City would be via Corporation Street, which is unlikely to have any bearing on future service provision.

There would be no modification to the outbound and inbound route taken by Metro Service 61 (via Dunbar Link, Corporation Street, Dock Street and Brougham Street) with implementation of any of the options. Metro Service 64 in both directions would however be affected, in the same manner as that described above for Metro Service 2.

Metro Service 96 would also benefit from the changes made to York Street on the outbound route, and the inbound route would be subject to change with the stopping-up of Nelson Street to through movements onto Great George's Street. Options B & D however would also result in a change to the outbound route, north of Dock Street (through the loss of the outbound bus lane on Nelson Street). Inbound service would be unaffected as the citybound bus lane on Nelson Street would be retained. In order to accommodate continuation of service, Garmoyle Street and Whitla Street would be modified to allow two-way running and connection to the outbound bus lane on Duncrue Street.

With regards to Ulsterbus and Express Goldline services, as the majority of outbound services utilise York Street or Westlink when accessing the M2, grade-separation of the strategic links would also be of great benefit to efficacy of services. On the inbound route, these services would also be affected by the changes to Nelson Street, and again the alternative route to the

City would be via Corporation Street, which is unlikely to have any bearing on future service provision.

As noted above, it is likely that Northside Park & Ride facility would cease operation in this locality, irrespective of option choice (though would not cease operation in the absence of the proposed scheme).

6.8.5.1.4 ***Pedestrian Facilities***

With regards to impact upon pedestrian facilities and the continuation of movements, the grade-separation of the strategic links between the Westlink and M2/M3 Motorways would be of great benefit, particularly along York Street where the highest movements have been recorded. Options B & C would provide the greatest benefit as all strategic links across York Street would be grade-separated. Whilst there would still be two controlled crossings for pedestrians to negotiate on the western side of York Street, these would be interacting with significantly reduced traffic volumes, reducing existing severance and waiting times. With Options A & D, movements along York Street would be less prioritised with continued at-grade junctions with Link D (Option A) and Link C (Option D), thus waiting times at controlled pedestrian crossings are likely to be longer (though less than under existing conditions).

With regards to amenity (i.e. the relative pleasantness of a journey), there would be distinct variations between options. As noted above, Options B & C would provide full grade-separation of strategic links, however in the case of Option B, this would result in negative amenity impacts. As Links A & D with this option would be elevated above York Street, local users would experience a significant visual intrusion associated with the flyovers and its structures (i.e. bridge piers). As the strategic links would pass under York Street with Option C, no visual intrusion would occur and thus the impact upon amenity in this regard would be beneficial. As Links A, B & D would be elevated above York Street with Option D, the visual intrusion and associated amenity impacts would be **Major**. The impact upon amenity for pedestrians would be much more significant and adverse than for other users, as they would dwell in the area for longer, thus would have the greatest exposure to the effects associated with overhead structures.

There is unlikely to any major need to provide footway along Nelson Street as a result of stopping-up the connection with Great George's Street. Whilst this impact is common to all options, it is unlikely to be significant considering the comparatively low pedestrian usage of footways adjacent to this road.

There would be no direct impact upon footway provision on Corporation Street, though the stopping-up of the connection of Nelson Street with Great George's Street would increase the volume of traffic using Corporation Street. Hence, there would be a perceived reduction in amenity through increases in proximal traffic. This would also result in amenity impacts on the Community Greenways, which are aligned along this corridor. It must also be noted that all four options would have a largely similar effect on the Community Greenways, and thus there is no preferred option from this perspective.

6.8.5.1.5 ***Cyclist Facilities***

NCN Route 93 would not be directly affected by any of the options, though there may be amenity impacts associated with the change in adjacent road layout at Garmoyle Street and Whitla Street, which would be modified to allow two-way running. Although this route is aligned close to Corporation Street, the redistribution of traffic onto this road (as a result of the stopping-up of through movements from Nelson Street to Great George's Street) is unlikely to directly affect NCN Route 93 users.

Local road users (particularly on York Street) would benefit greatly from grade-separation of the strategic links between the Westlink and M2/M3 Motorways and in terms of amenity, benefits would be greatest with depressed links (i.e. Option C and to a lesser extent Option A).

6.8.5.1.6 ***Equestrian Facilities***

As no equestrian facilities are located within the study area, none would be affected by any of the options.

6.8.5.2 *Construction*

The construction phase of the proposed scheme may result in three types of impact:

- Temporary impacts on local vehicle movements in the vicinity of York Street junction, as a result of construction activity.
- Temporary impacts upon community facilities and local businesses with regards to accessibility.
- Temporary impacts on the public bus network.
- Temporary severance or disruption to routes used by pedestrians and cyclists.

These impacts would typically be common to all options. Each option would cause disruption to traffic movements during the construction period, particularly movements between the M2/M3 and A12 Westlink. Traffic diversions and delays, particularly on routes around York Street itself, would have implications on driver stress and travel costs due to possible temporary closures, diversions and increased journey times. Diversions from York Street into the adjacent road network may increase pollution within surrounding residential areas. Even with mitigation measures, disruption to traffic movements through the York Street junction on a daily basis would have a ‘knock-on’ effect throughout the wider urban network as traffic may divert away from the area. This may cause traffic flows to slow and build up in other areas around the city, particularly around Antrim Road, North Queen Street and York Road. The off/on slips at Clifton Street are expected to close for a period during construction. Diversions in and around residential areas close to York Street would cause a degree of transient community severance. All options would require night closures at some stage during construction.

Other impacts upon local vehicle movements during the construction phase may result from increases in heavy goods/machinery traffic and temporary traffic management arrangements on the existing road network.

On the public rail network, possessions of the Dargan Bridge would be required for the construction of Options B & D. Such possessions would have to be carefully programmed through consultation with Translink to minimise delays to rail passengers.

Bus services through the York Street area would be disrupted during construction, to a similar extent as other travellers, with associated diversions and traffic management arrangements. Bus stops may be temporarily relocated during the construction phase.

The Park & Ride at Northside is unlikely to remain open during construction of the junction.

Throughout the construction period, disruption to cyclist and pedestrian movements would largely be restricted to urban roads affected by each option, such as York Street. This would include temporary impacts caused by the generation of noise, mud and dust, and the reduced amenity and visual impacts associated with major roadworks.

6.8.6 ***Mitigation and Enhancement Measures***

6.8.6.1 *Operation*

At the more detailed design stage, consideration would be given to refining the road layout further to enhance and improve movements. Consideration would be given to reinstating two-way movements along York Street, provision of bus and cycling lanes, alternative Park & Ride location and dedicated pedestrian crossing facilities, all of which would have the potential to further reduce community severance and improve amenity.

6.8.6.2 *Construction*

During the construction phase road safety would be the major concern, although an increase in traffic would also cause a reduction in amenity for non-vehicular road users. All road users would have to exercise greater care than usual to minimise the risk of collisions. The construction contract would include measures to restrict construction traffic to designated local roads. Temporary warning signs would be erected as necessary to highlight particular hazards, including site accesses and temporary traffic management measures. Traffic management would be in operation to facilitate safe passage for pedestrians and others, including barriers defining the footpaths and safety zones to prevent construction vehicles encroaching on pedestrian areas. Where appropriate, segregated pedestrian routes would be provided. Traffic management would be closely monitored on site and every effort would be made to ensure the safety of pedestrians and cyclists is maintained.

Careful attention to traffic management would minimise the overall level of disruption. The construction contract would require the contractor to ensure delays to local and strategic traffic are kept to a minimum and full use is made of the available carriageway space. Mitigation measures may include:

- Advanced publicity outlining the traffic management proposals and duration, and giving advance warning of specific traffic management measures
- Reducing lane widths
- Efficient phasing of contra-flow operations
- Adequate advance signing of the works.

These measures, designed to reduce delays to strategic traffic, would reduce traffic ‘rat-running’ on the local road network.

During construction, all temporary road layouts shall comply with the standards outlined in the DMRB Volume 8, Section 4, and Chapter 8 of the Traffic Signs Manual. Carriageway crossovers and temporary chicanes necessary to complete junctions and tie-ins to the existing road network shall be designed in accordance with TD9/93 (Highway Link Design).

6.8.7 ***Residual Impacts***

As noted earlier, it is not sufficient to assess the size and probability of potential impacts; their significance should also be assessed. The level of significance is to be assigned after consideration of any proposed mitigation (i.e. significance is assigned with mitigation in place allowing for the positive contribution of all mitigation that is proposed). It is therefore the residual impacts associated with the proposed scheme that are most reflective of what the overall predicted impact would be.

6.8.7.1 *Significance of Potential Effects*

6.8.7.1.1 ***Local Vehicle Movements (Proposed Road Network)***

The significance of effect of partially grade-separating (i.e. Options A & D) strategic links between the A12 Westlink and M2/M3 motorways would be **Moderate Beneficial** for local and strategic movements through York Street. The significance of effect of fully grade-separating (i.e. Options B & C) strategic links between the A12 Westlink and M2/M3 motorways would be Large Beneficial.

With regards to the effect of changing community severance and amenity, elevated options (i.e. Options B & D) would reduce severance with the reduction in strategic traffic interaction, leading to freer flowing conditions; however would negatively affect amenity due to the visual intrusion of overhead structures. Hence, the significance of effect would be **Moderate Beneficial** in this regard (as freer movements for local traffic are likely to be of greater benefit than visual amenity). In the case of the depressed options however (i.e. Options A & C), amenity would also be significantly improved as there would be no visual intrusion, with links passing under York Street. Hence, the significance of effect would be **Large** to **Very Large Beneficial** in this regard (as both freer movements and improvements in visual amenity would be achieved).

The loss of through movements onto Great George's Street from Nelson Street would be **Moderate Adverse** in terms of significance of effect, though this is common to all options. Even though a heavily trafficked and important route to the city centre would be lost, the close proximity of a viable alternative route (Corporation Street) and minimal increase in distance travelled to complete similar journeys, means the effect is therefore not considered more adverse. The significance of effect on Corporation Street would be considered **Slight Adverse**, due to increased traffic loading on this road, though again this effect is largely common to all options.

6.8.7.1.2 ***Community Facilities***

The significance of effect of relocating Northside Park & Ride, is likely to be **Moderate Beneficial** as the Strategic Review of Park & Ride (published by DRD - Transportation Policy Division, March 2011), stated that the Northside Park & Ride site would cease to operate as a Park & Ride facility in the long term. It may, more appropriately, operate as a short-stay provision and it would be subject to implementation of Park & Ride facilities at Sandyknowes and Templepatrick. A new location (i.e. further from the City Centre) may in fact be of greater benefit to the community and encourage more sustainable modes of transportation.

6.8.7.1.3 ***Public Transport***

Public Rail Network

The significance of effect on rail infrastructure, provision of services, connectivity and future proposals would be **Neutral** with all options.

Public Bus Network

As is the case with local movements, the effect of partially grade-separating (i.e. Options A & D) strategic links between the A12 Westlink and M2/M3 motorways would be **Moderate Beneficial** for bus services through York Street. The significance of effect of fully grade-separating (i.e. Options B & C) strategic links between the A12 Westlink and M2/M3 motorways would be **Large Beneficial.**

The loss of through movements onto Great George's Street from Nelson Street would be **Slight Adverse** to **Neutral** in terms of significance of effect with all options, as Corporation Street would be a viable alternative for bus services. The significance of effect on Corporation Street would be **Large Beneficial,** due to the increased connectivity to services as a result of the closure of Nelson Street to through movements.

6.8.7.1.4 ***Pedestrian Facilities***

The effect upon pedestrian facilities and the continuation of movements with grade-separation of the strategic links between the Westlink and M2/M3 motorways would be **Large Beneficial**, particularly along York Street where the highest movements have been recorded. Options B & C would provide the greatest benefit as all strategic links across York Street would be grade-separated.

With regards to amenity (i.e. the relative pleasantness of a journey), the significance of effect with elevated options (i.e. Options B & D) would be **Large Adverse** due to the visual intrusion associated with the flyovers and its structures (i.e. bridge piers) and the associated affects these would have on the surrounding environment. As pedestrians would be in the area for the longest period of time of any user, they would be much more susceptible to the adverse effects of such structures (i.e. reduced lighting, sightlines, perceived threats etc). In the case of the depressed options however (i.e. Options A & C), amenity would be significantly improved as there would be reduced visual intrusion, with links passing under York Street. As such, the significance of effect would be **Large Beneficial** in this regard (as both freer movements and improvements in visual amenity would be achieved).

As recorded movements on Nelson Street are minimal, the significance of effect associated with the loss of footway with all options would be **Slight Adverse**. The significance of effect on Corporation Street would be considered **Slight Adverse,** due to increased traffic loading on this road, though again this effect is largely common to all options.

6.8.7.1.5 ***Cyclist Facilities***

The significance of effect upon existing cycling facilities would be largely **Neutral.** The effect upon cyclist movements would however vary throughout the study area. Movements along York Street, with grade-separation of the strategic links between the Westlink and M2/M3 motorways would be **Large Beneficial**, with Options B & C providing the greatest benefit as all strategic links across York Street would be grade-separated.

With regards to amenity (i.e. the relative pleasantness of a journey), the significance of effect with elevated options (i.e. Options B & D) would be **Moderate Adverse** due to the visual intrusion associated with the flyovers and its structures (i.e. bridge piers) and the associated affects these would have on the surrounding environment. In the case of the depressed options however (i.e. Options A & C), amenity would be significantly improved as there would be reduced visual intrusion, with links passing under York Street. As such, the significance of effect would be **Moderate Beneficial** in this regard (as both freer movements and improvements in visual amenity would be achieved).

As recorded movements on Nelson Street are minimal, the significance of effect associated with all options would be **Slight Adverse**.

The significance of effect on Corporation Street would be considered **Slight Adverse**, due to increased traffic loading on this road, particularly as the highest cyclist movements have been recorded in this area, though again this effect is largely common to all options.

6.8.7.1.6 ***Equestrian Facilities***

The significance of effect upon equestrian facilities would be **Neutral.**

6.8.8 ***Summary and Conclusions***

- No community facilities of value to local users would be lost to any of the options.
- In terms of strategic and local vehicle movements, the preferred options would be B or C as the grade-separation of links is maximised, thus minimising local/strategic traffic interaction. The impact upon the wider city road network through traffic redistribution and physical alteration would also be minimised. In this regard Option C, would be preferred over Option B.
- As NMU movements are predominantly along the York Street arterial route, minimising strategic traffic interaction would be preferred (i.e. Options B or C), however Option B would negatively impact amenity, due to the presence of the overhead structures.
- With regards to impacts upon public transport and efficacy of services, full grade-separation would be preferred (i.e. Options B & C) over partial grade-separation, as it would facilitate easier bus movements.

6.9 Vehicle Travellers

6.9.1 ***Introduction***

This section of the environmental assessment reviews the impact of each interchange option on vehicle travellers in a two-fold manner. Firstly, the section addresses the views that vehicle travellers would have from the road as they travel along; secondly it addresses the predicted increase or decrease in driver stress levels on the road network, as a result of the proposed scheme.

The objective at this secondary stage is to undertake sufficient assessment, identifying variations in views from the road, urban landscape character and quality for vehicle travellers when selecting a preferred option. The objective is also to identify differences in interchange design characteristics, traffic flows and any other differences which would contribute to variations in driver stress levels between options.

6.9.1.1 *Views from the Road*

'Views from the road' is defined as the extent to which travellers, including drivers, are exposed to the different types of scenery. In accordance with the requirements of DMRB Volume 11, Section 3, Part 9, Chapter 2 (Stages in the Assessment of Impacts on Vehicle Travellers), aspects that are considered in the definition of 'Views from the road' are:

- types of scenery or the urban landscape character;
- extent to which travellers may be able to view the scene
- quality of the urban landscape, as assessed for baseline studies
- features of particular interest or prominence in the view.

6.9.1.2 *Driver Stress*

Driver stress is defined for the purposes of assessment as the adverse mental and psychological effects experienced by a driver travelling on the road network. Available research suggests that a finely graded assessment of driver stress is not justified. As a result, levels of driver stress attributable to different sections of road are classed as '**High**, **Moderate** or **Low'**, in accordance with guidance given in DMRB. Driver stress is caused by a number of factors which can result in discomfort, annoyance, frustration or fear, culminating in physical and emotional tension that detracts from the value and safety of a journey. These factors include road layout and geometry, junction frequency and flows and speeds per lane.

Frustration is caused by the driver's inability to drive at their desired speed in comparison to the standard of road. The primary causes of these conditions are congestion (heavy traffic levels such as at rush hour), road works causing delays, poor road standards, diversions and intersections. The quality of an intersection will affect the driver's stress levels. A poor intersection with, for example, bad visibility is more likely to increase driver stress levels.

Fear is caused by a driver's lack of control in their surroundings. For example, the presence of other drivers, inadequate sightline distances and the potential for pedestrians (particularly children) to step onto the road, all serve to increase driver stress levels. Bad weather, poor geometry, inadequate road surfacing and a high proportion of heavy goods vehicles on the road all contribute to increasing stress levels. Poor road lighting, road works and inadequate road signs for the driver's purposes increase the potential for confusion and increase levels of fear. Route uncertainty is caused primarily by inadequate signage.

6.9.2 *Methodology*

6.9.2.1 *Views from the Road*

The assessment of 'Views from the road' is based on the requirements of DMRB Volume 11, Section 3, Part 9, Chapters 2 & 5. The interchange arrangement would be set within an urban landscape, the extent to which travellers perceive this landscape varies with the relative level of the road, surrounding ground, and adjacent structures/built form. Therefore the assessment also notes where views are restricted, making allowance for the cumulative effect of these features on the view from the road.

There are four categories, which are used in assessing traveller's ability to see the surrounding urban landscape:

1. **No View** – road in deep cutting or contained by earth bunds, environmental barriers or adjacent structures.
2. **Restricted View** – frequent cuttings or structures blocking the view.
3. **Intermittent View** – road generally at ground level but with shallow cuttings or barriers at intervals.
4. **Open View** – view extending over many miles, or only restricted by existing urban landscape features.

6.9.2.2 *Driver Stress*

An assessment is made of the scheme options, taking into account the impact on driver stress through design characteristics (i.e. junction layouts and respective forecasted traffic and speed variations). Driver stress on the existing road network and with the various scheme options has been evaluated in accordance with the method outlined in DMRB Volume 11, Section 3, Part 9, Chapter 4 (Assessing Driver Stress). This is based on estimating average peak hourly flow (in flow units) per lane, and average journey speed for the route at that time. For comparison purposes, a car or light van is equal to 1 flow unit, and a commercial vehicle over 1½ tons unladen weight, or a public service vehicle, equals 3 flow units. **Tables 6.9.1 - 6.9.3** below provide a guide to driver stress levels for different levels of flow and speed on motorway, dual and single carriageway roads used in this assessment.

TABLE 6.9.1: PREDICTED STRESS LEVELS FOR MOTORWAYS

Average peak hourly flow per lane (flow Units/1 hour)	Average Journey Speed (km/hr)		
	Under 75	**75-95**	**Over 95**
Under 1200	High	Moderate	Low
1200 – 1600	High	Moderate	Moderate
Over 1600	High	High	High

Source: DMRB 11.3.9.4, pp 4/2, Table 1

TABLE 6.9.2 PREDICTED STRESS LEVELS FOR DUAL CARRIAGEWAY ROADS

Average peak hourly flow per lane (flow Units/1 hour)	Average Journey Speed (km/hr)		
	Under 60	**60 – 80**	**Over 80**
Under 1200	High *	Moderate	Low
1200 – 1600	High	Moderate	Moderate
Over 1600	High	High	High

* Moderate in urban areas (Source: DMRB 11.3.9.4, pp 4/2, Table 2)

TABLE 6.9.3 PREDICTED STRESS LEVELS FOR SINGLE CARRIAGEWAY ROADS

Average peak hourly flow per lane (flow Units/1 hour)	Average Journey Speed (km/hr)		
	Under 50	**50 – 70**	**Over 70**
Under 600	High *	Moderate	Low
600-800	High	Moderate	Moderate
Over 800	High	High	High

* Moderate in urban areas (Source: DMRB 11.3.9.4, pp 4/2, Table 3)

In accordance with DMRB requirements, the assessment has been made for the worst year (2034) in the first fifteen after the assumed ‘Opening Year’ (2020) for both the ‘Do-Minimum’ and ‘Do-Something’ scenarios. An assessment of the Base Year (2010) has also been made to give an indication of driver stress levels under existing conditions.

Traffic data for the driver stress assessment has been extracted from COBA Models prepared as part of the Traffic & Economic Assessment for the scheme.

6.9.3 *Regulatory/Policy Framework*

There is no legislation or local planning policy considered pertinent to the assessment of Views from the road or Driver Stress. The assessment has therefore been undertaken entirely in accordance with the guidance described within DMRB 11.3.9.

6.9.4 *Baseline Conditions*

6.9.4.1 *Views from the Road*

Views from roads within the existing junction arrangement vary from constrained and enclosed views at ground level, to more open views towards the Belfast Hills and Harbour Area when travelling along the elevated M3 Lagan Bridge. At ground level, views are generally constrained and enclosed by overhead structures, bridge piers and surrounding hoardings/panels and built development. When travelling along the M3, the vehicle traveller experiences elevated views of the Belfast Hills, distant views of church spires and the western docklands.

As noted earlier in **Section 6.5** (Landscape Effects), the urban landscape is deemed to be of poor quality. The contributory factors are mixed land uses, variation in scale and architectural style of buildings, Lagan and Dargan Bridges, and the large amount of surrounding derelict/vacant land. The poor landscape quality therefore results in poor existing views (other than those from the elevated M3) providing limited overall benefit to the vehicle traveller. The existing views experienced are therefore of a complex urban landscape, dominated by the junction, associated road links, and their relationship to adjacent buildings.

6.9.4.2 *Driver Stress (Existing Road Network)*

The existing junction arrangement at York Street accommodates the convergence of three strategic routes (M2, M3 and A12 Westlink), whilst also facilitating the through movement of local traffic. Hence, there are many factors which contribute to 'heightened' levels of driver stress, particularly during peak hour periods.

Within the existing junction arrangement, there are ten key links which, based on road layout, forecasted traffic volume and variations in speed, have been assessed for levels of driver stress currently experienced. **Table 6.9.4** below, contains these estimated driver stress levels for the existing road network in the Base Year (2010).

TABLE 6.9.4: EXISTING ROAD NETWORK (BASE YEAR 2010)

Links	Hourly Flow Category (vph)	Speed Category (km/h)	Driver Stress Level
Link A (M2 to Westlink):			
M2	1200-1600	<75	High
Nelson Street off-slip	<1200	<75	High
Nelson Street – York Street	<1200	<60	Moderate
Westlink	1200-1600	<60	High
Westlink	>1600	<60	High
Link B (Westlink to M2):			
Westlink	1200-1600	<60	High
Westlink - M2 on-slip	<1200	<60	Moderate
M2 on-slip	<1200	<75	High
M2	1200-1600	<75	High

TABLE 6.9.4: EXISTING ROAD NETWORK (BASE YEAR 2010)

Links	Hourly Flow Category (vph)	Speed Category (km/h)	Driver Stress Level
Link C (Westlink to M3):			
Westlink	1200-1600	<60	High
Westlink - York Link	<1200	<60	Moderate
M3 on-slip	<1200	<75	High
M3	1200-1600	<75	High
Link D (M3 to Westlink):			
M3	1200-1600	<75	High
M3 off-slip	<1200	<75	High
Nelson Street -York Street (via Great George's Street)	<1200	<60	Moderate
Westlink	1200-1600	<60	High
Westlink	>1600	<60	High
Link E (York Street South to York Street North):			
Frederick Street/Great Patrick Street Junction - Dock Street/Brougham Street Junction	<1200	<60	Moderate
Link F (York Street South to M2):			
Frederick Street/Great Patrick Street Junction - M2 on-slip	<1200	<60	Moderate
M2	<1200	<75	High
M2	1200-1600	<75	High
Link G (Westlink to York Street):			
Westlink	1200-1600	<60	High
Westlink - Dock Street/Brougham Street Junction	<1200	<60	Moderate
Link H (Corporation Street to Westlink):			
Garmoyle Street – York Street (via Dunbar Link)	<1200	<60	Moderate
York Street to Westlink	<600	<50	Moderate
Westlink	1200-1600	<60	High
Westlink	>1600	<60	High
Link I (Dock Street to M3):			
Dock Street – M3 on-slip	<1200	<60	Moderate
M3 on-slip	<1200	<75	High
M3	1200-1600	<75	High
Link J (M3 to York Street):			
M3	1200-1600	<75	High
Great George's Street off-slip	<1200	<75	High

TABLE 6.9.4: EXISTING ROAD NETWORK (BASE YEAR 2010)			
Links	**Hourly Flow Category (vph)**	**Speed Category (km/h)**	**Driver Stress Level**
Great George's Street - York Street	<1200	<60	Moderate

As the current junction arrangement at York Street accommodates the convergence of the above strategic routes, whilst also facilitating the through movement of local traffic, there are many factors which currently contribute to heightened driver stress, most notably during peak hour periods. With reference to **Table 6.9.4**, it is predicted that 'High' stress levels would be predominantly experienced on the strategic road network (i.e. M2, M3 & A12 Westlink), and on the local city road network estimated levels of stress would be predominantly 'Moderate'.

The 'High' levels of stress predicted on the strategic road network can be largely attributed to low speeds achieved due to high volumes of traffic moving between the M2/M3/A12 through an at-grade signalised gyratory system. Existing capacity issues also contribute towards heightened stress levels.

Stress levels on the signalised gyratory system itself are considered 'Moderate', as the capacity (i.e. lane numbers) is higher and movements more controlled through the signalised system. This however does lead to driver frustration, due to the inability to achieve desired speeds. As such, road users currently experience delays and congestion at peak periods travelling through this arrangement. Even at off-peak times, drivers still experience heightened stress levels due to the signalised junctions, the number of which negotiated depending upon route choice and road layout. In this regard, stress levels are also influenced by route choice depending on time of day. Even though traffic build up is an issue on most routes into the junction during peak periods, it is particularly severe on the M2 (southbound) during the morning peak period, and the Westlink (northbound) during the evening peak hour period.

The complexity of the current junction layout also contributes significantly to heightened driver stress levels. The movement of traffic between the M2, M3 and Westlink combined with local through movements, results in high driver stress through the number and timing of decisions and manoeuvres required. In this regard, stress levels are exacerbated further by traffic speed and frequency of manoeuvres, such as weaving over relatively short distances.

Although there are aspects of the current junction arrangement which reduce the levels of fear experienced, particularly as a consequence of low speeds due to the signalised junctions and heavy congestion, the presence of other vehicles (especially HDVs) and the potential for pedestrians (particularly children) to step onto the road, all contribute to heightened stress levels in the vicinity of the junction. York Street is a main pedestrian thoroughfare, connecting the City Centre to North Belfast, with dedicated pedestrian crossing points at the Westlink/York Street junctions. As mentioned in **Section 6.8**, pedestrian movements are significant along this part of the junction, and although controlled by signalised junctions, the risk of pedestrians stepping onto the road out of turn contributes to heightened levels of fear.

In terms of route uncertainty, the existing junction arrangement again contributes to heightened driver stress levels, particularly as a consequence of the wide-ranging route choices available when approaching it. This is a significant issue for the unfamiliar driver, uncertain of the manoeuvres required to attain the route/correct lane to their destination.

With the recent upgrading of Westlink, York Street junction has become the last major bottleneck between the M1 and M2 and therefore perceived levels of driver stress at this particular junction would only get higher with expected traffic growth. Drivers are no longer severely delayed at junctions, such as Broadway or Grosvenor Road, and thus are quickly delivered to the signalised York Street junction.

On the local city road network away from the signalised gyratory junction arrangement (i.e. York Street, Corporation Street, Dock Street, Dunbar Link), the stress levels are more reflective of typical city centre roads. Levels experienced are predicted to be 'Moderate' as whilst speeds are typically lower, road capacity is generally sufficient to accommodate local traffic movements.

6.9.5 ***Predicted Impacts***

6.9.5.1 *Operation*

6.9.5.1.1 ***Views from the Road***

Table 6.9.5 below contains the assessment of vehicle traveller's ability to see the surrounding urban landscape from each of the links associated with Options A to D.

TABLE 6.9.5: VIEW OF THE SURROUNDING URBAN LANDSCAPE

Link	Option A	Option B	Option C	Option D
Link A (M2 – Westlink)	RV	OV	RV	OV
Link B (Westlink - M2)	RV	RV	RV	OV
Link C (Westlink - M3)	RV	RV	RV	RV
Link D (M3 – Westlink)	IV	OV	RV	OV
Link E (York Street South - York Street North)	IV	RV	IV	RV
Link F (York Street South - M2)	IV	RV	IV	RV
Link G (Westlink – York Street)	RV	RV	RV	RV
Link H (Corporation Street – Westlink)	IV	RV	IV	RV
Link I (Dock Street - M3)	IV	RV	IV	RV
Link J (M3 – York Street)	IV	RV	IV	RV

As detailed in **Sub-section 6.9.2** (Methodology), there are four categories used in the assessment of vehicle traveller's ability to see the surrounding landscape. These are abbreviated in the above table and are as follows:

NV = No View; **RV** = Restricted View; **IV** = Intermittent View; and **OV** = Open View.

With reference to **Table 6.9.5**, there is a distinct variation in the views that would be achieved from the strategic and local city road network when considering the impact associated with elevated and depressed options.

With regards to the strategic road network, all links associated with Options A & C would be largely at or depressed below ground level. As would be expected, views from these links would be predominantly **Restricted** and/or **Intermittent**. As Option B contains a combination of depressed and elevated links, this would result in a variation in the views achieved, from **Open** (i.e. Links A & D) to **Restricted** (i.e. Links B & C). With Option D, three out of four strategic links would be elevated and thus more **Open** views would be achieved. The views that would be experienced on Links A & D would be beneficial, as they would provide extensive views across North & West Belfast to the Belfast Hills and towards the Harbour Area.

It must be noted that whilst the M2/M3 Lagan Bridge would not be subject to physical modification, this does not suggest that views from the road would not change. Depressed options (i.e. Options A & C) would result in **No Change** in openness of view achieved, whereas elevated options (i.e. Option B & D) would result in **Intermittent** views on the M3/M2 Lagan Bridge at the crossover point.

On the local city road network, all options would result in modification in views achieved; however these would be less adverse with depressed links, as these would pass under the local road network rather than over it. With the elevated links, the presence of new overhead structures and associated bridge piers would result in a radical alteration in views for the local vehicle traveller.

6.9.5.1.2 ***Driver Stress (Proposed Road Network)***

The objective of the assessment is to predict future driver stress levels for the 'Design Year' (2034), which as noted above (in terms of traffic conditions) is estimated to be the worst year in the first fifteen after the assumed 'Opening Year'. Projected flows for the 'Do-Minimum' and 'Do-Something' scenarios in 2034 have been produced, using National Road Traffic Forecast (NRTF) Central Growth Rates within the traffic model. The results of this assessment are summarised in **Tables 6.9.6 & 6.9.7** below.

TABLE 6.9.6: DO MINIMUM ROAD NETWORK (DESIGN YEAR 2034)

Links	Hourly Flow Category (vph)	Speed Category (km/h)	Driver Stress Level
Link A (M2 to Westlink):			
M2	>1600	<75	High
Nelson Street off-slip	1200-1600	<75	High
Nelson Street - York Street	<1200	<60	Moderate
Westlink	>1600	<60	High
Link B (Westlink to M2):			
Westlink	>1600	<60	High
Westlink - York Street	<1200	<60	Moderate
York Street - M2 on-slip	1200-1600	<60	High
M2 on-slip	1200-1600	<75	High
M2	>1600	<75	High
Link C (Westlink to M3):			
Westlink	>1600	<60	High
Westlink - Nelson Street	<1200	<60	Moderate
M3 on-slip	1200-1600	<75	High
M3	>1600	<75	High
Link D (M3 to Westlink):			

TABLE 6.9.6: DO MINIMUM ROAD NETWORK (DESIGN YEAR 2034)

Links	Hourly Flow Category (vph)	Speed Category (km/h)	Driver Stress Level
M3	>1600	<75	High
M3 off-slip	1200-1600	<75	High
M3 off-slip - Nelson Street	<1200	<75	High
Nelson Street - York Street (via Great George's Street)	<1200	<60	Moderate
Westlink	>1600	<60	High
Link E (York Street South to York Street North):			
Frederick Street/Great Patrick Street Junction - York Link	<1200	<60	Moderate
York Link	1200-1600	<60	High
York Link - Dock Street/Brougham Street Junction	<1200	<60	Moderate
Link F (York Street to M2):			
Frederick Street/Great Patrick Street Junction - York Link	<1200	<60	Moderate
York Link - M2 on-slip	1200-1600	<60	High
M2 on-slip	1200-1600	<75	High
M2	>1600	<75	High
Link G (Westlink to York Street):			
Westlink	>1600	<60	High
Westlink - Dock Street/Brougham Street Junction	<1200	<60	Moderate
Link H (Corporation Street to Westlink):			
Garmoyle Street – York Street (via Dunbar Link)	<1200	<60	Moderate
York Street to Westlink	<600	<50	Moderate
Westlink	>1600	<60	High
Link I (Dock Street to M3):			
Dock Street - M3 on-slip	<1200	<60	Moderate
M3 on-slip	1200-1600	<75	High
M3	>1600	<75	High
Link J (M3 to York Street):			
M3	>1600	<75	High
M3 off-slip	1200-1600	<75	High
M3 off-slip - Nelson Street	<1200	<75	High
Nelson Street - York Street (via Great George's Street)	<1200	<60	Moderate
York Street – York Link	1200-1600	<60	High
York Link - York Street (north)	<1200	<60	Moderate

With reference to **Tables 6.9.4 and 6.9.6,** as would be expected when comparing the 'Base Year (2010)' and Design Year (2034) 'Do-Minimum' driver stress scenarios, it is predicted that a larger proportion of the strategic and local city road network would experience higher levels of driver stress. Increases in driver stress would be primarily related to reducing capacity of the existing road network, as a result of anticipated growth in traffic volume over the next twenty years.

A primary objective of the proposed scheme is to remove the traffic bottleneck, which based on the information presented above, is set to worsen over time. The scheme would remove the bottleneck by addressing existing and arising capacity issues on as many of the key links as feasibly possible through improvements to the road network and reduction in the number of junctions (i.e. grade-separation). Therefore, it is expected that all options would result in a reduction in driver stress over 'Base Year (2010)' and Design Year (2034) 'Do-Minimum' scenarios. However, irrespective of option selection, the interchange would remain heavily trafficked and complex in its layout. As such, driver stress is likely to remain Moderate to High (as summarised in **Table 6.9.7** below, and detailed in **Appendix H** of this report). Even with the proposed improvements, it is expected that capacity on the road network would remain an issue in certain areas, contributing to continued heightened stress levels on parts of the proposed network.

TABLE 6.9.7: DO SOMETHING ROAD NETWORK (DESIGN YEAR 2034)

Link	Driver Stress			
	Option A	Option B	Option C	Option D
Link A (M2 – Westlink)	High	High	High	High*
Link B (Westlink - M2)	High	High	High	High*
Link C (Westlink - M3)	High	High	High	High*
Link D (M3 – Westlink)	High*	High	High	High
Link E (York Street South - York Street North)	Moderate	Moderate	Moderate	Moderate
Link F (York Street South - M2)	Moderate - High	Moderate - High	Moderate - High	Moderate - High
Link G (Westlink – York Street)	Moderate - High	Moderate - High	Moderate - High	Moderate - High
Link H (Corporation Street – Westlink)	Moderate - High	Moderate - High	Moderate - High	Moderate - High
Link I (Dock Street - M3)	Moderate - High	Moderate - High	Moderate - High	Moderate - High
Link J (M3 – York Street)	Moderate - High	Moderate - High	Moderate - High	Moderate - High

* Small length of link subject to Moderate levels of stress

With reference to **Table 6.9.7**, it is evident that the scheme options would have little effect on predicted stress levels expected on any of the key links throughout the study area. As is the case under the Existing and Do-Minimum scenarios, levels of stress would be 'High' on the strategic road network and generally 'Moderate' on the local city road network.

It is important to note however that all four scheme options would provide a form of stress containment through the grade-separation of the key strategic links; with links operating much more independently from each other. This would result in reduced driver stress for both the urban/local and strategic road users by removing the difficulties which arise from the existing mixing of these traffic flows. In this regard Options A and D would have the least potential to reduce driver stress, as they do not provide for full grade-separation of the strategic links. With Option A, M3 to Westlink (Link D) and with Option D, Westlink to M3 (Link C) would remain largely as existing, with York Street and Nelson Street junctions remaining at-grade, hindering the through flow of strategic traffic.

As noted above, due to the nature of the proposed scheme, there may be the possibility that reductions in driver stress due to reduced congestion and the partial/full separation of local and strategic traffic may be offset by the complexity of the proposed interchange. On approach to any of the options, route uncertainty may remain an issue, particularly for the vehicle traveller unfamiliar with the new road layout, although this should be minimised with appropriate advance directional signage on link approaches.

In general, the most desirable interchange layout would be an option which has the minimum number of decisions and manoeuvres, and where these decisions and manoeuvres do occur, they can be readily made with the least degree of turbulence and congestion. This essentially is a road geometry issue and has been considered in detail within **Sub-Section 5.11.1**. Road geometry issues which would contribute to variations in stress levels include:

- Weaving distances
- geometric effects
- gradient
- degree of curvature
- type and configuration of the merge and diverge
- the number of lanes on the mainline, on merges and on diverges
- visibility, including at night
- network consistency
- the proportion of HDVs.

In essence, in terms of road geometry, all options have substandard elements, due to constraints which would affect stress levels.

6.9.5.2 *Construction*

6.9.5.2.1 ***Views from the Road***

Construction of any of the options under consideration would result in a radical transient alteration in views from the road. The structures associated with this scheme would be the more visible operations as vehicle travellers pass through the area, as well as concentration of workers, construction machinery, associated materials and Temporary Traffic Management Measures. In terms of interest, it is likely that overhead structures would of greater visual interest during construction than depressed links.

6.9.5.2.2 ***Driver Stress***

During the construction phase, additional transient stress for strategic and local traffic would be unavoidable as a balance is required between maintaining the flow of traffic and safely/efficiently constructing the proposed scheme. As a result, driver stress would be expected to be ‘High’ throughout the entire road network for any of the options under consideration.

The works would require a number of temporary traffic management phases, even for regular users of the junction; these phases may bring additional associated stress as a result of uncertainty and fear caused by road works (narrow lanes, speed restrictions, signage, etc).

6.9.6 *Mitigation and Enhancement Measures*

6.9.6.1 *Views from the Road*

In terms of views from the road, mitigation measures should include:

- retention and enhancement of views from the road where appropriate
- there should be open parapets on overbridges to allow views from the road and to reduce the mass of the structure
- planting design should consider the conflict between retaining views from the road and screening the road to adjacent properties.

6.9.6.2 *Driver Stress*

As noted above, all options have substandard elements and no one option can address all capacity issues associated with the existing junction arrangement. However, upon selection of a preferred option, where feasible the scheme design will attempt to achieve consistent speeds, provide adequate sight distances, provide adequate signage and reduce interaction between local and strategic traffic, as well as between the vehicle and non-motorised user. All of these are forms of mitigation to reduce driver stress.

With any of the options, the negative impacts requiring mitigation would be primarily experienced during the construction phase. Adverse impacts on driver stress would be controlled by ensuring construction traffic uses routes identified in the Contract and adequate warning is provided to road users (through possibly the media and using signage) and this would help reduce driver stress by being aware of issues in good time, which would enable alternative planning of journeys if required.

Careful attention to traffic management would minimise the overall level of disruption. Mitigation measures may include:

- advanced publicity outlining the traffic management proposals and duration, and giving advance warning of specific Traffic Management Measures
- reduced lane widths
- efficient phasing of contra flow operations
- adequate advance signing of the works.

These measures, designed to reduce delays to strategic and local traffic, should reduce traffic rat-running on the local road network. During construction, all temporary road layouts shall comply with the standards outlined in Chapter 8 of the Traffic Signs Manual and the DMRB.

6.9.7 *Residual Impacts*

6.9.7.1 *Views from the Road*

Options B & D include elevated road links that would provide the most beneficial views from the road for vehicle travellers; as such the significance of effect would be **Slight Beneficial**. In contrast, Options A & C which include depressed link roads, would provide the most enclosed and potentially adverse views for vehicle travellers; as such the significance of effect would be **Slight Adverse**.

6.9.7.2 *Driver Stress*

In terms of impact upon Driver Stress with any of the options under the consideration, the significance of effect is likely to **Slight Beneficial** with full grade-separation likely to result in the greatest overall benefit (i.e. Options B & C) to vehicle travellers in terms of reduced stress levels.

6.9.8 *Summary and Conclusions*

6.9.8.1 *Views from the Road*

Option D and to a lesser extent Option B would be preferred in terms of views from the road, as the elevation of links would afford new expansive views of the urban landscape from the strategic road network. However from the local road network, Option D and to a lesser extent Option B, would be least preferred as elevated structures would restrict views.

6.9.8.2 *Driver Stress*

Based on the DMRB assessment of driver stress, there is very little difference between options. All options would include sub-standard elements and cannot fully address capacity issues associated with the existing junction arrangement. However it is expected that full grade-separation (i.e. Options B & C) would result in the greatest overall benefit to vehicle travellers in terms of reduced stress levels.

6.10 Road Drainage and the Water Environment

6.10.1 *Introduction*

The definition of a ‘waterbody or waterway’, as defined under The Water (Northern Ireland) Order 1999 (as amended), includes:

> *“any river, stream, watercourse, inland water (whether natural or artificial) or tidal waters and any channel or passage of whatever kind (whether natural or artificial) through which water flows but does not include-*
>
> *(a) the waters beyond 3 international nautical miles seaward from the baseline from which the breadth of the territorial sea adjacent to Northern Ireland is measured;*
>
> *(b) any public sewer or public sewage treatment works;*
>
> *(c) any main or service pipe within the meaning of the Water and Sewerage Services (Northern Ireland) Order 2006 which is vested in or under the control of a sewerage undertaker; and*
>
> *(d) any drain or road drain –*
>
> *i). constructed and laid by the Department for Regional Development under Article 45(1) of the Roads (Northern Ireland) Order 1993; or*
>
> *ii). Acquired by the Department for Regional Development under Article 45(6) of that Order.*

In this Order any reference to a waterway includes a reference to the channel or bed of a waterway which is for the time being dry".

Historically, roads have not been regarded as a major source of pollution and surface water runoff has been allowed to discharge, often rapidly, with no or minimal treatment. More recently, measures to control and treat runoff have been commonly included as part of road drainage designs where considered necessary. Pollution from road drainage can arise from a variety of sources, including accidents, general vehicle and road degradation, incomplete fuel combustion, small oil or fuel leaks and atmospheric deposition. Road runoff may also contain runoff from adjacent properties and brownfield sites in urban areas.

Roads are designed to drain freely to prevent build-up of standing water on the carriageway whilst avoiding exposure to or causing flooding. Contaminants deposited on the road surface are quickly washed off during rainfall. Where traffic levels are high the level of contamination increases and therefore, the potential for unacceptable harm being caused to the receiving water also increases. Although there are many circumstances in which runoff from roads is likely to have no discernible effect, a precautionary and best practice approach indicates the need for assessment of the possible impact of discharges from proposed trunk roads and motorways.

Essentially, operation and construction of the proposed scheme must ensure that:

- the need for the avoidance and reduction of impacts on the water environment is taken fully into account in the environmental evaluation
- the selection of appropriate means of preventing any significant predicted impact is made through modification of the drainage design, choice of discharge location(s) and/or adoption of runoff treatment methods, with the objective of designing out potential adverse environmental impacts.

6.10.2 *Methodology*

This assessment has been carried out in accordance with the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10 HD 45/09 (Road Drainage and the Water Environment). Essentially the objective at this secondary stage is to ensure that the key areas of assessment (surface water, groundwater, spillage and flood risk) are tailored to the characteristics of the proposed scheme and carried out to an appropriate level of detail, related specifically to the degree of environmental risk.

The levels of assessment, where applicable, are consequential and progression is dependent on the type of proposed project, the location of the site and local circumstances, as well as the nature of the potential impact (routine runoff, spillages, flooding). The process is also cyclical and is only completed when either no adverse impacts are predicted or other options avoid, treat or mitigate the potential impact, or an adverse impact is deemed to be outweighed by a beneficial impact. Where there is an adverse impact resulting in a change of project, design or mitigation or treatment, there is an obligation to reassess the changed design or efficacy of treatment.

The assessment requires a full appreciation of the proposed works and some knowledge of the landscape, hydrogeology and drainage pattern and process in which the proposed scheme is taking place. An assessment is required when there is potential for the proposed scheme to adversely affect water quality, flood risk or spillage risk. Therefore with reference to DMRB Volume 11, Section 3, Part 10, HD45/09 Chapter 6 (Levels of Assessment Impacts), if the answer to any of the following is yes, some form of assessment is necessary.

- Will the proposed scheme affect an existing surface water or floodplain?

- Will the proposed scheme either change the road drainage or natural land drainage catchments?
- Will the proposed scheme increase traffic flow in an area by more than 20%?
- Will the proposed scheme change the number or type of junctions?
- Will the proposed scheme impact on an indicative floodplain?
- Will the proposed scheme result in earthwork sediments being carried to surface waters? and
- Will the proposed scheme allow drainage discharges to the ground?

The Preliminary Options Report produced at Stage 1 concluded that whilst not all of the answers to the questions asked above were yes, an assessment of environmental impact is nevertheless required, as there is potential for adverse affects upon certain aspects of the water environment. Therefore the following topics were considered/assessed as necessary on an option-by-option basis:

- Effects of Routine Runoff on Surface Waters.
- Effects of Routine Runoff on Groundwater.
- Pollution Impacts from Accidental Spillages.
- Flood Impacts.

6.10.2.1 *Assessing the Significance of Effects*

With reference to DMRB Volume 11, Section 3, Part 10, HD 45/09 Chapter 5 (Procedure for Assessing Impacts), it is not sufficient to assess the size and probability of possible impacts: their significance should also be assessed. For example, the impact of a serious spillage event would be more significant if the surface water it discharges to is a source of potable water, and a flood would be more significant if it affects a residential area.

Firstly an assessment is made of the importance of the water environment by considering the features within the study area. The environmental importance of a feature, such as a river, is characterised by identifying and analysing its attributes, such as its use as a source of water, whether for potable or other use, its use for recreation, its function as a drainage channel, or its value to the economy. Guidance on estimating the importance of water environment attributes within the study area are contained within **Table 6.10.1** below (from DMRB 11.3.10 Annex IV Reporting of Significance of Potential Effects).

TABLE 6.10.1: DO MINIMUM ROAD NETWORK (DESIGN YEAR 2034)

Importance	Criteria	Typical Examples
Very High	Attribute has a high quality and rarity on regional or national scale	**Surface Water:** EC Designated Salmonid/Cyprinid fishery; WFD Class 'High'. Site protected/designated under EC or UK habitat legislation (SAC, SPA, ASSI, Ramsar site, Salmonid water) / Species protected by EC legislation.
		Groundwater: Principal aquifer providing a regionally important resource or supporting site protected under EC and UK habitat legislation.
		Flood Risk: Floodplain or defence protecting more than 100 residential properties from flooding.
High	Attribute has a high quality and rarity on local scale	**Surface Water:** WFD Class 'Good'. Major Cyprinid Fishery. Species protected under EC or UK habitat legislation.
		Groundwater: Principal aquifer providing locally important resource or supporting river ecosystem.
		Flood Risk: Floodplain or defence protecting between 1 and 100 residential properties or industrial premises from flooding.
Medium	Attribute has a medium quality and rarity on local scale	**Surface Water:** WFD Class 'Moderate'.
		Groundwater: Aquifer providing water for agricultural or industrial use with limited connection to surface water.
		Flood Risk: Floodplain or defence protecting 10 or fewer industrial properties from flooding.
Low	Attribute has a low quality and rarity on local scale	**Surface Water:** WFD Class 'Poor'.
		Groundwater: Unproductive strata.
		Flood Risk: Floodplain with limited constraints and a low probability of flooding of residential and industrial properties.

Source: extracted from DMRB 11.3.10, Annex IV, Table A4.5

With reference to DMRB 11.3.10.5, potential impacts should then be assessed in two steps: (i) estimation of the magnitude of impact, and then (ii) significance of any potential environmental effects identified as part of the assessment process. **Tables 6.10.2 and 6.10.3** (from DMRB 11.3.10 Annex IV) contain guidance for estimating these.

TABLE 6.10.2: DO MINIMUM ROAD NETWORK (DESIGN YEAR 2034)

Importance	Criteria	Typical Examples
Major Adverse	Results in loss of attribute and/ or quality and integrity of the attribute	**Surface Water:** Failure of both soluble and sediment-bound pollutants in HAWRAT and compliance failure with EQS values. Calculated risk of pollution from a spillage >2% annually. Loss or extensive change to a fishery. Major alteration to fish population levels in catchment as a whole, through fish mortality, habitat destruction or barrier to migration. Impacts long-term (>5 years) and/or irreversible. Loss or extensive change to a designated Nature Conservation site.
		Groundwater: Loss of, or extensive change to an aquifer. Potential high risk of pollution to groundwater from routine runoff – risk score >250. Calculated risk of pollution from spillages >2% annually. Loss of, or extensive change to, groundwater-supported designated wetlands.
		Flood Risk: Increase in peak flood level (1% annual probability) >100 mm.
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	**Surface Water:** Failure of both soluble and sediment-bound pollutants in HAWRAT but compliance with EQS values. Calculated risk of pollution from spillages >1% annually and <2% annually. Partial loss in productivity of a fishery. Appreciable alteration to fish population levels in specific sub-catchment or zone. Impacts medium-term (1-5 years) and/or irreversible.
		Groundwater: Partial loss or change to an aquifer. Potential medium risk of pollution to groundwater from routine runoff – risk score 150-250. Calculated risk of pollution from spillages >1% annually and <2% annually. Partial loss of the integrity of groundwater-supported designated wetlands.
		Flood Risk: Increase in peak flood level (1% annual probability) >50 mm.

TABLE 6.10.2: DO MINIMUM ROAD NETWORK (DESIGN YEAR 2034)

Importance	Criteria	Typical Examples
Minor Adverse	Results in some measurable change in attribute's quality or vulnerability	**Surface Water:** Failure of either soluble or sediment-bound pollutants in HAWRAT. Calculated risk of pollution from spillages >0.5% annually and <1% annually. Minor alteration to fish population levels in specific sub-catchment or zone. Impacts short-term (up to 1 year) and/or reversible through impact reduction or mitigation measures.
		Groundwater: Potential low risk of pollution to groundwater from routine runoff – risk score <150. Calculated risk of pollution from spillages >0.5% annually and <1% annually. Minor effects on groundwater-supported wetlands.
		Flood Risk: Increase in peak flood level (1% annual probability) >10mm.
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	**Surface Water:** No risk identified by HAWRAT (Pass both soluble and sediment-bound pollutants). Risk of pollution from spillages <0.5%. No measurable alteration to fish population levels. Impacts short-term and/or reversible.
		Groundwater: No measurable impact upon an aquifer and risk of pollution from spillages <0.5%.
		Flood Risk: Negligible change in peak flood level (1% annual probability) <+/- 10 mm.
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	**Surface Water:** HAWRAT assessment of either soluble or sediment-bound pollutants becomes Pass from an existing site where the baseline was a Fail condition. Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually).
		Groundwater: Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually).
		Flood Risk: Reduction in peak flood level (1% annual probability) >10 mm.

TABLE 6.10.2: DO MINIMUM ROAD NETWORK (DESIGN YEAR 2034)

Importance	Criteria	Typical Examples
Moderate Beneficial	Results in moderate improvement of attribute quality	**Surface Water:** HAWRAT assessment of both soluble and sediment-bound pollutants becomes Pass from an existing site where the baseline was a Fail condition. Calculated reduction in existing spillage by 50% or more (when existing spillage risk >1% annually).
		Groundwater: Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually).
		Flood Risk: Reduction in peak flood level (1% annual probability) >50 mm.
Major Beneficial	Results in major improvement of attribute quality	**Surface Water:** Removal of existing polluting discharge, or removing the likelihood of polluting discharges occurring to surface water.
		Groundwater: Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring; Recharge of an aquifer.
		Flood Risk: Reduction in peak flood level (1% annual probability) >100 mm.

Source: extracted from DMRB 11.3.10, Annex IV, Table A4.4

TABLE 6.10.3: ESTIMATING THE SIGNIFICANCE OF POTENTIAL EFFECTS

IMPORTANCE OF ATTRIBUTE					
	Very High	Neutral	Moderate/Large	Large/Very Large	Very Large
	High	Neutral	Slight/Moderate	Moderate/Large	Large/Very Large
	Medium	Neutral	Slight	Moderate	Large
	Low	Neutral	Neutral	Slight	Slight/Moderate
		Negligible	**Minor**	**Moderate**	**Major**
		MAGNITUDE OF IMPACT			

Source: extracted from DMRB 11.3.10, Annex IV, Table A4.5

6.10.3 *Regulatory/Policy Framework*

Water resource management in Northern Ireland is reflected through but not limited to the following European and National legislation, and planning policy:

- The Water Framework Directive (WFD), 2000/60/EC.

- The Groundwater Daughter Directive to WFD, 2006/118/EC.
- The Fish Directive (consolidated), 2006/44/EC.
- The Nitrates Directive (consolidated), 91/676/EEC.
- The Urban Waste Water Treatment (UWWT) Directive (consolidated), 91/271/EEC.
- The Floods Directive, 2007/60/EC.
- The Water (Northern Ireland) Order 1999.
- The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003.
- The Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003 (COSHH Regulations).
- The Environment (Northern Ireland) Order 2002 (as amended).
- The Birds Directive (2009/147/EC).
- The Habitats Directive (92/43/EEC).
- The Fisheries Act (Northern Ireland) 1966 (as amended).
- The Fisheries (Amendment) (Northern Ireland) Order 1991.
- The Surface Waters (Fish Life) (Classification) Regulations (Northern Ireland) 1997.
- The Drainage (Northern Ireland) Order 1973 (as amended).
- The Groundwater Regulations (Northern Ireland) 2009 (as amended).
- The Waste and Contaminated Land (Northern Ireland) Order 1997.
- The Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006.
- The Pollution Prevention and Control Regulations (Northern Ireland) 2003.
- The Control of Pollution (Oil Storage) Regulations (Northern Ireland) 2010.
- Planning Policy Statement (PPS) 15: Planning and Flood Risk (December 2004).

6.10.3.1 *The Water Framework Directive (WFD)*

The WFD established a framework for management of water resources throughout the European Union. The Directive came into force in December 2000, and was implemented in Northern Ireland via The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003. These regulations identified the Department of the Environment (DoE) as the competent authority for each River Basin District (RBD) within Northern Ireland. The leading body on the technical work within the DoE is the Northern Ireland Environment Agency (NIEA), who in partnership with the Department of Agriculture and Rural Development (DARD) (Rivers Agency), the Department of Culture, Arts and Leisure (DCAL) (Inland Waterways & Fisheries) and the Department for Regional Development (DRD), formally adopted the North Eastern River Basin Management Plan (RBMP) for the study area in December 2009. The WFD will be fully effective by 2015 and its key objectives provided for in the RBMP, are to:

- Prevent deterioration, enhance and restore bodies of surface water, achieve ‘Good’ chemical and ecological status of such water, and reduce pollution from discharges and emissions of hazardous substances.

- Protect, enhance and restore all bodies of groundwater, achieve 'Good' chemical and quantitative status of groundwater, prevent the pollution and deterioration of groundwater, and ensure a balance between groundwater abstraction and replenishment.
- Preserve protected areas.

As noted above, the WFD is implemented through river basin planning, which introduces a six-yearly cycle of planning, action and review. Every six years a RBMP will be produced for each RBD. In common with the rest of Europe, NIEA has developed three plans for the Province for the period from 2009 to 2015.

6.10.3.2 *The Groundwater Daughter Directive*

Since January 2009, the Groundwater Daughter Directive to WFD (2006/118/EC) has operated alongside the Groundwater Directive (80/68/EEC) and will continue to do so until the latter is repealed in December 2013. The Groundwater Daughter Directive requires the prevention of all inputs of hazardous substances into groundwater. It also requires the limitation of any inputs from all other pollutants into groundwater so as to prevent pollution, deterioration in status or any significant downward trends in quality.

In addition to the requirements of the Groundwater Daughter Directive, if the groundwater is abstracted for drinking water supply, then additional restrictions may apply in order to protect Drinking Water Standards.

The Groundwater Regulations (Northern Ireland) 2009 (as amended) essentially give absolute protection to groundwaters, regardless of the presence of abstraction and associated Source Protection Zones (SPZs). Though in England, SPZs protect potable abstraction sources from pollution, there are none zoned in Northern Ireland.

As noted above, the Groundwater Directive will be repealed in December 2013. Further to this, under the WFD, the following Directives will also be repealed during this time:

- The Fish Directive (Consolidated), 2006/44/EC
- Shellfish Waters Directive, 79/923/EEC
- Dangerous Substances Directive, 2006/11/EC.

6.10.3.3 *The Floods Directive*

The European Directive on the Assessment and Management of Flood Risks (2007/60/EC), known as the Floods Directive, came into force on 26th November 2007. The Floods Directive is designed to help Member States establish a framework for managing flood risk that is aimed at reducing the adverse consequences of flooding on human health, the environment, cultural heritage, and economic activity.

DARD Rivers Agency is the competent authority with responsibility for implementation of the Directive in Northern Ireland. The Water Environment (Floods Directive) Regulations (Northern Ireland) 2009, which implement the Directive in Northern Ireland, came into operation on 14th December 2009.

The main requirements contained within the Directive are to:

- Undertake a Preliminary Flood Risk Assessment of all river basins and coastal zones in Northern Ireland by December 2011. On the basis of this assessment, identify all areas at potential significant flood risk.
- Produce detailed Flood Hazard Maps and Flood Risk Maps for the areas determined to be at potential significant flood risk by December 2013.

- Produce Flood Risk Management Plans that are focused on prevention, protection and preparedness, and which contain objectives and measures to reduce significant risk in these areas. Plans must be produced by December 2015.
- Co-ordinate efforts with the Republic of Ireland in relation to implementation of the provisions for international catchments (river basins).
- Encourage the active involvement of interested parties in the production of Flood Risk Management Plans and co-ordinate this with the involvement of interested parties in the Water Framework Directive.
- Make available to the public the Preliminary Flood Risk Assessment, Flood Hazard Maps, Flood Risk Maps and the Flood Risk Management Plans.

6.10.3.4 *Regional Development Strategy 2035*

The Strategic Guidance set out within the RDS 2035 deals directly with the economy, society and the environment. With regard to flooding, the RDS (p46) highlights the need to *"minimise development in areas of flood risk from flooding from rivers, the sea and surface water run-off"*. It goes on to seek that a precautionary approach to development in areas of flood risk, and all development should incorporate Sustainable Drainage Systems (SuDS).

6.10.3.5 *PPS 15 - Planning & Flood Risk*

Planning Policy Statement (PPS) 15 *'Planning and Flood Risk'* sets out policies to minimise flood risk to people, property and the environment. It embodies the Government's commitment to sustainable development and the conservation of biodiversity. It adopts a precautionary approach to development and the use of land that takes account of climate change and is supportive to the wellbeing and safety of people.

The main objectives of this Statement are to:

- Adopt a precautionary approach by ensuring that both the available scientific evidence and scientific uncertainties which exist in relation to flood risk are taken into account when determining planning applications.
- Ensure that new development is not exposed to the direct threat of flooding and that it does not increase flood risk elsewhere.
- Secure and promote the natural role of floodplains as a form of flood defence and an important environmental and social resource and ensure that this is recognised in the decision making process.
- Promote an integrated and sustainable approach to the management of development and flood risk which contributes to:
  - the safety and wellbeing of everyone
  - the prudent and efficient use of economic resources
  - the conservation and enhancement of biodiversity.

6.10.3.5.1 ***Policy FLD 1- Development in Floodplain***

Planning Policy FLD 1 *'Development in Flood Plains'* states that development within floodplains will not normally be permitted unless the project falls within one of the exceptions listed or it is demonstrated that the proposal is of overriding regional importance. Criteria (d) which is listed as an exception to the policy, relates to *'development where location within a flood plain is essential for operational reasons, for example, navigation and water based recreation uses or transport and utilities infrastructure which has to be there'.*

As the proposed scheme is part of the Eastern Seaboard Key Transport Corridor and forms a major regional city gateway, it is considered to be of regional importance. Policy FLD 1 goes on to highlight the need for proposals which fall within the exceptions to be accompanied by an assessment of the flood risk that may affect the development, or result elsewhere because of it. Where appropriate, the assessment shall include details of measures to mitigate any increase in flood risk.

The Strategic Flood Map (NI) produced by DARD indicates that the proposed scheme is located within an undefended coastal and river flood plain. The amplification of Policy FLD1 states that *"undefended flood plains perform an invaluable function in mitigating the natural fluvial and tidal processes important to the wider flood management system"* therefore built development will only be permitted in exceptional cases. Again the policy highlights infrastructure works where it is demonstrated that a specific flood plain location is essential for operational reasons and that an alternative lower risk location is not available. Land raising (the raising of ground levels in association with building works or as an operation in its own right) is not considered for the purposes of PPS15 to be a flood prevention measure. It can adversely affect drainage systems and it removes flood storage capacity and interferes with the conveyance of water, which can increase the risk of flooding elsewhere.

6.10.4 ***Baseline Conditions***

6.10.4.1 *Existing Road Drainage*

The topography of the study area is such that it generally drains in an easterly direction (i.e. from the A12 Westlink towards Belfast Harbour). Based on information received from NI Water, Rivers Agency and Roads Service, the existing drainage regime associated with the York Street study area consists of a network of road gullies and pipes collecting runoff from carriageways and adjacent areas. Primarily, runoff from the existing road network outfalls by gravity to the existing combined storm and foul water sewers (which are generally owned and maintained by NI Water). The exceptions to this are a section of elevated M3 Motorway between the M3 Lagan Bridge and Nelson Street which drains into Belfast Harbour via a NI Water combined storm water/foul water overflow culvert (though this culvert no longer conveys foul water), and an area of the existing M2 Motorway (north of Dock Street) which drains to the Mile Water culvert and discharges into Pollock Dock.

As noted above, the existing road network primarily drains (via gravity) to the existing combined storm and foul water sewers, all of which connect to a large 2400mm diameter combined low level sewer, which gravitates in a northerly direction along Corporation Street. The recently completed Belfast Sewers Project storm tunnel generally follows the same alignment as this low level sewer, though at a considerably lower depth (approximately 25m below existing ground level). Both sewers convey the flow of storm and foul water in a northerly direction to Belfast Wastewater Treatment Works at Duncrue Street. From a review of the existing records, it is evident that there is currently no pumped road drainage within the immediate study area.

6.10.4.2 *Surface Waters*

With reference to the 'North Eastern River Basin Management Plan (RBMP) Summary' (NIEA 2009), the study area is located entirely within the North Eastern River Basin District, which covers an area of approximately 3000 km^2. This takes in large parts of Counties Antrim and Down and a small portion of County Londonderry. The district is flanked by the Antrim Plateau and Glens of Antrim to the north, and the Mourne Mountains, (which include Slieve Donard, the highest peak in Northern Ireland), to the south. Over 0.7 million people live in the District, which includes the most densely populated region of Northern Ireland, the Belfast Metropolitan Area, and surrounding commuter areas including Lisburn, Newtownabbey, Carrickfergus, Bangor and Newtownards.

At a more local level, the study area is located within the Lagan Local Management Area (LMA) which covers an area of approximately 606km^2. With reference to the 'Lagan LMA Information Leaflet' (NIEA 2009), the River Lagan rises around Slieve Croob and flows approximately 70km to Stranmillis Weir in Belfast from which point it is transitional (estuarine). There are also sections of the river that feed the Lagan Canal, which is currently being strategically assessed for reopening.

Lagan Weir, further downstream from Stranmillis, is the lower limit of the River Lagan. It was completed in 1993 by Laganside Corporation to improve aesthetics and assist in the environmental management of the estuarine section, thus impounding part of the Lagan Estuary. The weir was Laganside's first project, and became the catalyst for the urban regeneration of the surrounding area.

From Lagan weir, the Lagan flows into the fully tidal Belfast Lough, which in part (Belfast Harbour) forms the lower reach of the Lagan LMA. This area also contains Belfast Harbour Estate (approximately 2000 acres), the busiest passenger port in Northern Ireland and handles 60% of Northern Ireland's sea borne trade. George Best Belfast City Airport is also situated on the Estate.

With reference to the 'Belfast Lough LMA Information Leaflet' (NIEA 2009), Belfast Lough is a semi-closed inter-tidal sea lough at the mouth of the River Lagan. The inner region of the lough contains an inter-tidal area comprising a series of mudflats, while the outer area is mainly rocky shores, with some sandy bays. The mudflats provide a valuable habitat for a range of bird species and the shallow waters on either side of the main shipping channel, which runs through the middle of the lough, sustain a growing shellfish industry.

The main land use in the Lagan LMA is improved grassland (42%), arable farming (13%) and suburban/rural development (11%). The River Lagan also supports a number of outdoor activities, such as canoeing, angling, bird watching and walking. The main land use within the Belfast Lough LMA is improved grassland (33%), suburban and urban development (18%), arable farming (13%) and dense dwarf shrub heath (7%).

Whilst Belfast Harbour (the mouth of the River Lagan) is located to the immediate southeast of the York Street study area, only one surface water passes through the area (the Mile Water). With reference to **Figure 6.10.1**, the Mile Water is located on the very northern periphery of the study area, flowing in a west to east direction under the M2 Motorway. It is culverted for significant lengths, including to the immediate upstream and downstream sides of the M2 and discharges into Belfast Harbour at Pollock Dock.

To the south of the study area, the Farset River also flows in a west to east direction and is culverted over the majority of its length. Through the City Centre, it flows under High Street and discharges at Custom House on the downstream side of the Lagan Weir (Figure 6.10.1).

6.10.4.3 *Surface Water, Heavily Modified and Artificial Water body Classification*

With reference to the 'Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive Report' (UKTAG, 2007), Member States are required to classify the 'status' of surface waterbodies. This is determined by whichever is the lower of a waterbody's 'ecological' or 'chemical' status. To achieve the overall aim of 'Good' Surface Water Status, the Directive requires that surface waters be of at least 'Good' ecological and 'Good' chemical status. 'Good' surface water status is one of the principal objectives for surface waterbodies not designated as heavily modified or artificial. The other principal objective is to prevent deterioration of surface water status.

With reference to the 'North Eastern RBMP', the ecological quality of surface waters is an expression of the quality of the structure and functioning of surface water ecosystems as indicated by the condition of a number of 'quality elements'. The Directive uses the term "quality elements" to refer to the different indicators of ecological quality comprising its ecological status classification schemes. The quality elements used to assess ecological status are:

- biological quality elements (invertebrates, plants, fish, phytobenthos and phytoplankton);
- general chemical and physiochemical quality elements (phosphorous in rivers and lakes, nitrogen in transitional and coastal waters, dissolved oxygen and pH); and
- hydromorphological quality elements (water flow and physical modifications).

For each waterbody, the ecological quality elements are classified individually and chemical quality is determined by the levels of certain hazardous and dangerous substances. The ecological and chemical results are then combined to give an overall status in one of five classes:

- High Ecological Status (HES);
- Good Ecological Status (GES);
- Moderate Ecological Status (MES);
- Poor Ecological Status (PES); and
- Bad Ecological Status (BES).

As noted above, the Directive requires that the overall ecological status of a waterbody be determined by the results for the biological or physiochemical quality element with the worst class (i.e. the quality element worst affected by human activity). This is called the 'one out - all out' principle. If a waterbody is classified as 'High' or 'Good' status, then it has a healthy ecology, which deviates only slightly from natural conditions, is an important natural asset, and can support a wide range of uses such as recreation, fishing and drinking supply. If a waterbody is classified as 'Moderate', 'Poor' or 'Bad', then the ecology is adversely affected and the range of uses that can be supported is reduced.

With reference to the North Eastern RBMP, some waterbodies have been modified to such an extent that they can no longer be restored to their original condition without compromising their current use (heavily modified waterbodies). Other waterbodies have been created where no water body previously existed (artificial waterbodies). There are four classes for the status of heavily modified and artificial waterbodies:

- Good Ecological Potential or better (GEP);
- Moderate Ecological Potential (MEP);
- Poor Ecological Potential (PEP); and
- Bad Ecological Potential (BEP).

The classification system for heavily modified and artificial waterbodies takes into account the modified nature of these waterbodies; thus instead of the aim of achieving 'GES', these surface waters must aim to meet 'GEP'. Their ecological potential is assessed for water quantity, water flow and physical habitat, depending on whether reasonable effort has been made to maximise the quality of the ecology and habitats. The ecological potential classification also reflects the chemical quality of the water.

6.10.4.4 *Surface Water Quality*

With reference to the Lagan LMA Information Leaflet' (NIEA 2009), one transitional waterbody (Lagan Estuary) and one coastal waterbody (Belfast Harbour) have been classified under the new surface water quality system within the study area, both of which are heavily modified. The Belfast Harbour coastal water body is the only one to receive direct discharges from the existing York Street junction arrangement at M3 Lagan Bridge and Pollock Dock. As noted above, the majority of discharges from the existing junction outfall to the existing combined storm and foul water sewerage network. There are no river waterbodies classified within the study area.

In terms of the current status of waterbodies in the Lagan LMA, all surface waters have been classified as less than ‘Good’ status and 36% of these have been identified as being heavily modified. The current status and environmental objectives of the surface waters within the study area have been summarised in **Table 6.10.4** below and shown on **Figure 6.10.2**.

TABLE 6.10.4: SUMMARY OF CURRENT STATUS AND ENVIRONMENTAL OBJECTIVES

Water Body Code	Water Body Name	2009 Status	2015 Objective	Importance
UKGBNI6NE100	Belfast Harbour	MEP	MEP	Medium
UKGBNI5NE100010	Lagan Estuary	BEP	MEP	Low

(Source: NIEA – Water Management Unit’s Information Management Team & River Basin Plan Map Viewer).

With reference to the ‘Lagan LMA Information Leaflet’ (NIEA 2009) and **Figure 6.10.2**, the current status of the Belfast Harbour waterbody has been identified as being of ‘Moderate Ecological Potential’ (MEP) and the Lagan Estuary identified as being of ‘Bad Ecological Potential’ (BEP). The main reasons for the current status of these waterbodies are due to impacts upon invertebrate communities, Dissolved Oxygen (DO) levels and levels of Dissolved Inorganic Nitrogen (DIN). As a major shipping port, Belfast Harbour is also significantly impacted in terms of changes to morphology. Neither of these waterbodies is expected to achieve ‘Good’ status by 2015.

With reference to the North Eastern RBMP (NIEA 2009), the WFD recognises that achieving ‘Good’ status for surface waterbodies may not be possible within the first cycle for the following reasons:

- the scale of improvements may take several cycles, for reasons of technical feasibility
- carrying out the improvements by 2015 may be disproportionally expensive
- natural conditions may not allow for timely improvements.

In such cases, as long as the waterbody is not allowed to deteriorate, the necessary improvements may extend over several planning cycles. The WFD also allows a less stringent objective to be set, where it is considered that ‘Good’ status cannot be achieved by 2027. With reference to the Lagan LMA – Reason for Status and Setting of Alternative Objectives (NIEA 2009), in the case of Belfast Harbour, the time taken for the plants and animals to re-colonise and become established after the chemical and physiochemical or hydromorphological conditions have been restored to ‘Good’, or the time taken for the habitat conditions to stabilise after improvement works have been implemented, will cause a delay in reaching ‘Good’ status until after 2015.

With reference to the Agri-Food & Biosciences Institute (AFBI) [on-line], the inner area of the lough (including Belfast Harbour) has been identified as being hypernutrified (as a result of anthropogenic impacts), and is subject to eutrophication. The harbour is home to two large sewage treatment works, discharging into the Inner Lough as well as a fertiliser plant and other substantial port facilities. Industrial sources have been the main contributors of DIN to the waterbody, with the sewage treatment works contributing approximately 30% of the DIN load. The large mixing capacity of the Inner Lough allows effluent to be dispersed quickly between the Inner and Middle Lough.

With reference to the 'Lagan LMA Action Plan 2010/2011' the failing elements of the Belfast Harbour waterbody are Phytoplankton, General Conditions, and Benthic Invertebrates. This document identifies actions to be taken to address the failing elements on a waterbody-by-water body basis; in the case of Belfast Harbour these include:

- Creation of an inventory of river channel and bank physical structures within the Lagan LMA.
- Continue monitoring to confirm evidence of trophic status.
- Target Pollution Prevention advice to industrial premises and investigate any unconsented industrial discharges. Where required, ensure Water Order consent is obtained.
- Work with and support Belfast Harbour Commissioners and other local Stakeholders in raising awareness of environmental issues and projects. Seek to identify solutions to water management problems and develop and promote the Lagan LMA Action Plan.
- Encourage riparian zone management with an aim to improve biodiversity and minimise sedimentation through practical management measures on farms.
- Develop leaflets and articles to promote effective farm nutrient and waste management.
- Collate existing information on location of aquatic invasive alien species.
- Promote the control of invasive alien species on farmland.
- Raise awareness and promote the benefits of effective farm nutrient and waste management.
- Investigate the sedimentation problems in the Lagan LMA, determine potential sources and take action to promote better sediment management.

With reference to the 'Lagan LMA Information Leaflet' (NIEA 2009), in no instance has road runoff been specifically identified as a source of pressure within the Belfast Harbour water body, thus DRD Roads Service has not been identified as a body which needs to take action to address any particular pressures/concerns. Nevertheless, with reference to the North Eastern RBMP (NIEA 2009), existing and planned measures have been identified to ensure that existing water uses are appropriately managed and that the water environment can achieve 'Good' status. In the case of new road schemes, As detailed within the North Eastern RBMP (NIEA 2009), DRD Roads Service has made a commitment to assess the environmental impact of new roads in accordance with the Roads (Environmental Impact Assessment) Regulations (NI) 1999 and has made a commitment to adopt Sustainable Drainage Systems (SuDS) for all new motorways, dual carriageways and improvements to roads of motorway and dual carriageway standard, where technically and economically feasible.

6.10.4.5 *Protected Areas*

The WFD requires that a register of protected areas be identified to help ensure that the management of relevant waterbodies is geared towards achieving protected area objectives. Protected areas are identified as those requiring special protection under existing National or European legislation, either to protect their surface water or groundwater, or to conserve habitats or species that directly depend on those waters. The purpose of the protected area register is to bring all EC water-related legislation under one umbrella. With reference to the

North Eastern RBMP, the District has important habitats and wildlife living in areas identified as needing special protection under existing laws. These protected areas include:

- Areas designated for the abstraction of water intended for human consumption under the WFD.
- Areas designated for the protection of economically significant aquatic species. For example, this may include waters previously designated under the Shellfish Waters Directive (2006/113/EEC) or the Fish Directive (2006/44/EC).
- Bodies of water designated as bathing waters under the Bathing Waters Directive 2006/7/EC.
- Nutrient-sensitive areas, including areas designated as Vulnerable Zones under the Nitrates Directive, and areas designated as Sensitive Areas under the Urban Waste water Treatment (UWwT) Directive, Council Directive 91/271/EEC.
- Areas designated for the protection of habitats or species under the Habitats Directive (Council Directive 92/43/EEC) or the Birds Directive (Council Directive 2009/147/EC), where the maintenance or improvement of the status of water is an important factor in their protection.

6.10.4.5.1 ***Areas designated for abstraction of water intended for human consumption***

This is a new category of protected area which replaces the system of drinking water protection previously provided by the Drinking Water Abstraction Directive (75/440/EEC) and will also incorporate groundwaters.

With reference to the 'Lagan LMA Information Leaflet' (2009), there is only one drinking water protected river within the Lagan LMA, though it is not located within the study area.

6.10.4.5.2 ***Areas designated for protection of economically significant aquatic species***

Shellfish waters are designated under the Shellfish Waters Directive (2006/113/EC) in order to ensure a suitable environment for shellfish growth. With reference to the 'Lagan LMA Information Leaflet' (2009), there are no designated shellfish waters within or close to the study area. However with reference to the 'Belfast Lough LMA Information Leaflet' (2009), the lough itself is designated as a shellfish water. With reference to AFBI [on-line], the shellfish aquaculture area within Belfast Lough includes twelve individual sites covering a total area of $7.5km^2$. Located on the western side of the lough between Newtownabbey (Greencastle) and Carrickfergus, the cultivated species at all twelve sites is mussel.

The Fish Directive (FD) (Consolidated), 2006/44/EC is concerned with the protection and improvement of fresh waters in order to support fish life. It sets water quality standards and monitoring requirements to ensure the protection of coarse and game fisheries. The Directive requires the designation of appropriate rivers and lakes into two categories of water: those suitable for Salmonids (mainly salmon and trout), and those suitable for Cyprinids (coarse fish including carp, tench, bream, roach, chub and minnows). As noted earlier, the FD will be revoked at the end of 2013. With reference to the 'Lagan LMA Information Leaflet' (2009), there are 134km of rivers (37.5km designated Cyprinid, 96.5km designated Salmonid) and 5.7km of canal (all designated Cyprinid) identified under the FD, though understandably none of these surface waters are located within the study area due to the transitional nature of the water environment.

6.10.4.5.3 ***Bathing Waters***

Bathing Waters are areas protected for recreational and bathing use under the Bathing Waters Directive (2006/7/EC) and must meet mandatory and guideline standards for microbiological quality in order to protect human health. With reference to the 'Lagan LMA Information Leaflet' (2009), there are no identified bathing waters within or near to the study area. With reference to the 'Belfast Lough LMA Information Leaflet' (2009), there are however four identified bathing waters within the Outer Lough at Ballyholme, Crawfordsburn, Groomsport and Helen's Bay.

6.10.4.5.4 ***Nutrient Sensitive Areas***

Nutrient Sensitive Areas comprise nitrate vulnerable zones and polluted waters designated under the Nitrates Directive (consolidated) (91/676/EEC) and areas designated as sensitive areas under the Urban Waste water Treatment (UWwT) Directive (consolidated) (91/271/EEC) in relation to nutrient enrichment. With reference to the 'Lagan LMA Information Leaflet' (2009), a total territory approach has been adopted in Northern Ireland under the Nitrates Directive. With regards to the UWwT Directive, three sensitive areas have been identified within the LMA. These include the River Lagan, Tidal Lagan and Inner Belfast Lough.

6.10.4.5.5 ***Areas designated for the protection of habitats or species (Natura 2000 Sites)***

The objective for Natura 2000 Protected Areas identified in relation to relevant areas designated under the Habitats Directive (92/43/EEC) is to:

> "*Protect and, where necessary, improve the status of the water environment to the extent necessary to achieve the conservation objectives that have been established for the protection or improvement of the site's natural habitat types and species of Community Importance in order to ensure the site contributes to the maintenance of, or restoration to, favourable conservation status (i.e. to protect and, where necessary, improve the water or water dependent environment to the extent necessary to maintain at or restore to favourable conservation status, the water-dependent habitats and species for which the Protected Area is designated)*".

The objective for Natura 2000 Protected Areas identified in relation to relevant areas designated under the Birds Directive (2009/147/EC) is to:

> "*Protect and where necessary improve the water environment to the extent necessary to achieve the conservation objectives that have been established for the protection or improvement of the site in order to ensure that the site contributes to the conservation (survival and reproduction in their area of distribution) of bird species listed in Annex I of the Birds Directive*".

Where a Natura 2000 Protected Area forms part of a waterbody, or where a waterbody lies within such an area, the WFD status objectives apply in addition to the requirement to maintain at favourable conservation status or restore it to that status. For those waterbodies that coincide with Natura 2000 protected areas that have been heavily modified, the aim in this case is to achieve 'GEP' in addition to the objective of favourable conservation status.

With reference to the 'Lagan LMA Information Leaflet' (2009), there are no water-dependent Special Areas of Conservation (SAC) within the Lagan LMA; there are however water dependent Special Protection Areas (SPA) located on the periphery of the LMA at Belfast Lough (Figure 6.4.1). Belfast Lough SPA is located between Outer Belfast Lough and Inner Belfast Lough and is designated primarily for the fauna (particularly wildfowl) present in the Inner Lough, and geological features in the Outer Lough, NIEA 2012 [Online]. The SPA boundary is entirely coincident with that of Outer Belfast Lough Area of Special Scientific Interest (ASSI) and Belfast Lough Ramsar Site. However, within the immediate harbour area, the boundary has been redrawn to take into account permitted port related development and landfill, which has taken place since the Inner Belfast Lough ASSI was declared in 1987. Hence the SPA boundary is not entirely coincident with that of Inner Belfast Lough ASSI.

With reference to the 'Lagan LMA Information Leaflet' (2009), Belfast Lough SPA is in an unfavourable condition. Unfavourable SPAs require investigation to identify external and internal factors. The issues affecting this SPA are unclear. The unfavourable condition may be caused by changes in migratory patterns, disturbance to high tide roost sites, water quality and/or ecological factors.

6.10.4.6 *Groundwater*

Groundwater occurs everywhere beneath the ground across Northern Ireland. It plays a significant role in supporting surface water flows and levels through natural discharge from the ground to rivers, lakes, streams and wetlands. This contribution to surface waters can also act to dilute pollutant concentrations in the surface water, therefore helping support the overall ecological and amenity value of these systems.

With reference to the 'Groundwater Body Classification Report,' (NIEA, 2009), the WFD requires the status of groundwater management units (groundwater bodies) within each river basin to be determined as 'Good' or 'Poor' (with respect to the target date of 2015).

Groundwater bodies are assessed by examining the main land-use pressures that are likely to be affecting them; these include chemical (diffuse and point sources) and quantitative (water abstraction and quarry dewatering) pressures. Using the monitoring data from 2000 to 2008, the following is considered:

- scale, frequency and distribution of the pressures
- nature of the link between the pressure and the groundwater
- trends in groundwater (and surface water) quality and levels
- relationship between groundwater bodies and the surface water bodies and wetland systems to which they eventually discharge.

With reference to the North Eastern RBMP (NIEA 2009), groundwater occurs to some degree from nearly all rock types within the district. Significant supplies are found in the Lagan and Enler Valleys within sandstone aquifers and near Dundonald and Comber within sand & gravel deposits. In the past, these aquifers have been used extensively for public supply, and still represent an important strategic resource that requires management and protection.

With reference to the 'Lagan LMA Information leaflet,' one out of four groundwater bodies are failing to achieve 'Good' status. The Belfast Groundwater Body (in which the study area is partially located) currently achieves 'Poor' overall status, due to water balance (quantitative) and nitrate level (chemical) issues. The study area is also partially located within the Belfast Hills – Islandmagee Groundwater Body, which is classified as 'Good' for both Quantitative and Qualitative status.

6.10.4.7 *Hydrogeology*

A new aquifer classification system has been developed by Geological Survey of Northern Ireland (GSNI) and British Geological Survey (BGS), in accordance with WFD guidance to assess and manage all waters within Member State boundaries in a unified manner. With reference to the 'Water Framework Directive – Aquifer Classification Scheme for Northern Ireland' GSNI (2005), the WFD describes a groundwater body as a '*distinct volume of water within an aquifer or aquifers'*. For the purposes of WFD analysis, the aquifer classification scheme considers the following elements in defining aquifer type/category:

- Strata type (Bedrock or Superficial)
- Relative 'productivity' with respect to exploitation history/well yields (where data is available)

- Flow Type (intergranular, fractured, karstic or combination).

In terms of hydrogeology, with reference to the GeoIndex map viewer [on-line] and **Figure 6.10.3**, there is a variation in bedrock aquifer types within the study area. In essence there is largely an east/west split in aquifer type/category underlying the York Street junction arrangement. To the west, the aquifer category underlying part of York Street and the A12 Westlink is classified as Bp (f), a bedrock aquifer of poor productivity and fracture flow, typical of the Mercia Mudstone Group. To the east of York Street, the aquifer category underlying the rest of the study area is classified as Bh (I-f), a bedrock aquifer of high productivity and fracture flow, typical of the Sherwood Sandstone Group.

There are no superficial aquifers within the study area.

Due to the scale (1:250,000) of the digital geological mapping available, the classification of these areas is generalised, however it provides an overall understanding as to the bedrock aquifer type/category throughout the study area.

6.10.4.8 *Groundwater Vulnerability*

A new methodology for groundwater vulnerability assessment has also been developed by Geological Survey of Northern Ireland (GSNI) and British Geological Survey (BGS), in accordance with WFD guidance to help characterise and assess risk to groundwater bodies. In order to carry out risk assessments, knowledge of the vulnerability of groundwater is necessary. Typically, groundwater is of high quality and often requires little treatment prior to use. However, it may be vulnerable to contamination from both diffuse and point source pollutants, from direct discharges into groundwater, and indirect discharges into or onto land. Groundwater decontamination is difficult, prolonged, and expensive, and therefore the prevention of pollution is important.

With reference to ‘A Groundwater Vulnerability Screening Methodology for Northern Ireland Report’ BGS (2005), groundwater vulnerability is defined as the tendency and likelihood for general contaminants to reach the water table after introduction at the ground surface. All groundwater is to some degree vulnerable, and the groundwater vulnerability screening methodology is designed to reflect the ability of contaminants to reach the water table surface.

The screening methodology applies to the situation where contamination from the land surface leaches vertically downwards to the water table within the uppermost aquifer at a particular locality. The groundwater vulnerability assessment is, therefore, influenced by several factors that relate to the pathway element of a typical source – pathway – receptor risk assessment. In this case, the pathway is characterised by the geological and hydrogeological characteristics of the soil layer, the underlying superficial deposits, and bedrock.

The pathway between the ground surface and the water table can affect the degree of attenuation of contaminants. Factors that can influence attenuation include:

- The permeability and clay content of the superficial deposits.
- The thickness of the superficial deposits.
- The mode of groundwater flow in bedrock aquifers (fracture or intergranular flow).
- The permeability and clay content of intergranular bedrock aquifers.
- The depth to the water table in both superficial and intergranular bedrock aquifers.

It is the above factors that determine the vulnerability classification. Vulnerability has been divided into five categories, with Class 1 areas having the lowest risk of groundwater pollution and Class 5 the highest, as shown in **Table 6.10.5** below.

TABLE 6.10.5: VULNERABILITY DEFINITIONS FOR POTENTIALLY POLLUTING ACTIVITIES

Vulnerability Category	Description	Frequency of activity	Travel time
5	Vulnerable to most water pollutants with rapid impact in many scenarios	Vulnerable to individual events	Rapid
4	Vulnerable to those pollutants not readily adsorbed or transformed	↓	↓
3	Vulnerable to some pollutants with many significantly attenuated	↓	↓
2	Vulnerable to some pollutants but only when continuously discharged/leached	↓	↓
1	Only vulnerable to conservative pollutants in the long-term when continuously and widely discarded and leached	Vulnerable only to persistent activity	Very slow

Source: A Groundwater Vulnerability Screening Methodology for Northern Ireland Report' BGS (2005)

Class 4 is further subdivided according to the nature of the pathway:

- 4a – sand & gravel cover
- 4b – moderate permeability cover
- 4c – low permeability cover
- 4d – thin soil over bedrock
- 4e – where superficial aquifers are present.

In terms of Groundwater Vulnerability, there is also an east/west split within the study area, with York Street again largely forming the boundary between areas of differing vulnerability. With reference to **Figure 6.10.4**, to the west of York Street, the study area is categorised as Vulnerability 'Class 2', vulnerable to some pollutants but only when continuously discharged/leached. To the east of York Street, the study area is categorised as Vulnerability 'Class 1', only vulnerable to conservative pollutants in the long-term when continuously and widely discarded and leached. Overall, groundwater within the study area is vulnerable only to persistent activity and the travel time of contaminants is typically very slow.

Due to the scale (1:250,000) of the digital geological mapping available, the classification of these areas is generalised, however it provides an overall understanding as to how vulnerable the groundwater is to contamination.

6.10.4.9 *Existing River & Coastal Floodplain*

With reference to the Rivers Agency Strategic Flood Map for Northern Ireland, which provides a strategic overview of the flood risk in Northern Ireland, the River Lagan has associated Q_{100} floodplain which encroaches into the study area (Figure 6.10.5). As the study area is located close to Belfast Harbour and on the fringe of Belfast Lough, it is also located within a coastal (tidal) Q_{200} floodplain and thus vulnerable to sea surge.

The Strategic Flood Map illustrates the areas throughout Northern Ireland that have flooded from rivers and the sea in the past, and those predicted to be prone to flooding now and in the future. Primarily, it has been developed to indicate if a general area may be affected by flooding in the absence of existing flood defences. However, it is not sufficiently accurate to determine the flood risk to individual properties or specific point locations. The Q_{100} floodplain is defined as the extent of a flood event with a 1% annual probability of exceeding the peak floodwater level, and the Q_{200} floodplain is defined as the extent of a flood event with a 0.5% annual probability of exceeding the peak floodwater level.

The presence of the river and coastal floodplain indicates that the study area is at risk of potential flooding if existing flood defences were breached or overtopped.

Information received from Rivers Agency during the current study has however confirmed that the anticipated likelihood of flooding within the study area from rivers and sea is minimal.

6.10.4.10 *Surface Flooding*

Although not illustrated on **Figure 6.10.5**, the Rivers Agency Strategic Flood Map for Northern Ireland also provides information on areas likely to experience localised surface water flooding during extreme rainfall events (i.e. land naturally vulnerable to surface water or “pluvial” flooding). Surface water flooding occurs as a result of rainfall which overwhelms natural or man-made drainage systems, resulting in water flowing overland and ponding in depressions in the ground. With reference to the Rivers Agency Strategic Flood Map for Northern Ireland, sections of the existing local road network (i.e. York Street, Nelson Street, Dock Street and Corporation Street) within the study area are considered susceptible to localised flooding during such events. The strategic road network within the study area (i.e. A12 Westlink, M2 or M3) is not particularly susceptible to such events; however the A12/York Street/York Link junction has been identified as being at risk.

As runoff from the existing road network primarily outfalls by gravity to the existing combined storm and foul water sewers, NI Water has been consulted in connection with the possible risk of surface water flooding. They provided output data from their hydraulic storm and foul sewerage model which demonstrates that there are areas present within York Street and Dock Street which could be subject to surface water flooding under a 1 in 5 year return period design storm event. However NI Water indicated that to their knowledge, there are no recorded historical flooding incidents in the area of the existing York Street junction.

6.10.5 ***Predicted Impacts***

6.10.5.1 *Operation*

As noted earlier, operation of the proposed scheme must ensure that:

- the need for avoidance and reduction of impacts on the water environment is taken fully into account in the environmental evaluation of the options under consideration.

6.10.5.1.1 ***Proposed Road Drainage***

The options under consideration would traverse made ground in the form of hardstanding and brownfield land. As such, the existing terrain is generally quite impervious including large areas of brownfield land that has been cleared and left in a derelict state. As noted earlier, the majority of land is drained through road gullies, drainage and sewerage pipes to a large diameter combined sewer which runs in a south to north direction beneath Corporation Street.

Drainage of any option would be achieved primarily through the use of road drainage gullies discharging to longitudinal collector pipes. At underpass or elevated structure locations and in areas with unavoidable shallow longitudinal gradients, it is anticipated that combined kerb and drainage units discharging to carrier pipes would be utilised as the most appropriate drainage mechanism.

The disposal or discharge of surface water runoff generated from any of the options would however present a number of challenges which would be resolved as part of the ongoing design process. These challenges include the identification of locations for appropriate drainage outfalls, ascertaining permitted rates of storm water discharge, achieving consent to discharge, and obtaining agreement with the appropriate authorities to the acceptable permitted quality of the drainage water to be discharged.

Consultations with NI Water are ongoing and seek to achieve an agreed drainage strategy for the proposed scheme. An assessment of storm water volume and discharge rates from any of the options under consideration would result in minimal increases in volume and rates over existing conditions. Consequently the proposed drainage design (irrespective of which option is preferred) would be centred on the utilisation of the existing adjacent drainage infrastructure. There would however be subtle differences in the outline drainage design proposed between options, which may have associated environmental effects.

All but one of the options under consideration (Option D) would comprise depressed links in the form of underpasses. Option C would require four links to be depressed (Links A, B, C & D), Option A, three links (Links A, B & C), and Option B, two links (Links B & C). As the depressed links would be below existing ground level, they would have to be drained by way of pumping routine runoff to a level where it is able to establish a gravity connection with the existing drainage infrastructure. From an environmental perspective, the adverse affects associated with this would not be particularly significant, other than the fact that a pumping station would be required to achieve gravity connection. Therefore, operation of such a facility over the lifetime of the proposed scheme would be much less sustainable from a drainage perspective than the operation of the elevated links, where gravity drainage systems would be an appropriate solution without recourse to the use of pumped drainage. Furthermore, a pumping station may also be at risk of failure, which may have localised flooding implications if water could not be removed from the carriageway (though such flooding would be contained within the carriageway environment to a point where gravity connection would be achieved). There is scope to provide an emergency overflow drainage connection to the recently completed Belfast Sewers Project storm tunnel (which is approximately 25m below existing ground level); however this would not remove the need for a pumping station. It is expected that this may allow for drainage of the depressed elements of the scheme only in an emergency situation, so that health and safety issues do not arise. This will be given further consideration at Stage 3.

In contrast, the elevation of links from and to the M2 Motorway would increase the surface area which would drain to the Mile Water. To achieve sufficient conveyance capacity, an upgrade of the existing drainage infrastructure to this surface water may also be required. Thus in the case of Option B, and in particular Option D, a significant proportion of Links A & B would drain towards the M2. It is envisaged at this stage that an additional pipeline would also need to be constructed within the eastern M2 Motorway verge or hard shoulder which would outfall to the Mile Water Culvert at the northern end of the scheme. This would result in an increase (though minimal) in routine runoff discharging unattenuated to the Mile Water.

6.10.5.1.2 ***Surface Waters***

As noted earlier, the Mile Water (**Figure 6.10.1**) is the only surface water which passes through the study area. In terms of predicted impacts, Options A and C would require no modification of the existing strategic and local road network in the vicinity of this surface water, thus no direct morphological impact is expected. Options B & D would result in modification of the local road layout at the M2/Duncrue Street off-slip at which the Mile Water is culverted underneath towards Pollock Dock. It is not however expected that this change would require any modification of the existing culvert, thus no direct impact is envisaged at this stage.

The transitional waters of the River Lagan within Belfast Harbour would also not experience any direct morphological modification with any of the options under consideration, as this surface water is beyond the area where physical changes to existing road layout are proposed.

In terms of magnitude of impact, no morphological modification of surface waters is expected with any of the options, thus the effect would be **Negligible**. In essence, there would be no perceptible difference from a morphological perspective to assist in the selection of a preferred York Street Interchange arrangement.

Effects of Routine Runoff on Surface Waters

With reference to DMRB 11.3.10.2, when considering the effects of routine runoff from road improvement schemes, relevant pollutants and their limiting concentrations typically need to be estimated.

In accordance with the objectives identified in the WFD, there must not be any overall deterioration in water quality in any waterbodies affected. Essentially, discharges from the road should not contribute to a deterioration in the classification status of any receiving surface water identified in the Lagan LMA, and if possible contribute to improved overall water quality.

As noted above, the proposed scheme drainage design (irrespective of which option is preferred) would be centred on the utilisation of the existing adjacent drainage infrastructure. In terms of the effects of routine runoff, there would be minimal impact on surface waters as the majority of discharges from any of the options under consideration would drain to the storm and foul water sewerage network and directed to Belfast Wastewater Treatment Works at Duncrue Street. As noted earlier, any public sewer or public sewage treatment works or any main or service pipe within the meaning of the Water and Sewerage Services (Northern Ireland) Order 2006 which is vested in or under the control of a sewerage undertaker does not meet the definition of a ‘water body or waterway’, as defined under The Water (Northern Ireland) Order 1999 (as amended). At Duncrue Street, runoff would undergo multiple stages of treatment, and at times of significantly high flows, at minimum it would undergo primary treatment. In essence, there would be little change over existing conditions with any of the options under consideration with regards to the effects of routine runoff on surface waters.

All options would result in a slight increase in the volume of routine runoff discharging to the Mile Water when compared to existing conditions, though the change would be minimal. Nevertheless, Option D would result in the largest increase, due to the extended elevation of the M2 links, and Options A & C the smallest (as the M2 links would be primarily depressed). As such, there would be an effect on the Mile Water associated with routine runoff; however this would likely be of an insufficient magnitude to affect use or integrity. Consequently, there is little justification at this stage for undertaking a quantitative assessment of environmental risk, when there is likely to be little perceptible difference between options and negligible change over existing conditions. Once a preferred option is selected, further consideration will be given to undertaking a quantitative assessment to establish the degree of environmental risk and if measures would be necessary to mitigate potential adverse impacts.

With implementation of any of the options, there would be minimal or no change to existing discharge arrangements to Belfast Harbour, and there would be minimal or no change to the volume of traffic utilising the M3 Motorway within this drainage area. As such, there would be no perceptible difference between options and minimal change over existing conditions. Hence there is little justification for undertaking a quantitative assessment to establish the degree of environmental risk at this stage, though considering the extensive dilution capability of this surface water, the environmental effect is likely to be insignificant.

In terms of magnitude of impact, even though the difference between options from a routine runoff perspective and subsequent effects on surface waters would be largely **Negligible**, the increase in volume of runoff discharging to the Mile Water with Option D and to a lesser extent Option B, would be less preferred from a water environment perspective.

Pollution Impacts from Accidental Spillages to Surface Waters

The DMRB assessment of pollution impacts from accidental spillages is used to provide an indication of the risk of a spillage causing a pollution impact upon receiving waterbodies.

The risk is defined as the probability that there will be an accidental pollutant spillage and that the pollutant will reach and impact the waterbody to such an extent that a serious pollution incident occurs. The probability is the product of two separate risks:

1. The probability that there will be a spillage with the potential to cause a serious pollution incident.

2. The probability, assuming such a spillage has occurred, that the pollutant will cause a serious incident.

Again, as the majority of discharges from the proposed scheme would be conveyed to Belfast Wastewater Treatment Works via the foul and storm water sewerage network, the risk of a spillage causing a serious pollution incident is minimal.

As noted above, the increase in road surface area draining to the Mile Water with Option D and to a lesser extent with Option B would increase the risk of a pollution incident occurring within the Mile Water, particularly as routine discharges currently do not and may not receive attenuation with scheme implementation. Hence there is little justification at this stage for undertaking a quantitative assessment of spillage risk, when there is likely to be little perceptible difference between options and negligible change over existing conditions. Once a preferred option is selected, further consideration will be given to undertaking a quantitative assessment to establish the degree of environmental risk and if measures would be necessary to mitigate potential adverse effects.

Since the proposed scheme would offer significant improvement to the safety and standard of the highway environment, it would be naturally expected that the risk of a serious pollution incident occurring (when compared to existing conditions) within the Mile Water would be reduced. However, considering the limited change to the existing road layout and minimal increase in surface area, the magnitude of impact would be largely **Negligible**.

6.10.5.1.3 ***Groundwater***

Since the WFD will be fully effective by 2015, a key objective in the North Eastern RBMP is to:

- Protect, enhance and restore all bodies of groundwater, achieve good chemical and quantitative status, prevent pollution and deterioration, and ensure a balance between groundwater abstraction and replenishment.

Assessment of Pollution Impacts from Routine Runoff to Groundwaters

The DMRB has developed a method for assessing risk to groundwater quality through a step-wise framework, identifying and assessing individual components of overall risk posed by the discharge of road runoff to the ground. It provides a means of understanding and assessing generic processes that influence the level of groundwater protection inherent to different source and pathway characteristics. The framework is based on an examination of the 'Source-Pathway-Receptor (SPR) protocol' used in risk assessment developed for contaminated land evaluation and is defined as follows:

- Source - the road drainage.
- Pathway - the processes which may modify the pollutants during transmission through the discharge system and soil and subsoil until the actual 'point of entry' to groundwater (this includes the unsaturated zone).
- Receptor - the groundwater.

All elements of the SPR linkage have to be present to create a pollutant linkage. As there would be no direct discharges to groundwater with the proposed drainage design, no 'point of entry' would exist with any of the options and thus the SPR linkage is not complete. As such, there is no risk to groundwater with any of the options under consideration and no difference between options from a groundwater perspective to assist in the selection of a preferred option.

Pollution Impacts from Accidental Spillages to Groundwater

As there would be no direct discharges to ground with any of the options under consideration, there is no requirement to undertake a quantitative assessment of the risk of pollution impacts from accidental spillages to groundwater.

6.10.5.1.4 ***Flood Risk Assessment***

As discussed in **Sub-Section 6.10.4.9**, the proposed scheme would encroach into the expansive Q_{100} floodplain associated with the River Lagan and the Q_{200} coastal floodplain associated with Belfast Lough. This would raise issues in relation to the requirements of the DMRB and DARD Rivers Agency in terms of:

- impacts which the floodplain may have on the scheme
- impacts which the scheme may have on the floodplain and the current mechanisms and influences on flood progression.

It should be noted that significant existing infrastructure within the greater study area, including parts of Belfast City Centre, is currently within the designated coastal and river floodplain and is subject to flood risk but is protected from regular flooding by existing flood protection measures which are in place along the river banks. The existing circumstances with respect to the floodplain and potential impact of a flood event which breaches the existing protection on the urban area of Belfast City Centre, may create an opportunity for the development of a joint strategy between Roads Service and Rivers Agency. Such a forum could see the development of York Street Interchange being progressed so as to be a beneficial influence on the level of protection afforded to Belfast City Centre during a significant flood event.

A general review suggests that the depressed elements of the scheme options, which require the development of underpass structures, would be at risk of becoming inundated with flood water, should an extreme flood event occur. Preliminary preventative design investigations have been carried out to assess whether existing roads at locations close to proposed on-ramps into underpasses could be raised. Further design investigations have also been carried out to assess whether proposed underpass walls could be raised above envisaged flood levels and thereby be utilised as flood protection walls, which could act in conjunction with raised on-ramps to keep the underpasses free from flood inundation.

Consideration of elevated links, the decks of which would be constructed above the predicted levels of flooding, would remain free from the risk of flood inundation during flood events, however the potential impacts of structural piers and their locations on the floodplain and the progression of a flood event through the site area would need to be assessed.

Design work in connection with the impacts and protection of the scheme will be continued in further detail at Stage 3 and through ongoing consultation with Rivers Agency.

6.10.5.2 *Construction*

The assessment of operational phase impacts undertaken in **Sub-Section 6.10.5.1** does not take cognisance of potential for pollution incidents arising during construction of any of the options under consideration. By their very nature, the construction of projects such as road schemes has the potential to pose significant risk to the water environment at every stage of the construction process.

In terms of physical proximity to surface waters, such as Belfast Harbour or Mile Water, there is very little difference between options. Hence the risk of surface water contamination from construction would be similar if any of the options were constructed.

With regards to the scheme design, depressed options (i.e. Options A & C) would present the greatest risk of surface water contamination (if a pathway can be established) due to the volume of material that would need to be excavated. Considering the underlying ground conditions, this material is likely to be saturated, thus the potential for silt laden runoff discharging to surface waters or the storm and foul water sewerage network during excavation, storage and/or transportation of materials would be high. The elevated options (i.e. Options B & D) would also present a risk to surface waters (as material would be excavated to construct bridge piers), however to a much lesser extent. Furthermore, as Brownfield land (which historically has had previous industrial uses) would predominantly be affected, there is potential for contaminated groundwater to be released to surface waters during excavation.

The depressed options (i.e. Options A & C) would present the greatest risk of disruption to natural flow due to the physical subterranean barrier that would be created through the retaining structures associated with links below existing ground level.

The construction activities that pose the highest risk of surface water impact are extensive and detailed in **Table 6.10.6** below, along with the options which are likely to pose the greatest pollution risk.

TABLE 6.10.6: CONSTRUCTION ACTIVITIES THAT POSE A HIGH RISK OF SURFACE WATER IMPACT

Pollution Risk	Hazards	Option(s) likely to pose the greatest risk w/o mitigation (ranked highest to lowest)
1. Activities that provide a pollution source.	• Uncontrolled sediment erosion and contaminated silty runoff;	Option C, A/B, D
	• Refuelling facilities, chemical and waste storage or handling areas;	All
	• Polluted drainage and discharges from site; and	Option C, A/B, D
	• Contaminated groundwater from dewatering of contaminated sites.	Option C, A/B, D
2. Activities that cause significant variations in natural flow.	• Unregulated and poorly constructed abstractions and discharges e.g. dewatering;	Option C, A/B, D
	• Changes to the existing drainage network including interception and redirection of natural and artificial watercourses (e.g. field drains);	Option C, A/B, D
	• Discharge of groundwater to surface water.	Option C, A/B, D
3. Activities that significantly modify or destroy physical habitats.	• Watercourse crossings; • Works within water; and • Outfall points.	N/A

Source: CIRIA 648 'Control of Water Pollution from Linear Construction Projects'

During construction, pollution from mobilised suspended solids generally forms the primary risk with regards to adverse impacts upon the water environment, but spillage of fuels, lubricants, hydraulic fluids and cement from construction plant may lead to incidents, especially where there are inadequate pollution mitigation measures. Other risks include (though not exhaustive):

- Pollution due to vandalism of stores or plant.
- Pollution due to waste materials, dust or residues from handling contaminated land .
- Pollution from pumped discharges, for example, dewatering. These can also cause erosion.

6.10.6 *Mitigation and Enhancement Measures*

6.10.6.1 *Operation*

Appropriate management of carriageway surface water runoff would maintain water quality and quantity in existing surface waters and prevent adverse impacts arising. As noted earlier, the majority of routine runoff from any of the options would discharge direct to the storm and foul water sewerage network and treated in Belfast Wastewater Treatment Works at Duncrue Street.

With reference to the North Eastern RBMP, DRD Roads Service has made a commitment to reduce pollution and flood risk by adopting Sustainable Drainage Systems (SuDS) on all new motorways, dual carriageways and roads to be improved of that standard (where technically and economically feasible). In the case of York Street Interchange, due to the existing urbanised nature of the study area, the proposed cumulative discharge rates and similar to existing discharge volumes, from a water quantity perspective there is little justification for the use of SuDS. As there are limited areas of vegetation within the study area, and as available land is limited and costs high, the additional land required to provide vegetated SuDS solutions would be technically and economically difficult to provide/acquire when there is little justification for SuDS from a water quality perspective. The introduction of open water hazards in an urban environment could also be seen as a significant health and safety risk.

The provision of other non-vegetated/'hard' SuDS features will be considered at Stage 3. At this stage it is anticipated that road edge gullies discharging to carrier drains with intermediate catchpits/chambers would be proposed, along with sumps to remove coarse silts from routine runoff.

6.10.6.2 *Construction*

Measures to protect the water environment during construction would be formulated in accordance with best practice guidance, such as Pollution Prevention Guidelines (PPG's), jointly published by NIEA, the Environment Agency, the Scottish Environment Protection Agency (SEPA) and CIRIA guidance documentation *C648 'Control of Water Pollution from Linear Construction Projects'*, C532 *'Control of Water Pollution from construction sites: guidance for consultants and contractors'* (Masters-Williams et al, 2001) and SP156 *'Control of Water pollution from construction sites – guide to good practice'* (Murnane et al, 2002). This documentation comprehensively details issues that present the risk of adverse impacts occurring within the water environment and how to mitigate such impacts. In essence, irrespective of which option is selected, stringent mitigation measures would be tailored and applied to ensure adverse impacts upon the water environment are avoided.

6.10.7 ***Residual Impacts***

As noted earlier, it is not sufficient to assess the size and probability of potential impacts; their significance should also be assessed. The level of significance is to be assigned after consideration of any proposed mitigation (i.e. significance is assigned with mitigation in place allowing for the positive contribution of all mitigation that is proposed). It is therefore the residual impacts associated with the proposed scheme that are most reflective of what the overall predicted impact would be upon the water environment during the operation and construction phase.

6.10.7.1 *Significance of Potential Effects (Operation)*

In terms of morphological impacts on surface waters, the significance of potential effects would be **Neutral** with all options under consideration, as no surface water is expected to experience morphological changes with scheme implementation.

With regards to effects of routine runoff on surface waters, the significance of potential effects would also be **Neutral** with all options under consideration, as the majority of discharges would be to the existing foul and storm water sewerage network, which does not meet the definition of a 'water body or waterway', as defined under The Water (Northern Ireland) Order 1999 (as amended). There would be a slight increase in the volume of routine run-off that would discharge to the Mile Water (particularly with Option D), however considering the importance of the receiving surface water and minimal change over existing conditions, the effect would be no worse than **Neutral**.

In terms of pollution impacts from accidental spillages to surface waters, again the significance of potential effects would be **Neutral** with all options under consideration, as the majority of discharges would be to the existing foul and storm water sewerage network, thus the risk of a spillage causing a serious pollution incident is minimal.

With regards to the assessment of impacts from routine runoff to groundwaters and the potential for impacts from accidental spillages, the significance of potential effects would be **Neutral** with all options under consideration, as no pathway to groundwater would be established with scheme implementation.

As the proposed scheme is unlikely to increase the risk of flooding within the study area, the significance of effect is likely to be **Neutral**, even though there is the risk of depressed links being inundated during flood events.

6.10.7.2 *Significance of Potential Effects (Construction)*

Even though the receiving water environment is not deemed to be particularly important/sensitive and has significant dilution capabilities, without prescriptive and stringent mitigation measures being effectively implemented on site, there would be an adverse risk to the water environment during the construction of any of the options under consideration, though particularly with Option C (due to the significant degree of excavation required). With effective mitigation, the majority of potential effects would however be assessed as **Neutral**. Nevertheless, the significance of effect would entirely depend upon committed application on-site through continuous monitoring, reporting and communication before, during and after the construction phase.

6.10.7.3 *Summary and Conclusions*

Very few of the adverse impacts upon the water environment associated with any of the options under consideration would be fundamental to the decision making process when selecting the Preferred Option.

In essence the risk to the water environment would be minimal with utilisation of the existing adjacent drainage infrastructure for routine runoff. However, strictly in accordance with the WFD, the elevated options (Options B & D) would be least preferred, due to the minimal increase in volume of runoff that would discharge to the Mile Water, thus impacting upon water quality. This however should not be considered fundamental to the decision making process in selecting the Preferred Option.

During construction, the depressed options (Options A & C) would be least preferred, as the volume of material to be excavated would pose the greatest risk to the water environment, though again with effective mitigation this should not be considered fundamental to the decision making process in selecting the Preferred Option.

6.11 Geology and Soils

6.11.1 *Introduction*

Geology and soils play an important part in determining the environmental character of an area. The nature and alignment of rocks has a major influence on landform and subsequent road development. Northern Ireland has approximately 97 soil parent materials, making it the most geologically diverse area of its size in the British Isles. The nature of geology as a parent material influences the character of the soil of a region. Soil chemistry and physical structure would influence the type of vegetation native to that area. Soil type is a major determining influence on the agricultural worth of an area of land. Road schemes can have an impact on both the geology and soils of an area, and it is therefore important that the potential impacts of development on these environmental factors are considered fully.

Geological or geomorphological features, which are considered to be of significant national importance, are designated as Areas of Special Scientific Interest (ASSI's), meaning that they have a certain degree of statutory protection against operations which might cause damage or loss of that important feature. Consideration must be given to the impact of proposals on ASSI's. In Northern Ireland, other sites of geological importance are classified by Northern Ireland Environment Agency (NIEA) – Natural Heritage as being Earth Science Conservation Review (ESCR) sites.

The objective at this secondary stage is to consider the impact of the interchange options upon the geological and soil assets/constraints within the area and the significance of those effects. This includes assessment of impact upon soils, contaminated land, and sites of geological importance/interest.

6.11.2 *Methodology*

Assessment at this secondary stage considers the following areas:

- impact on important geological mineral deposits
- impact on soils
- impact on any sites that have educational or scientific interest due to their rarity
- the possibility of hazardous materials being exposed.

In accordance with the requirements of DMRB Volume 11, Section 3, Part 11 (Geology & Soils), Chapter 7 (Stages of Assessment), the steps taken include:

- Consultation with the Geological Survey of Northern Ireland (GSNI) and NIEA – Natural Heritage to confirm details on the location and nature of any designated sites of geological interest within the study area.
- Confirming and updating information on the superficial and solid geology, and nature of soils in the study area.
- Consultation with the Department of Agriculture and Rural Development (DARD) to obtain information on the agricultural quality of land within the study area (where appropriate).
- Consultation with Belfast City Council and NIEA – Land & Resource Management Unit to confirm and update information on any known or potential areas of contaminated land within the study area.

6.11.2.1 *Assessing the Significance of Effects*

With reference to DMRB Volume 11, Section 2, Part 5 HA 205/08, Chapter 2 (Determining Significance of Environmental Effects), it is not sufficient to assess the size and probability of possible impacts: their significance should also be assessed. The significance of the effect is formulated as a function of the receptor or resource's environmental value (or sensitivity) and the magnitude of project impact (change). In other words, significance criteria are used to report the effect of the impact; however DMRB does not provide an approach to determining the significance of effects resulting from changes to geology & soils associated with the proposed scheme.

Firstly, to assess the overall significance of potential effects of the scheme options on geology & soils, an assessment has been made of the sensitivity of the resource, using the general criteria contained in **Table 6.11.1**.

TABLE 6.11.1: ESTIMATING THE IMPORTANCE OF GEOLOGY & SOILS

Importance	Criteria	Example
High	High Attribute with high quality and rarity, national scale	Area of educational or scientific geological interest (i.e. ASSI) Earth Science Conservation Review (ESCR) site Free draining agricultural soils (i.e. Rankers, Brown Earths)
Medium	Attribute with medium quality and rarity, regional scale	Non-designated areas of educational or scientific geological interest (i.e. outcrop exposure) Areas licensed for mineral extraction Free draining agricultural soils (i.e. Shallow Brown Earths, Podzols)
Low	Attribute with low quality and rarity, local scale	Sites not in the above categories but with some geological interest. Impeded/Poor draining agricultural soils – Surface Water Gleys, Alluvium
Negligible	Areas of little or no interest	Other areas of superficial geology or geomorphological feature. No soil profile - Peat, Urban, Disturbed.

The presence and sensitivity of receptors at risk from potential land contamination can be assessed by consideration of the following:

- surrounding land uses, based on mapping and site visits and the occupants of the proposed adjacent sites.
- proposed end-use, based on the nature of the proposed development
- type of construction operations that will be necessary as part of the proposed scheme
- surrounding sites of nature conservation importance
- geology, hydrogeology and hydrology of the site and its surrounding area.

The sensitivity of potential receptors can be described qualitatively, according to the categories shown in **Table 6.11.2**.

TABLE 6.11.2: DESCRIPTIVE SCALE FOR SENSITIVITY OF RECEPTORS

Qualitative Description (Receptor Sensitivity)	End Users (operational workers/ visitors)	Surrounding Land Uses	Construction Workers	Ecological Sites	Built Environment
High	Residential, allotments, play areas	Residential area	Extensive earthworks, and demolition of buildings.	Nationally or internationally designated ecological sites.	Buildings, including services and foundations of high historic value or other sensitivity.
Medium	Landscaping or open space	Open space or commercial area	Limited earthworks	Locally designated ecological sites.	Buildings, including services and foundations.
Low	“Hard” end use (e.g. roads, industrial, car parking)	Industrial area	Minimal disturbance	No sites of significant ecological value close by.	Not applicable.

The magnitude of impact is defined wherever possible using the terms defined in **Table 6.11.3**.

TABLE 6.11.3: ESTIMATING THE MAGNITUDE OF IMPACT ON AN ATTRIBUTE

Importance	Criteria
Major	Direct loss of a feature of interest, High risk of exposure of a sensitive receptor to potentially harmful levels of contamination via a confirmed pathway.
Moderate	Partial loss of a feature of interest Proven source – pathway – receptor pollutant linkage identified with elevated level of contamination recorded.
Minor	Minor effect on a feature of interest, Superficial disturbance to geology, changes in geomorphology, Identified source – pathway – receptor pollutant linkage identified but contamination likely to be low risk.
Negligible	Insufficient impact to affect feature of interest. Changes to made ground deposits, No source – pathway – receptor pollutant linkage identified.

DMRB Volume 11, Section 3, Part 11 does not describe how the significance of effects should be scaled with regards to geology & soils. Therefore, **Table 6.11.4** outlines a suggested means of estimating the significance of potential effects, based upon the magnitude of impact and sensitivity of the receptor. Professional judgement and awareness of the relative balance of importance between sensitivity and magnitude allows the overall significance of impact to be assessed. The significance of impact is assessed with mitigation to define residual impacts.

TABLE 6.11.4: ESTIMATING THE SIGNIFICANCE OF POTENTIAL EFFECTS

IMPORTANCE OF ATTRIBUTE					
	High	Neutral	Moderate/Large	Large/Very Large	Very Large
	Medium	Neutral	Slight/Moderate	Moderate/Large	Large/ Very Large
	Low	Neutral	Slight	Moderate	Large
		Negligible	**Minor**	**Moderate**	**Major**
		MAGNITUDE OF IMPACT			

Source: DMRB 11.2.5.2 (Arriving at the Significance of Effect Categories - adapted)

6.11.3 ***Regulatory/Policy Framework***

The following key planning policy and national legislation is pertinent to the assessment of the approved options in relation to impacts upon geology and soils.

6.11.3.1 *The Environment (Northern Ireland) Order 2002*

This legislation requires NIEA to identify and designate Areas of Special Scientific Interest (ASSI's). ASSI's are nationally important sites which are designated for their important flora, fauna or geological features. The Order replaces the original ASSI provisions contained in the Nature Conservation and Amenity Lands (NI) Order 1985 (as amended).

6.11.3.2 *The Waste and Contaminated Land (Northern Ireland) Order 1997 (Part 3)*

The Order contains the main legal provisions for the introduction of a contaminated land regime in Northern Ireland. The Order was enacted in 1997 but the regime is not yet in operation. The Part 3 regime aims to deal with the legacy of historically contaminated land through the "polluter pays" principle. This will ensure that, where possible, those who pollute the land will pay for its remediation so that it is "suitable for use".

6.11.3.3 *The Waste Management Regulations (Northern Ireland) 2006 and The Water Order (Northern Ireland) 1999*

The management of all materials onto and off the scheme construction site should be suitably authorised through the Waste Management Regulations (Northern Ireland) 2006 and/or the Water Order (Northern Ireland) 1999. This should be demonstrated through a Site Waste Management Plan (SWMP) (see http://www.netregs.gov.uk).

6.11.3.4 *The Plant Health Order (Northern Ireland) 2006*

Under Articles 10 to 12 of this Order, certain relevant material shall not be removed from an area of plant health control (defined in Article 10(2)) until the Department is satisfied as to the matters specified in Article 12, unless an inspector has discharged that relevant material or the removal of that relevant material is permitted under Part 6 (measures to control the landing of relevant material and prevent the spread of plant pests).

6.11.3.5 *Planning Policy Statement 2 (PPS 2) Planning and Nature Conservation*

Strongly guided by Government policy, PPS 2 states the policy for nature conservation for the whole of Northern Ireland. It helps to protect designated areas and advises on the treatment of nature conservation issues in development plans. In addition, it outlines the criteria that Planning NI employs when processing planning applications which might affect nature conservation interests, and to which developers should have regard when preparing proposals. Geological features and landforms are included as important components which form the focus of the conservation policies within the document.

6.11.4 ***Baseline Conditions***

6.11.4.1 *Superficial Geology*

With reference to the BGS/GSNI GeoIndex map viewer [on-line], the study area is underlain by drift deposits mainly comprising of:

- Raised Beach (shore line) Deposits
- Estuarine Alluvium
- Glacial Deposits including (firm clay, stiff clay, stiff clay occasionally with thin laminations, and glacial sand & gravel bands).

On the map viewer geological plan there is a line which marks the indicative upper most level of the raised beach shore line. These deposits are localised and occur predominately beneath the made ground across the western edge of the study area. These normally consist of sand and sand & gravels, with occasional cobbles and shell debris present.

Estuarine Alluvial Deposits (locally known as “Belfast Sleech”) is encountered beneath the made ground and are present over much of the study area. These normally consolidated grey silty clay sediments with variable organic content extend to approximately 9.5m to 12m below ground level (bgl). They are highly compressible and typically very soft, or soft with very low bearing strength. In some areas, alluvial sand with layer thickness up to 2.8m is encountered underlying the made ground and overlying the soft estuarine deposits.

A thin layer of peat is commonly found underlying the estuarine deposits with thickness varying between 0.3m to 1.5m. The peat is generally described as dark brown friable sub-amorphous peat with decayed roots and occasional lenses of grey fine sand. Peat is a weak and highly compressible material that that is likely to undergo significant settlement, which may extend over many years. Peat is unsuitable for use as general engineering fill material, and is often unsuitable for use as landscape fill.

Alluvial deposits generally underlie part of the estuarine deposits and consist of medium density sandy gravel and occasionally medium density silty gravelly sand, separated in areas by the peat layer. The layer thickness encountered varies between 2.2m to 3.4m as recorded in the historical exploratory holes. Cohesive alluvial materials are generally unsuitable for use as general engineering fill material, but may be suitable for use as landscape fill. Granular alluvial deposits may be suitable for use as engineering fill, depending on its composition.

The glacial deposits (boulder clay) are encountered beneath the alluvial and estuarine deposits. These deposits are generally described as firm to stiff, becoming very stiff sandy silty clay with presence of occasional cobbles and boulders. The glacial deposits in Belfast are generally divided into three layers (the Upper Boulder Clay, the Middle (Malone) Sands, and the Lower Boulder Clay).

Upper Boulder Clay comprises brown to reddish brown plastic clay with a low stone content. It may include partings and lenses of silt and fine sand, and some laminated clay. The material is typically firm to stiff, with medium to low compressibility and is slightly overconsolidated.

The Middle (Malone) Sands are typically a stratified reddish-brown, fine to medium grained, silty sand with occasional gravel layers and laminated clay. The material is typically medium density with medium to low compressibility.

Lower Boulder Clay comprises reddish brown clay with a high stone and boulder content. It may include sand lenses and laminated clays. The material is typically stiff to very stiff, with low compressibility.

Glacial till may be suitable for engineering purposes, such as foundations or earthworks depending on the material properties. Reuse of till for earthworks general fill may be possible, depending on its strength and other properties. Moisture modification of wet glacial tills may allow re-use, otherwise the material will only be suitable for re-use as landscaping fill.

6.11.4.2 *Solid Geology*

With reference to the BGS/GSNI GeoIndex map viewer [on-line], the underlying bedrock of the study area consists of the Sherwood Sandstone Group (formerly 'Bunter Sandstone') of Triassic age. This consists of reddish brown fine grained sandstone and siltstone, and mudstones with occasional small conglomerate bands. The bedrock is weathered to differing degrees across the study area. At the M3 embankment section (adjoining the M2 motorway), bedrock is encountered at a depth of approximately 13.8m to 23m bgl. The bedrock then dips east towards the River Lagan, reaching a depth of approximately 39m to 51m bgl. The sandstone bedrock is generally described as weak to moderately strong, dark orange brown, and brown fine grained sandstone.

The bedrock has been intruded by several basalt dykes of Tertiary age which trend in a northwest to southeast direction. Basalt is encountered in and around the North Queen Street and Great George's Street junction, between 4m to 12.2m bgl. This is generally described as weak to moderately strong, fine to medium grained Basalt with calcite veining. Basalt is also encountered in and around the Yorkgate Railway Station area, between 17.7m to 19.2m bgl.

6.11.4.3 *Soils*

With reference to the 1:50 000 Soils Map for Belfast (Sheet 15), the study area is classified as 'urban'. Thus it does not offer any significant information, other than to suggest that the upper layer of the soils may have been modified. There are numerous man made features in the study area, given its urban location. These include, but are not limited to, the following:

- existing retaining walls along Great George's Street and Little George's Street, which support the A12 Westlink
- the rigid pavement construction of A12 Westlink, comprising a continuously reinforced concrete slab
- M3 and M2 road embankments
- North Queen Street Bridge
- Dock Street Bridge
- Lagan Bridge and Dargan Bridge
- Northside Park & Ride facility
- Roads Service car parks at Corporation Street (under the Lagan Bridge)
- Roads Service's Corporation Street Depot
- Roads Service's land adjacent to their Corporation Street Depot (presently being used as a contractor's compound for the Belfast 'Streets Ahead' project).

Historical exploratory holes indicate the placement of fill material, which is likely to be associated with providing a firmer surface above the soft alluvial sleech deposits.

6.11.4.4 *Earthquake Seismicity*

With reference to the BGS/GSNI GeoIndex map viewer [on-line], there has only been one known historical earthquake epicentre within a 10 km of the site. Earthquake magnitude was 2.5, based just to the north of Carrickfergus in October 1990.

6.11.4.5 *Minerals*

There are no known minerals of economic importance, active quarries, or areas licensed for mineral development within the study area. With reference to the BGS/GSNI GeoIndex map viewer [on-line], there are no historic mine workings, such as Shafts or Adits, or petroleum license areas within the study area.

6.11.4.6 *Contaminated Land*

Given that the study area is located on the periphery of the City Centre, the historical land use has varied as much as Belfast's industrial past. As such, it is reasonable to expect that unquantified fill material would be present across the site and that within some of that material, contaminants may be present.

Where land has been contaminated by waste and residues from former industrial processes, the presence of toxic or other hazardous material may pose threats to human health or impose other constraints. Consultation with Belfast City Council (Health & Environmental Services Department), has confirmed that there are a plethora of sites of potentially contaminated land within the study area, due to past and present industrial usage of this land. With reference to Figure 6.11.1, the sites of potential contamination within the immediate study area include:

- mechanical engineering adjacent to Shipbuoy Street
- food preparation & processing site between Nelson Street and Corporation Street
- petrol stations / fuel storage sites at various locations (York Street & Corporation Street).

There are several potentially contaminated sites surrounding the study area. With reference to **Figure 6.11.1**, these include:

- Petrol Stations/Fuel Storage
- Printing Works
- Food Preparation and Processing
- Tobacco Works
- Timber Treatment
- Iron and Steel Works
- Ship Building.

Of the above potential sources of contamination, it is considered that the bridging/infill layer of fill material, and those sites/buildings now demolished and underlying the present road corridor may pose a moderate to high risk.

6.11.4.7 *Designated and Non-Designated sites*

With reference to NIEA - Natural Heritage digital data sets of protected sites and BMAP (Draft) 2015, it is evident that there are no national or international sites of geological significance within the immediate study area. Beyond the study area, there is however a number of sites designated in part for their geological features.

Belfast Lough, located approximately 1.5 km northeast of the study area, is designated at both national and international level. The inner part of the lough comprises areas of intertidal foreshore, consisting of mudflats and lagoons, and reclaimed land which form important feeding/roosting sites for significant numbers of wintering waders and wildfowl. The outer lough is restricted to mainly rocky shores, with some small sandy bays and beach-head saltmarsh. The shoreline of mudflats, sandy bays and rocky shores are designated as an Area of Special Scientific Interest (ASSI). The ASSI designations consist of two separate sites; Inner Belfast Lough ASSI and Outer Belfast Lough ASSI.

Inner Belfast Lough ASSI contains several Earth Science Conservation Review (ESCR) sites of national geological interest in the form of Ordovician, Carboniferous and Permian features. Outer Belfast Lough ASSI is also geologically important, due to the Ordovician series of spilitic lavas, black shales and greywackes, amongst other series located here.

6.11.5 ***Predicted Impacts***

6.11.5.1 *Superficial Geology*

Each of the options under consideration would affect similar underlying superficial deposits, though the magnitude of impact would vary depending on whether a link would be elevated or depressed. Option C, and to a lesser extent Options A & B, would require deep cuttings to accommodate depressed links. These would expose estuarine/alluvial deposits which may be contaminated and are expected to have high groundwater levels which would need to be drained/controlled as part of the design and construction of cuttings. Nevertheless, the disturbance to such deposits would be in itself superficial, thus the magnitude of impact would be **Minor Adverse** to **Negligible**.

Elevated links (i.e. Option D, and to a lesser extent Option B) would also impact upon superficial geology, particularly where deposits are soft and compressible, and thus would be unsuitable as fill material and for supporting structures. To provide stability and settlement control, it is likely that driven and bored piles would be utilised.

6.11.5.2 *Solid Geology*

It is not expected that bedrock would be encountered to any great extent with any of the options under consideration, thus the magnitude of impact would be considered **Negligible**. There is the possibility however that in order to stabilise certain structures, piling into bedrock may be required.

6.11.5.3 *Soils*

As the soils affected by any of the options under consideration are classified as 'Urban' (i.e. made ground), the upper layer may have been modified and thus has no soil profile. Therefore the magnitude of impact would be **Negligible**.

6.11.5.4 *Minerals*

As there are no areas of known mineral deposits, active quarries, or licensed areas of mineral development in the vicinity of the proposed options, no impact can be expected. Hence, the magnitude of impact would be **Negligible** with any of the options under consideration.

6.11.5.5 *Contaminated Land*

6.11.5.5.1 ***Overview***

Contaminated land assessment is typically carried out on a source-pathway-receptor model whereby a source of contamination is identified, its potential to migrate, be transported or otherwise interact with receptors determined, and the possible consequences that could result from such interaction assessed. The factors below are by no means exhaustive and, given the limitations of the information available at this stage, are liable to change following detailed investigation.

6.11.5.5.2 ***Sources***

Information on sites of potential contamination was obtained from NIEA – Land & Resource Management Unit (**Figure 6.11.1**). This information was provided on a 'without prejudice' basis and has not been fully validated.

Based upon this information, a number of locations would be directly affected by the options under consideration and have been identified as being of high risk of contamination, due to past or current activities. These include:

- fuel tanks and fuel storage (between Nelson Street and Corporation Street)
- mechanical engineering works (between Great George's Street and Shipbuoy Street)
- food preparation and processing (between Nelson Street and Corporation Street).

A number of other potentially contaminated features have also been noted close to the proposed options. Most of these locations have been verified through a review of the historical mapping.

While no current activities are registered, the nature of the infill in such areas is unknown and may contain potentially contaminated materials that require treatment or removal from site. It is possible that recently developed areas of land for housing may have been contaminated by the use of irregular infill materials.

The potential contaminants present and risks posed would need to be identified as part of assessing any option, particularly those shown in cutting (Option C, and to a lesser extent Options A & B).

6.11.5.5.3 ***Pathways***

The sources of contamination discussed above require some form of pathway in order to reach a receptor. This type of contamination and its current state would determine how it can be transported, but the following is a brief summary of the key pathways:

- Air
  - typically affecting dust and other windborne particles that can be inhaled, ingested or blown into direct contact. Also includes any ground or landfill gases.
- Surface waters
  - contaminants running into drainage ditches or watercourses.
- Groundwater
  - contaminants leaching into the soils and infiltrating the local water table with the potential to reach abstraction wells.
- General soil contamination
  - either at the original source where not suitably remediated or being spread across the wider area through poor working practice, direct contact with receptors, including ingestion and inhalation, interacting with the location would be the main pathway.

- The natural food-chain
  - consumption of crops, livestock or fish that have all come into contact with contaminants.

6.11.5.5.4 ***Receptors***

The sources of contamination discussed above are likely to have minimal impact on the immediate end-users who, in the context of this scheme, would be members of the public driving vehicles and therefore be protected from much of the contamination. Other receptors would be at greater risk however, and include the following:

- Construction workers during the building of the road and to a lesser degree, public walking through the area on a transient basis.
- Highway and utility maintenance workers following construction of the road.
- Flora, including crops, through uptake from contaminated soils or surface/ground waters.
- Fauna, particularly aquatic life that could be affected through contamination of watercourses.

6.11.5.6 *Designated and Non-Designated sites*

There would be no designated or non-designated geological sites affected within the study area. The closest site is Inner Belfast Lough ASSI to the northeast. As a result, a **Negligible** magnitude of impact rating is considered appropriate.

6.11.6 ***Mitigation and Enhancement Measures***

As there would be no significant impact on the geology and soils of the area from an operational perspective, no mitigation would be considered necessary.

In terms of construction and its impact on superficial and solid geology, no mitigation is proposed as the study area is already highly disturbed, and implementation of any of the options is unlikely to cause any further disruption. Similarly, there is no anticipated impact on soils in the area, due to its urban nature.

On encountering any contaminated material, a full investigation would be required; with the issue being dealt with in accordance with the advice of the relevant authorities and if necessary special disposal arrangements. An appropriately licensed landfill site for excavated material may be required. During Stage 1 BCC has advised that records of potentially contaminated land are by no means complete and the only means in which land can be determined as contaminated is to conduct a Contaminated Land Risk assessment, in line with current government guidance *(Model Procedures for the Management of Land Contamination (CLR11)*). Hence, potentially contaminated land would be investigated further, possibly as part of the geotechnical investigation at a later design stage. Remediation measures (if necessary) would be determined by this ground investigation.

6.11.7 ***Residual Impacts***

As noted earlier, it is not sufficient to assess the size and probability of potential impacts; their significance should also be assessed. The level of significance is to be assigned after consideration of any proposed mitigation (i.e. significance is assigned with mitigation in place allowing for the positive contribution of all mitigation that is proposed). It is therefore the residual impacts associated with the proposed scheme that are most reflective of what the overall predicted impact would be during the operation and construction phase.

6.11.7.1 *Significance of Potential Effects*

From a geology and soils perspective, considering that there are no features of geological interest and the soil has no profile, the importance of geology and soil assets within the study area are **Negligible**. Furthermore in terms of impact, there are relatively few key issues other than the impact upon groundwater and potentially contaminated land with options in cutting (Option C, and to a lesser extent Options A & B). Nevertheless, these effects would be transient and in the long term, **Neutral**.

6.11.8 ***Summary and Conclusions***

- No significant effect on superficial or solid drift geology is anticipated with implementation of any option.
- With the entire study area being classified as 'urban' in terms of soil, no significant effect is anticipated on the soil environment.
- There is no anticipated impact on areas of mineral extraction with any option.
- Potential areas of contaminated land may be encountered at a number of locations throughout the study area. Where contaminated land is encountered, further investigation would be necessary, including a Contaminated Land Risk assessment, to assess the appropriate remediation/mitigation measures. The chance of encountering contaminated land would be higher with Option C, and to a lesser extent Options A & B.
- There is no anticipated impact on designated or non-designated areas with any option.

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7 TRAFFIC AND ECONOMIC ASSESSMENT

7.1 Introduction

The York Street Interchange in the centre of Belfast is one of the most heavily trafficked junction arrangements in Northern Ireland.

Operating conditions in the York Street area of Belfast, at the intersection of the strategic M1 / Westlink, M2 and M3 Motorways, are such that road users experience significant delays and congestion during periods of peak traffic demand.

As a result of a programme of ongoing improvements in the area, traffic conditions have changed significantly over the past few years. The M1 / Westlink improvement was completed in March 2009 and delivers traffic more efficiently to the York Street area. The M2 Motorway widening, which was completed in August 2009, also improves the flow of traffic heading towards the York Street Interchange.

The study area for the traffic and economic assessment focuses on the immediate area around York Street, York Link, Nelson Street and Great George's Street. This area has been extended to include modelling of the key junctions along Dock Street in the north, Great Patrick Street in the south and the Clifton Street slips in the west to allow consideration of the wider traffic effects of the proposed York Street improvements. The survey area also extends to the Fortwilliam junction to allow modelling of the effects of the proposed changes to the speed limits on the M2 Motorway and the effects of potential traffic redistribution at Duncrue Street.

A general location of the York Street Interchange and the surrounding road network area is shown in **Figure 7.1.1**. A more detailed key location plan is shown in **Figure 7.1.2**.

The primary objective of this section of the report is to describe existing traffic conditions in the York Street area, to outline the indicative costs, risks and optimism bias associated with each of the scheme options assessed and to describe the modelling work undertaken to develop the computer models. This section also considers future traffic conditions over the economic life of the scheme and presents the results of an operational and economic assessment of the preliminary options. Given the uncertainty in predicting future traffic conditions, the results from a sensitivity test have also been reported in this section.

7.2 Existing Conditions

Existing conditions in the York Street area are subject to significant congestion during periods of peak traffic demand due to the convergence of traffic from the M1 Westlink, the M2 and M3 motorways and the local surface streets. This demand is controlled by a series of signalised junctions, where signal timings are monitored and adjusted regularly to improve traffic flow during peak periods. The key junctions in the immediate area around York Street are described below.

At the York Street / Great George's Street signalised junction, northbound traffic on York Street approaches Great George's Street in five lanes with an additional left-turn lane to access both Great George's Street (west) and the Westlink. Great George's Street is six lanes wide at the junction, with the left lane dedicated for Great George's Street (west), three lanes continuing through to Westlink and two lanes accommodating right-turn manoeuvres on to York Street.

At the Westlink / York Street / York Link junction, traffic approaches from Westlink in six lanes. The left lane is dedicated for traffic turning left on to York Street. Three lanes continue through to the M2 motorway northbound on-slip and the remaining two lanes continue on to York Link. The five lanes approaching the junction from York Street separate to provide two straight-through lanes continuing along York Street and three right-turn lanes on to the M2 motorway northbound on-slip. An additional slip lane is available for traffic turning right on to York Link.

At the York Link / Nelson Street junction, York Link approaches the junction in three lanes, two of which continue to the M3 motorway eastbound on-slip. The remaining lane turns right on to Nelson Street and the surface street network. The Nelson Street approach from the north provides a total of five lanes, three of which continue through the junction heading towards the right turn on to Great George's Street and two of which are divided between the left turn movement on to the M3 motorway eastbound on-slip and the straight though movement on to Nelson Street heading towards the Dunbar Link.

At the M3 Motorway / Nelson Street / Great George's Street junction, traffic approaches the junction in four lanes from the M3 motorway off-slip which widens to create an additional left turn lane on to Nelson Street. The Nelson Street approach is separated by a raised kerb with three lanes turning right on to Great George's Street and a further two lanes continuing through the junction on to Nelson Street heading towards the Dunbar Link.

The existing junction layout and lane configuration at York Street Interchange is shown in **Figure 7.2.1**.

To assist in establishing traffic conditions at the key junctions, a programme of traffic surveys was undertaken in 2010. Details of the traffic surveys are described in **Section 7.3**.

7.3 Data Collection Surveys

7.3.1 *Introduction*

A programme of data collection surveys was undertaken in 2010 to assist in establishing traffic volumes, turning flows and vehicle proportions at key junctions in the York Street area.

In summary, the survey data included the following:

- Manual Classified Counts
- Pedestrian and Cyclist Counts
- Journey Time Surveys.

7.3.2 *Manual Classified Counts*

7.3.2.1 *Methodology*

A programme of Manual Classified Counts (MCCs) was carried out at twenty four locations within the study area on Wednesday 21 April and Thursday 22 April 2010 to define current traffic volumes and turning movements. This included seventeen junction turning counts (JTCs), three link counts and four car park counts. It should be noted that in/out manoeuvres only were recorded at the four car park sites.

The MCC data for all sites were collected in 15-minute intervals between 07:00 hours and 19:00 hours during the weekday surveys to provide a 12-hour record of turning movements and link flows.

Due to the anticipated volumes of traffic at the junctions identified above, a simpler vehicle classification than the standard COBA 5-vehicle classification was adopted for the surveys. The vehicle types recorded were as follows:

- Light Vehicles (LV) = Car and LGV
- Heavy Goods Vehicles (HGV) = OGV1 and OGV2
- Buses = Buses and Coaches.

7.3.2.2 *MCC Locations*

The locations of the MCCs are shown in **Figure 7.3.1**.

The Junction Turning Count MCCs were undertaken at the following locations:

- J1 – York Street / M2 On-Slip / York Link / Westlink
- J2 – York Street / Westlink / Great Georges Street
- J3 – Nelson Street / Great Georges Street
- J4 – Nelson Street / York Link
- J5 – Corporation Street / Clarendon Road
- J6 – Corporation Street / Corporation Square
- J7 – Nelson Street / Dock Street / Garmoyle Street / Corporation Street
- J8 – York Street / Dock Street / Brougham Street
- J9 – Duncairn Gardens / North Queen Street / Brougham Street
- J10 – North Queen Street / Great Georges Street
- J11 – Clifton Street / A12 Westlink
- J12 – Clifton Street / Carrick Hill / Donegal Street / North Queen Street
- J13 – Frederick Street / North Queen Street
- J14 – Frederick Street / York Street / Great Patrick Street
- J15 – Nelson Street / Dunbar Link / Edward Street
- J16 – Corporation Street / Dunbar Link
- J17 – M2 Junction 1 Fortwilliam.

The Link Count MCCs were undertaken at the following locations:

- L1 – York Street to M2 On-Slip
- L2 – M2 Off-Slip at Nelson Street
- L3 – M2 Off-Slip at Duncrue Street.

The Car Park MCCs were undertaken at the following locations:

- C1 – York Street
- C2 – Little York Street
- C3 – Cityside Retail Park Car Park (York Street)
- C4 – Cityside Retail Park Car Park (Brougham Street).

It should be noted that incomplete data was recorded at MCC Site L3, which is the M2 off-slip at Duncrue Street, between 07:00 hours and 10:00 hours. As a result, this site was re-surveyed on Tuesday 27 April 2010.

7.3.2.3 *MCC Results*

The observed 12-hour traffic flows for all vehicles derived from the MCC surveys for all sites are summarised in **Figures 7.3.2A and 7.3.2B**. The observed a.m. and p.m. peak hour traffic flows based on 08:00 hours to 09:00 hours and 16:30 hours to 17:30 hours are shown in **Figures 7.3.3A, 7.3.3B, 7.3.4A and 7.3.4B** respectively.

A summary of the MCC data is also shown in **Tables 7.3.1A to 7.3.1C inclusive and Tables 7.3.2A to 7.3.2C inclusive**.

TABLE 7.3.1A: SUMMARY OF 12 HOUR TRAFFIC VOLUMES (JTC SITES)

Site	Total Traffic Flow Through Junction
J1	56,924
J2	56,063
J3	44,537
J4	45,708
J5	8,118
J6	7,899
J7	25,525
J8	25,926
J9	22,199
J10	14,612
J11	32,896
J12	31,604
J13	22,555
J14	27,872
J15	25,082
J16	25,595
J17	111,264*

*Flow at J17 is a two-way flow

TABLE 7.3.1B: SUMMARY OF 12 HOUR TRAFFIC VOLUMES (LINK COUNT SITES)	
Site	**Total Traffic Flow on Link (One-Way)**
L1	1,501
L2	18,566
L3	9,279

TABLE 7.3.1C: SUMMARY OF 12 HOUR TRAFFIC VOLUMES (CAR PARK COUNT SITES)		
Site	**Traffic Entering Car Park**	**Traffic Exiting Car Park**
C1	86	79
C2	304	297
C3	2,545	1,354
C4	4,158	4,879

TABLE 7.3.2A: SUMMARY OF MCC 12 HOUR JUNCTION FLOWS & VEHICLE PROPORATIONS (JTC SITES)					
Site	**Units**	**LV**	**HGV**	**Bus**	**Total**
J1	Flow	52,202	4,009	713	56,924
	%	91.7%	7.0%	1.3%	100.0%
J2	Flow	51,314	4,070	679	56,063
	%	91.5%	7.3%	1.2%	100.0%
J3	Flow	40,112	3,714	711	44,537
	%	90.1%	8.3%	1.6%	100.0%
J4	Flow	41,183	3,773	752	45,708
	%	90.1%	8.3%	1.6%	100.0%
J5	Flow	7,749	335	34	8,118
	%	95.5%	4.1%	0.4%	100.0%
J6	Flow	7,518	338	43	7,899
	%	95.2%	4.3%	0.5%	100.0%
J7	Flow	22,437	2,502	586	25,525
	%	87.9%	9.8%	2.3%	100.0%
J8	Flow	23,596	1,744	586	25,926
	%	91.0%	6.7%	2.3%	100.0%
J9	Flow	21,469	393	248	22,110
	%	97.1%	1.8%	1.1%	100.0%

TABLE 7.3.2A: SUMMARY OF MCC 12 HOUR JUNCTION FLOWS & VEHICLE PROPORATIONS (JTC SITES)

Site	Units	LV	HGV	Bus	Total
J10	Flow	14,238	269	105	14,612
	%	97.4%	1.8%	0.7%	100.0%
J11	Flow	31,027	1,149	720	32,896
	%	94.3%	3.5%	2.2%	100.0%
J12	Flow	30,237	686	681	31,604
	%	95.7%	2.2%	2.2%	100.0%
J13	Flow	21,891	507	157	22,555
	%	97.1%	2.2%	0.7%	100.0%
J14	Flow	26,050	774	1,048	27,872
	%	93.5%	2.8%	3.8%	100.0%
J15	Flow	23,671	723	688	25,082
	%	94.4%	2.9%	2.7%	100.0%
J16	Flow	24,711	694	190	25,595
	%	96.5%	2.7%	0.7%	100.0%
J17	Flow	103,043	7,439	782	111,264
	%	92.6%	6.7%	0.7%	100.0%
Total	**Flow**	**542,448**	**33,119**	**8,723**	**584,290**
	%	**92.8%**	**5.7%**	**1.5%**	**100.0%**

TABLE 7.3.2B: SUMMARY OF MCC 12 HOUR JUNCTION FLOWS & VEHICLE PROPORATIONS (LINK COUNT SITES)

Site	Units	LV	HGV	Bus	Total
L1	Flow	1,362	137	2	1,501
	%	90.7%	9.1%	0.1%	100.0%
L2	Flow	16,795	1,695	76	18,566
	%	90.5%	9.1%	0.4%	100.0%
L3	Flow	8,698	320	261	9,279
	%	93.7%	3.4%	2.8%	100.0%
Total	**Flow**	**26,855**	**2,152**	**339**	**29,346**
	%	**91.5%**	**7.3%**	**1.2%**	**100.0%**

TABLE 7.3.2C: SUMMARY OF MCC 12 HOUR JUNCTION FLOWS & VEHICLE PROPORATIONS (CAR PARK COUNT SITES)					
Site	**Units**	**LV**	**HGV**	**Bus**	**Total**
C1	Flow	165	0	0	165
	%	100.0%	0.0%	0.0%	100.0%
C2	Flow	601	0	0	601
	%	100.0%	0.0%	0.0%	100.0%
C3	Flow	3,891	6	2	3,899
	%	99.8%	0.2%	0.1%	100.0%
C4	Flow	8,935	85	17	9,037
	%	98.9%	0.9%	0.2%	100.0%
Total	**Flow**	**13,592**	**91**	**19**	**13,702**
	%	**99.2%**	**0.7%**	**0.1%**	**100.0%**

As the majority of vehicles using the car parks are cars (light vehicles), the car park counts have been excluded from the calculation of the overall vehicle classification percentages. The overall vehicle classification percentages are therefore based on the JTC and Link Counts only. From the above JTC and Link counts, the following overall vehicle classification percentages were derived:

- 92.8% Light Vehicles
- 5.7% Heavy Goods Vehicles
- 1.5% Buses.

The observed 2-way 12-hour link flows recorded for all vehicles are shown in **Figures 7.3.5A and 7.3.5B**.

7.3.3 *Pedestrian and Cyclist Count*

7.3.3.1 *Methodology*

A Pedestrian and Cyclist Count was undertaken within the study area on Wednesday 21 April and Thursday 22 April 2010 to define current pedestrian and cyclist volumes and movements in the vicinity of the existing York Street signalised interchange.

The pedestrian and cyclist data were collected in 15-minute intervals between 07:00 hours and 19:00 hours during the weekday survey to provide a 12-hour record of movements.

It should be noted that incomplete data were recorded at Site L3, which is the M2 off-slip at Duncrue Street, between 07:00 hours and 10:00 hours. As a result, this site was re-surveyed on Tuesday 27 April 2010.

The data were recorded using the following classification system:

- Adult
- Child

- Disabled
- Cyclist.

7.3.3.2 *Pedestrian and Cyclist Count Locations*

The Pedestrian and Cyclist Counts were undertaken at the same locations as the MCC surveys. In addition, pedestrian and cyclist counts were also undertaken at four pedestrian crossing points on North Queen Street.

The locations of the Pedestrian and Cyclist Counts on North Queen Street are shown in **Figure 7.3.6.**

7.3.3.3 *Pedestrian and Cyclist Count Results*

The observed 12-hour pedestrian and cyclist flows derived from the Pedestrian and Cyclist Counts for all Sites are summarised in **Figures 7.3.7A and 7.3.7B**. The observed a.m. and p.m. peak hour traffic flows based on 08:30 hours to 09:30 hours and 16:30 hours to 17:30 hours are shown in **Figures 7.3.8 and 7.3.9** respectively.

A summary of the Pedestrian and Cyclist Count data is also shown in **Tables 7.3.3 to 7.3.6**.

TABLE 7.3.3: SUMMARY OF 12 HOUR PEDESTRIAN AND CYCLIST MOVEMENTS (JTC SITES)

Site	Total Pedestrians and Cyclists Crossing				
	Child	Adult	Disabled	Cyclist	Total
J1	28	1,341	0	36	1,405
J2	62	1,949	0	31	2,042
J3	1	214	3	3	221
J4	1	42	0	3	46
J5	6	166	0	43	215
J6	5	270	0	32	307
J7	40	858	1	136	1,035
J8	78	861	11	41	991
J9	98	755	2	24	879
J10	50	621	0	14	685
J11	470	2,513	20	77	3,080
J12	280	2,367	9	90	2,746
J13	34	912	1	27	974
J14	105	3,193	1	62	3,361
J15	118	1,541	4	28	1,691

TABLE 7.3.3: SUMMARY OF 12 HOUR PEDESTRIAN AND CYCLIST MOVEMENTS (JTC SITES)

Site	Total Pedestrians and Cyclists Crossing				
	Child	Adult	Disabled	Cyclist	Total
J16	105	1,689	10	28	1,832
J17	0	0	0	0	0

TABLE 7.3.4: SUMMARY OF 12 HOUR PEDESTRIAN AND CYCLIST MOVEMENTS (LINK COUNT SITES)

Site	Total Pedestrians and Cyclists Crossing				
	Child	Adult	Disabled	Cyclist	Total
L1	3	46	0	1	50
L2	0	0	0	0	0
L3	0	94	0	5	99

TABLE 7.3.5: SUMMARY OF 12 HOUR PEDESTRIAN AND CYCLIST MOVEMENTS (CAR PARK COUNT SITES)

Site	Total Pedestrians and Cyclists Crossing				
	Child	Adult	Disabled	Cyclist	Total
C1	61	1,237	0	34	1,332
C2	7	210	0	1	218
C3	5	376	0	20	401
C4	7	47	1	2	57

TABLE 7.3.6: SUMMARY OF 12 HOUR PEDESTRIAN AND CYCLIST MOVEMENTS (NORTH QUEEN STREET PEDESTRIAN CROSSING POINT SITES)

Site	Total Pedestrians and Cyclists Crossing				
	Child	Adult	Disabled	Cyclist	Total
P1 A	58	522	0	10	590
P1 B	117	433	0	9	559
P2 A	90	440	0	13	543
P2 B	66	416	7	5	494

7.3.4 ***Automatic Traffic Counters***

7.3.4.1 *Permanent Automatic Traffic Counters*

To provide an indication of the level of variation in traffic flows throughout the year, the daily, weekly and monthly average daily traffic flows were extracted from the available Permanent Automatic Traffic Count (ATC) information.

The locations of these Permanent ATCs are described below

- ATC 202 – Fortwilliam Interchange, Southbound Carriageway, including on-slip road
- ATC 203 – Fortwilliam Interchange, Northbound Carriageway, including off-slip road
- ATC 290 – Westlink at Clifton Street, Southbound Carriageway, including off-slip road
- ATC 291 – Westlink at Clifton Street, Northbound Carriageway, including on-slip road.

The locations of the Permanent ATCs are shown in **Figure 7.3.10**.

The seven-day two-way annual average daily traffic flows (AADTs) recorded by the Permanent ATCs are summarised in **Table 7.3.7**.

TABLE 7.3.7: SUMMARY OF 7 DAY ONE WAY ANNUAL AVERAGE DAILY TRAFFIC FLOWS

	7-Day AADT (One-Way)					
Permanent ATC	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
202	49,220	48,050	45,000	45,050	48,460	48,325
	-	*-2.38%*	*-6.35%*	*0.11%*	*7.57%*	*-0.28%*
203	49,260	48,550	50,430	48,270	48,950	48,629
	-	*-1.44%*	*3.87%*	*-4.28%*	*1.41%*	*-0.66%*
290	30,380	28,320	28,900	30,890	35,620	37,511*
	-	*-6.78%*	*2.05%*	*6.89%*	*15.31%*	*5.31%*
291	37,710	34,910	35,350	35,880	38,070	40,091
	-	*-7.43%*	*1.26%*	*1.50%*	*6.10%*	*5.31%*

Notes:
Values in italics refer to year-on-year growth.
*There is data missing at ATC 290 in 2010, therefore the 2010 data has been adjusted using data from ATC 291.

7.3.4.2 *Derivation of Annual Average Daily Traffic Flows*

Examination of the above information indicates that there is data missing at ATC 290.

ATC 290 is situated on the southbound carriageway of the M1 / Westlink at Clifton Street. Further examination of ATC 290 indicates that in 2010 there are only 197 days of complete data with no data from 1 January to 21 January inclusive, from 5 April to 26 August inclusive and from 13 October to 14 October inclusive. The 2010 AADT at ATC 291 is based on 365 days of data.

A 2010 AADT flow of 37,511 has been calculated on a pro-rata basis using the data available from ATC 291 and is considered to be representative of typical conditions.

7.3.5 *Journey Time Surveys*

7.3.5.1 *Methodology*

A survey of current journey times was undertaken in the York Street area, including the M1 Westlink, the M2 Motorway and the M3 Motorway, to assist in defining current operating conditions within the corridor.

The surveys were carried out on Wednesday 21 April and Thursday 22 April 2010 using two survey vehicles over two routes, namely the Red Route and the Blue Route. Various runs were carried out for the two routes between 07:00 hours and 19:00 hours to record variations in journey times throughout the day. The survey periods were as follows:

- AM Peak Period: 07:00 hours – 10:00 hours
- Interpeak Period: 11:00 hours – 15:00 hours
- PM Peak Period: 16:00 hours – 19:00 hours.

A total of fifty four runs were carried out over the two days for the Red Route, with twenty seven of the runs carried out on Wednesday 21 April and twenty seven runs on Thursday 22 April. A total of sixty five runs were carried out over the two survey days for the Blue Route, with thirty three of the runs carried out on Wednesday 21 April and thirty two runs on Thursday 22 April.

The survey was based on the standard moving observer technique to record journey times at each of the predefined measurement points along the route.

7.3.5.2 *Journey Time Survey Locations*

The limits of the Journey Time Survey routes and the locations of the measurement points are shown in **Figures 7.3.11A and 7.3.11B**.

7.3.5.3 *Journey Time Survey Results*

Weather conditions during the surveys varied with sunny, cloudy and overcast spells at various times throughout each day.

Delays were recorded at various times on each route during the days of survey.

The results from the Journey Time Surveys are shown in **Tables 7.3.8A to 7.3.8B inclusive, Tables 7.3.9A and 7.3.9B and Tables 7.3.10A and 7.3.10B**.

TABLE 7.3.8A: SUMMARY OF JOURNEY TIME SURVEY RESULTS: RED ROUTE AM PEAK PERIOD

Measurement Points	Speed Limit (mph)	Average Time (hh:mm:ss)	JTS Length (km)	Average Speed (mph)	Average Speed (kph)
R1 – R2	50	00:01:07	0.621	21	34
R2 – R3	30	00:00:05	0.074	32	51
R3 – R4	70	00:00:24	0.451	43	69
R4 – R5	70	00:00:29	0.582	54	86
R5 – R6	70	00:01:35	1.336	32	51
R6 – R7	30	00:00:41	0.360	20	32
R7 – R8	70	00:01:37	1.345	31	50
R8 – R9	70	00:02:22	0.698	11	18
R9 – R10	70	00:01:10	0.253	8	13
R10 – R11	30	00:01:29	0.276	7	11
R11 – R12	30	00:00:17	0.104	14	22
R12 – R13	30	00:00:18	0.149	18	29
R13 – R14	50	00:00:55	0.573	23	38
R14 – R15	30	00:00:54	0.175	7	12
R15 – R16	30	00:00:22	0.234	24	38
R16 – R17	30	00:00:13	0.183	31	49
R17 – R18	30	00:00:44	0.318	16	26
R18 – R19	30	00:01:07	0.274	9	15
R19 – R20	30	00:00:44	0.217	11	18
R20 – R21	30	00:00:25	0.309	27	44
R21 – R22	30	00:00:14	0.133	21	33
R22 – R23	30	00:01:00	0.322	12	19
R23 – R24	30	00:00:40	0.199	11	18
R24 – R25	30	00:00:36	0.149	9	15
R25 – R26	30	00:01:34	0.304	7	12
R26 – R27	30	00:00:51	0.195	9	14
R27 – R28	30	00:00:34	0.155	10	17
R28 – R29	30	00:00:32	0.126	9	14
		00:23:01	**10.115**	**17**	**27**

Note: Recorded speeds include junction delays that are relevant to journey time route.

TABLE 7.3.8B: SUMMARY OF JOURNEY TIME SURVEY RESULTS: BLUE ROUTE AM PEAK PERIOD

Measurement Points	Speed Limit (mph)	Average Time (hh:mm:ss)	JTS Length (km)	Average Speed (mph)	Average Speed (kph)
B1 – B2	50	00:01:19	0.822	23	38
B2 – B3	30	00:01:55	0.595	12	19
B3 – B4	30	00:00:47	0.157	7	12
B4 – B5	50	00:00:34	0.420	28	45
B5 – B5a	40	00:00:19	0.315	37	60
B5a – B6	40	00:00:38	0.307	18	29
B6 – B7	30	00:02:03	0.740	13	22
B7 – B7a	40	00:00:15	0.180	28	45
B7a – B8	50	00:00:18	0.315	38	62
B8 – B9	30	00:01:33	0.367	9	14
B9 – B10	30	00:00:33	0.165	11	18
B10 – B11	30	00:00:47	0.149	7	11
B11 – B12	30	00:00:59	0.190	7	12
B12 – B13	30	00:00:31	0.122	9	14
B13 – B14	30	00:01:21	0.281	8	13
B14 – B15	30	00:01:05	0.146	5	8
B15 – B16	30	00:01:28	0.335	9	14
B16 – B17	30	00:00:17	0.104	14	22
B17 – B18	30	00:00:18	0.149	18	30
B18 – B19	50	00:00:41	0.556	31	50
B19 – B20	50	00:01:21	0.816	23	37
		00:19:03	**7.231**	**14**	**23**

Note: Recorded speeds include junction delays that are relevant to journey time route.

TABLE 7.3.9A: SUMMARY OF JOURNEY TIME SURVEY RESULTS: RED ROUTE PM PEAK PERIOD

Measurement Points	Speed Limit (mph)	Average Time (hh:mm:ss)	JTS Length (km)	Average Speed (mph)	Average Speed (kph)
R1 – R2	50	00:01:10	0.621	20	32
R2 – R3	30	00:00:05	0.074	32	51
R3 – R4	70	00:00:24	0.451	43	69
R4 – R5	70	00:00:28	0.582	56	90
R5 – R6	70	00:01:15	1.336	40	64
R6 – R7	30	00:00:39	0.360	21	34
R7 – R8	70	00:00:59	1.345	51	83
R8 – R9	70	00:01:09	0.698	23	37
R9 – R10	70	00:01:21	0.253	7	11
R10 – R11	30	00:01:53	0.276	6	9
R11 – R12	30	00:00:33	0.104	7	11
R12 – R13	30	00:00:36	0.149	9	15
R13 – R14	50	00:00:48	0.573	27	43
R14 – R15	30	00:00:53	0.175	7	12
R15 – R16	30	00:00:22	0.234	24	38
R16 – R17	30	00:00:16	0.183	26	41
R17 – R18	30	00:00:55	0.318	13	21
R18 – R19	30	00:00:56	0.274	11	18
R19 – R20	30	00:00:56	0.217	9	14
R20 – R21	30	00:00:24	0.309	29	46
R21 – R22	30	00:00:14	0.133	22	35
R22 – R23	30	00:01:13	0.322	10	16
R23 – R24	30	00:00:47	0.199	10	15
R24 – R25	30	00:00:38	0.149	9	14
R25 – R26	30	00:01:44	0.304	7	11
R26 – R27	30	00:00:47	0.195	9	15
R27 – R28	30	00:00:30	0.155	12	19
R28 – R29	30	00:00:47	0.126	6	10
		00:22:39	**10.115**	**17**	**27**

Note: Recorded speeds include junction delays that are relevant to journey time route.

TABLE 7.3.9B: SUMMARY OF JOURNEY TIME SURVEY RESULTS: BLUE ROUTE PM PEAK PERIOD

Measurement Points	Speed Limit (mph)	Average Time (hh:mm:ss)	JTS Length (km)	Average Speed (mph)	Average Speed (kph)
B1 – B2	50	00:01:20	0.822	23	37
B2 – B3	30	00:01:41	0.595	13	21
B3 – B4	30	00:00:24	0.157	14	23
B4 – B5	50	00:00:28	0.420	33	53
B5 – B5a	40	00:00:18	0.315	39	64
B5a – B6	40	00:00:43	0.307	16	26
B6 – B7	30	00:02:46	0.740	10	16
B7 – B7a	40	00:00:19	0.180	21	34
B7a – B8	50	00:00:22	0.315	32	51
B8 – B9	30	00:01:30	0.367	9	15
B9 – B10	30	00:00:39	0.165	10	15
B10 – B11	30	00:00:53	0.149	6	10
B11 – B12	30	00:00:51	0.190	8	13
B12 – B13	30	00:00:17	0.122	17	27
B13 – B14	30	00:01:00	0.281	11	17
B14 – B15	30	00:00:57	0.146	6	9
B15 – B16	30	00:01:51	0.335	7	11
B16 – B17	30	00:00:27	0.104	9	14
B17 – B18	30	00:00:32	0.149	11	17
B18 – B19	50	00:00:41	0.556	31	49
B19 – B20	50	00:01:05	0.816	28	45
		00:19:04	**7.231**	**14**	**23**

Note: Recorded speeds include junction delays that are relevant to journey time route.

TABLE 7.3.10A: SUMMARY OF JOURNEY TIME SURVEY RESULTS: RED ROUTE FULL DAY

Measurement Points	Speed Limit (mph)	Average Time (hh:mm:ss)	JTS Length (km)	Average Speed (mph)	Average Speed (kph)
R1 – R2	50	00:01:01	0.621	23	37
R2 – R3	30	00:00:05	0.074	32	51
R3 – R4	70	00:00:24	0.451	43	69
R4 – R5	70	00:00:28	0.582	56	90
R5 – R6	70	00:01:23	1.336	36	58
R6 – R7	30	00:00:41	0.360	20	32
R7 – R8	70	00:01:09	1.345	44	70
R8 – R9	70	00:01:11	0.698	22	36
R9 – R10	70	00:00:48	0.253	12	19
R10 – R11	30	00:01:20	0.276	8	12
R11 – R12	30	00:00:24	0.104	10	16
R12 – R13	30	00:00:28	0.149	12	19
R13 – R14	50	00:00:52	0.573	25	40
R14 – R15	30	00:00:56	0.175	7	11
R15 – R16	30	00:00:22	0.234	24	38
R16 – R17	30	00:00:15	0.183	27	44
R17 – R18	30	00:00:53	0.318	14	22
R18 – R19	30	00:01:00	0.274	10	17
R19 – R20	30	00:00:51	0.217	10	15
R20 – R21	30	00:00:25	0.309	28	45
R21 – R22	30	00:00:13	0.133	22	36
R22 – R23	30	00:01:01	0.322	12	19
R23 – R24	30	00:00:43	0.199	10	17
R24 – R25	30	00:00:34	0.149	10	16
R25 – R26	30	00:01:33	0.304	7	12
R26 – R27	30	00:00:51	0.195	9	14
R27 – R28	30	00:00:32	0.155	11	18
R28 – R29	30	00:00:53	0.126	5	9
		00:21:16	**10.115**	**18**	**29**

Note: Recorded speeds include junction delays that are relevant to journey time route.

TABLE 7.3.10B: SUMMARY OF JOURNEY TIME SURVEY RESULTS: RED ROUTE FULL DAY

Measurement Points	Speed Limit (mph)	Average Time (hh:mm:ss)	JTS Length (km)	Average Speed (mph)	Average Speed (kph)
B1 – B2	50	00:01:07	0.822	28	45
B2 – B3	30	00:01:20	0.595	17	27
B3 – B4	30	00:00:38	0.157	9	15
B4 – B5	50	00:00:33	0.420	28	46
B5 – B5a	40	00:00:18	0.315	40	65
B5a – B6	40	00:00:36	0.307	19	31
B6 – B7	30	00:02:06	0.740	13	21
B7 – B7a	40	00:00:16	0.180	25	40
B7a – B8	50	00:00:20	0.315	36	58
B8 – B9	30	00:01:05	0.367	13	21
B9 – B10	30	00:00:40	0.165	9	15
B10 – B11	30	00:00:45	0.149	7	12
B11 – B12	30	00:00:55	0.190	8	12
B12 – B13	30	00:00:25	0.122	11	17
B13 – B14	30	00:01:07	0.281	9	15
B14 – B15	30	00:00:53	0.146	6	10
B15 – B16	30	00:01:16	0.335	10	16
B16 – B17	30	00:00:18	0.104	13	20
B17 – B18	30	00:00:26	0.149	13	21
B18 – B19	50	00:00:41	0.556	30	49
B19 – B20	50	00:01:11	0.816	26	42
		00:16:55	**7.231**	**16**	**26**

Note: Recorded speeds include junction delays that are relevant to journey time route.

Examination of the journey times recorded during the a.m. peak period indicates that the average speed along the Red Route is 17 mph / 27 kph. Examination of the journey times during the a.m. peak period also indicates that the average speed along the Blue Route is 14 mph / 23 kph.

Examination of the journey times recorded during the p.m. peak period indicates that the average speed along the Red Route is 17 mph / 27 kph. Examination of the journey times during the p.m. peak period also indicates that the average speed along the Blue Route is 14 mph / 23 kph.

Examination of the journey times for the full day indicates that the average speed along the Red Route is 18 mph / 29 kph. Examination of the journey times for the full day also indicates that the average speed along the Blue Route is 16 mph / 26 kph.

The average speeds observed during the journey time surveys for the full day are also shown in **Figures 7.3.12A to 7.3.12C**.

This information provides an indication of existing travel conditions within the study area against which the effects of the proposed improvements can be considered.

7.4 Indicative Costs, Risks and Optimism Bias

7.4.1 *Basis of Cost Estimates*

Cost estimates were prepared for all options. These costs, which are based on current rates, were used to define both the total construction cost and total land cost for each of the options.

A comprehensive risk workshop was undertaken in October 2011 involving key representatives from all disciplines. Based on the results and conclusions of the workshop, an appropriate allowance for risk was determined for each of the options. These risk allowances are included in the estimated scheme costs shown in **Table 7.4.1**.

Full details of the derivation of the cost estimates are set out in this report.

A breakdown of the estimated costs of the options in Quarter 4, 2011 prices is shown in **Table 7.4.1**.

TABLE 7.4.1: ESTIMATED SCHEME COST SUMMARY

Item	Scheme Cost			
	Option A (£M's)	Option B (£M's)	Option C (£M's)	Option D (£M's)
Total Construction Cost (Including Risk)	64.273	74.488	73.053	76.785
Total Land Cost	3.602	0.627	4.751	1.090
Preparation (9% of Total Construction & Land Cost)	6.109	6.760	7.002	7.009
Supervision (5% of Total Construction & Land Cost)	3.394	3.756	3.890	3.894
Total Scheme Cost	**77.378**	**85.631**	**88.697**	**88.778**

Note: All costs are in Q4, 2011 prices and exclude VAT.

7.4.2 *Optimism Bias*

As there is a tendency for project appraisers to be overly optimistic when assessing total scheme costs, optimism bias has been included in the appraisal to increase the capital expenditure estimate of the options and the potential for delays during construction, in accordance with the operational advice concerning H.M. Treasury's New Green Book on Appraisal and Evaluation in Central Government.

As schemes progress through the various stages from the identification of a general corridor to the development of various route options and finally the selection of the Preferred Option, the level of optimism bias is likely to reduce accordingly.

Current Roads Service guidance recommends that the costs used in the economic appraisal of schemes include an upper bound allowance. At this stage of the project, an allowance of 16.5% for optimism bias has been used.

A breakdown of the estimated scheme costs including an allowance of 16.5% for optimism bias is shown in **Table 7.4.2**. All costs are in Quarter 4, 2011 prices.

TABLE 7.4.2: ESTIMATED SCHEME COST SUMMARY (INCLUDING 16.5% OPTIMISM BIAS)

Item	Scheme Cost			
	Option A (£M's)	Option B (£M's)	Option C (£M's)	Option D (£M's)
Total Construction Cost (Including Risk)	74.878	86.779	85.107	89.455
Total Land Cost	4.196	0.730	5.535	1.270
Preparation (9% of Total Construction & Land Cost)	7.117	7.876	8.158	8.165
Supervision (5% of Total Construction & Land Cost)	3.954	4.375	4.532	4.536
Total Scheme Cost	**90.145**	**99.760**	**103.331**	**103.426**

Note: All costs are in Q4, 2011 prices and exclude VAT.

7.4.3 *Cost Profile*

For the purpose of the economic appraisal, the cost profiles shown in **Tables 7.4.3 and 7.4.4** have been adopted.

Options A, B and C are based on a three year construction period, whilst Option D is based on a slightly shorter two and a half year construction period.

TABLE 7.4.3: COST PROFILE SCHEME OPTIONS A, B AND C

Year	Cost Profile Options A, B and C	
	Construction	Land
2016	0%	100%
2017	30%	0%
2018	34%	0%
2019	33%	0%
2020	3%	0%

Note: The construction cost profile is based on typical profiles with a 3 year construction period.

TABLE 7.4.4: COST PROFILE SCHEME OPTION D		
Year	Cost Profile Option D	
	Construction	Land
2016	0%	100%
2017	16%	0%
2018	42%	0%
2019	39%	0%
2020	3%	0%

Note: The construction cost profile is based on typical profiles with a 2½ year construction period.

7.5 Development of Computer Models

7.5.1 *Overview of Model Development*

The quantitative assessment of the transport economic efficiency and road safety aspects of a proposed road improvement scheme requires the development and application of various computer models. In the case of the York Street Interchange, this has involved the development of a COBA (Cost Benefit Analysis) model and QUADRO (Queues and Delays at Roadworks) model.

The COBA model was developed to compare the cost and road user benefits of the proposed Scheme Options taking into account both transport economic efficiency and road safety issues.

The QUADRO model was developed to provide an assessment of the economic effects of road user delays associated with the construction of the proposed improvement.

7.5.2 *The COBA Model*

COBA is the standard computer program introduced in the 1970s to examine proposed investments in the trunk road network by comparing the costs of the road scheme with the associated road user benefits. The procedures for developing and applying the COBA model are set out in Design Manual for Roads and Bridges (DMRB) Volume 13.

The overall geographical area of the model, which extends from the Fortwilliam junction in the north, to the M3 slips in the east, to Dunbar Link in the south and to the Clifton Street slips in the west, was defined to encompass the effects of the improvement options being considered.

The modelled area is shown in **Figure 7.5.1**. Aerial views of the existing York Street junction captured from the 3-dimensional model of the area are shown in **Figure 7.5.2**.

The York Street Interchange models are based on the 12-hour traffic flows and turning movements observed in 2010.

The assessment is based on standard COBA and QUADRO default values where these have been considered appropriate. For example, the default proportion of in-work trips has been adopted and default accident rates have been applied to both the Do-Minimum and Do-Something networks.

7.5.3 *Appraisal and Evaluation in Central Government*

In 2003, HM Treasury published the revised Green Book – Appraisal and Evaluation in Central Government, which came into effect on 1 April 2003 and outlines the best practice guide to carrying out appraisal and evaluation of capital projects, and in particular, concentrates on economic appraisal in the form of cost-benefit analysis.

The main changes in the new procedures are a stronger emphasis on the identification, management and realisation of benefits, the introduction of a new 3.5% annual discount rate to replace the previous 6% rate, and the introduction of explicit adjustment procedures to redress the systematic optimism that historically has affected the appraisal process.

The Northern Ireland (NI) Practical Guide to the Green Book represents current Department of Finance and Personnel (DFP) guidance and requirements on the appraisal, evaluation, approval and management of policies, programmes and projects. The document, published in 2003, contains practical guidance tailored specifically to the needs of the Northern Ireland Department, such as DFP's approval requirements, local policies and institutional arrangements.

In September 2009, DFP launched the latest on-line guide to expenditure, appraisal, evaluation, approval and management. The Northern Ireland Guide to Expenditure Appraisal and Evaluation (NIGEAE) supersedes the NI Practical Guide to the Green Book. The guide notes that the government spends billions of pounds every year delivering public services in Northern Ireland. It is vital that this money is put to use in a way that delivers the maximum benefit to the local population. It is also important that all spending is accountable to the NI Executive and Assembly.

7.5.4 *COBA Do-Minimum Model*

7.5.4.1 *Do-Minimum Network*

When undertaking cost benefits analyses using the COBA computer model, three discrete scenarios need to be considered, namely the Do-Nothing scenario, the Do-Minimum scenario and the Do-Something scenario.

The Do-Nothing scenario represents the existing road network without any improvement.

The Do-Minimum network is the base road network against which the Do-Something network is assessed. In the case of the York Street Interchange, no specific changes to the base road network have been identified and consequently the Do-Minimum network is consistent with the existing Do-Nothing network.

The limits of the highway network defined for the Do-Minimum model were defined to encompass the area surrounding the York Street Interchange that is likely to be significantly affected by the potential reassignment of traffic on to the improved routes.

The location and identification of the various links and nodes which define the Do-Minimum network are shown in **Figure 7.5.3**.

7.5.4.2 *Trip Matrix Building*

The traffic flows and junction turning movements included in the COBA model were defined from direct observation during the April 2010 traffic surveys. Consequently, the development of a separate trip matrix and a trip assignment algorithm is not required to define existing traffic conditions on the network.

The 12-hour traffic composition based on the observed traffic from within the modelled area is as follows:

- 92.8% Light Vehicles
- 5.7% Heavy Goods Vehicles
- 1.5% Buses.

The 12-hour traffic composition adopted for the model is based on a combination of the simplified vehicle classes adopted for the April 2010 traffic surveys and national characteristics as follows:

- 82.8% Cars
- 10.0% Light Goods Vehicles (LGV)
- 3.9% Other Goods Vehicles 1 (OGV1)
- 1.8% Other Goods Vehicles 2 (OGV2)
- 1.5% Passenger Service Vehicles (PSV).

7.5.4.3 *Trip Assignment*

The characteristics of the current York Street Interchange are such that relevant trip patterns through the immediate area can be estimated from observed traffic flows entering and exiting the interchange at the various junctions. The 12-hour link flows and turning movements are therefore based on the observed traffic flows.

7.5.4.4 *Traffic Annualisation Factors*

7.5.4.4.1 ***Introduction***

Traffic annualisation factors are used within the COBA model to derive total annual information from the observed daily traffic flow data.

The 12-hour, 16-hour and 24-hour flows obtained from the permanent Automatic Traffic Counters located on the M2 Motorway and Westlink are summarised in **Table 7.5.1**. The 12-hour flows for each site on the day of survey are also included.

TABLE 7.5.1: SUMMARY OF PERMANENT ATC INFORMATION

Permanent ATC	12-Hour Day of Survey	12-Hour 5 Day	16-Hour 5 Day	24-Hour 5 Day	24-Hour 7 Day
202	46,221	43,275	50,332	53,193	48,325
203	47,126	42,804	50,116	53,767	48,629
Two-Way (202 + 203)	**93,347**	**86,079**	**100,448**	**106,960**	**96,954**
290	33,541	33,554	39,132	41,594	37,511
291	36,673	34,997	41,535	44,426	40,091
Two-Way (290 + 291)	**70,214**	**68,551**	**80,667**	**86,020**	**77,602**
Combined	**163,561**	**154,630**	**181,115**	**192,980**	**174,556**

In COBA, the 'E-Factor' is used to convert the 12-hour average weekday traffic flow to a corresponding 16-hour average weekday traffic flow and the 'M-Factor' is used to convert this 16-hour flow to a 24-hour total annual flow to provide a suitable basis for the 60-year economic appraisal of the proposed Scheme Options.

7.5.4.4.2 ***E-Factor***

A local E-Factor has been derived from the following available information:

- 12-Hour 2010 AAWDT Flow: 154,630 vehicles
- 16-Hour 2010 AAWDT Flow: 181,115 vehicles

This information is considered sufficient to derive a local E-Factor, which at 1.17 is similar to the default value of 1.15 for a Built-up Principal Network.

The E-Factor adopted for the COBA model is 1.17.

7.5.4.4.3 ***M-Factor***

A local M-Factor has been derived to factor the estimated 16-hour flows to represent the total annual flow from the following available information:

- 16-Hour 2010 AAWDT Flow: 181,115 vehicles
- 24-Hour 2010 AADT Flow: 174,556 vehicles

This information is considered sufficient to derive a local M-Factor, which at 352 is slightly lower than the default value of 360 for a Built-Up Principal Network in the month of April. However, the local M-Factor of 352 is thought to be more representative of local conditions.

7.5.4.4.4 ***Local Adjustment Factor***

In addition to the factors described above, a local adjustment factor has been derived to adjust for the difference between the 12-hour traffic flow observed on the day of survey and the 12-hour 2010 AAWDT flow. The factor has been derived from the following information:

- 12-Hour 2010 Day of Survey Flow: 163,561 vehicles
- 12-Hour 2010 AAWDT Flow: 154,630 vehicles

This information indicates that the traffic flow on the day of survey is 5% higher than the 12-hour 2010 AAWDT. The M-Factor has therefore been reduced by an additional factor of 5%.

The M-Factor adopted for the COBA model is 333.

7.5.4.5 *Model Calibration and Validation*

The Do-Minimum COBA model was calibrated by varying the characteristics of the links and junctions to obtain a reasonable representation of observed conditions.

In the case of the York Street Interchange, changes in travel times between the Do-Minimum and the Do-Something networks are likely to represent the most significant change in road user economic benefits. It is therefore important to demonstrate that the Do-Minimum model provides a reasonable basis to assess transport conditions within the study area.

To demonstrate that the model provides a reasonable representation of existing transport conditions in the area, the observed journey times and modelled times on the network derived from the COBA model were compared. The results of this comparison for the Red and Blue routes are shown in **Tables 7.5.2 and 7.5.3** respectively.

TABLE 7.5.2: COMPARISON OF OBSERVED AND MODELLED LINK TIMES RED ROUTE

Red Route	Average Total Time (secs)	Average Speed (kph)
Observed	1,183	28.9
Modelled	1,161	29.5
Difference	-22	0.6
% Difference	-1.9	1.9%

TABLE 7.5.3: COMPARISON OF OBSERVED AND MODELLED LINK TIMES BLUE ROUTE

Blue Route	Average Total Time (secs)	Average Speed (kph)
Observed	823	24.9
Modelled	845	24.3
Difference	22	-0.7
% Difference	2.7%	-2.6%

The correlation between the observed times on both the Red and Blue Routes and the modelled times derived from the calibrated model confirms that the model provides a reasonable representation of actual operating conditions on the network.

7.5.5 *COBA Do-Something Models*

The general layout of the options, including aerial views captured from the 3-dimensional model of the area, and the corresponding network diagrams indicating the locations of the various links and nodes which define the highway network for the COBA Do-Something models, are shown in Figures 7.5.4 to 7.5.15.

The COBA Do-Something networks consist of four discrete models, one for each of the options.

As noted above, the characteristics of the York Street junction and indeed the proposed options are such that relevant trip patterns through the area can be estimated from observed traffic flows. For the strategic movements in the area, it is likely that all traffic would transfer on to the new links.

The majority of traffic movements would be accommodated by the proposed new links. However, on some options, the closure of links in the existing network, including for example the Westlink on-slip at Clifton Street, results in traffic being displaced on to the surrounding road network.

7.5.6 *The QUADRO Model*

An assessment of the economic effects of the road user delays associated with the construction of the proposed improvement options has been undertaken using Release 10 of the computer program QUADRO 4 (Queues and Delays at Roadworks) model.

As the future maintenance costs associated with the various options would be similar, these costs have not been quantified at this stage as part of the comparative assessment.

7.5.6.1 *The Construction Programme*

For the purpose of the QUADRO assessment, it has been assumed that the construction period for each option would be as shown in **Table 7.5.4**.

TABLE 7.5.4: QUADRO DO SOMETHING SCHEME OPTION CONSTRUCTION PERIODS

	Construction Start Date	Construction End Date
Option A	1 January 2017	31 December 2019
Option B	1 January 2017	31 December 2019
Option C	1 January 2017	31 March 2020
Option D	1 January 2017	30 April 2019

7.5.6.2 *Description of Traffic Management*

The proposed traffic management arrangements included in the QUADRO assessment are as follows:

Traffic management would be in place for 24 hours per day, 7 days a week for the duration of the works for each option, including holiday periods. No overnight or weekend closures have been modelled at this stage as these are likely to be less significant in economic terms due to the reduced volumes of traffic. It has also been assumed that a temporary speed limit of 30 mph would be in place over the network throughout the duration of the works.

The traffic management would be implemented in phases over the duration of the works with each phase incorporating a series of traffic management measures. These measures would change as the construction of the new option proceeds. Details of the proposed phasings and individual jobs are illustrated on **Drawings S105296-R-SK-A-301 to 310 inclusive, Drawings S105296-R-SK-B-301 to 310 inclusive, Drawings S105296-R-SK-C-301 to 310 inclusive and Drawings S105296-R-SK-D-301 to 306 inclusive**.

7.5.6.3 *Diversion Routes*

As there would be multiple diversion routes available within the local road network, specific diversion routes have not been included in the models, however a Maximum Q-Delay of 5 minutes was defined to reflect the likely level of additional delays for the comparative assessment of the options.

7.5.6.4 *Modelled Traffic Conditions*

The QUADRO model is based on the 12-hour Annual Average Daily Traffic (AADT) flows for each link in the model using the information observed during the MCC surveys and the default traffic flow profile.

It should be noted that Roads Service intends to promote a number of traffic reduction initiatives during the construction of the scheme. Several measures were implemented during the construction phase of the Westlink upgrade to reduce the volumes of traffic entering the area including signed alternative routes for drivers with destinations outwith the city centre, restricting as far as possible other roadworks on roads in the area throughout the duration of the works and additional Variable Message Signs located at outer approaches to Belfast to allow users to choose alternative routes. It is assumed that similar measures will be implemented during the construction of the York Street Interchange. Therefore, a 10% reduction in traffic entering the area during the construction of the scheme has been assumed and the observed 12-hour AADT flows for each link in the model have been reduced accordingly.

The 12-hour vehicle composition adopted in the QUADRO assessment is consistent with the COBA models. This information is summarised below in **Table 7.5.5**.

TABLE 7.5.5: 12 HOUR VEHICLE COMPOSITION

Year	Cars (%)	LGV (%)	OGV1 (%)	OGV2 (%)	PSV (%)
2010	82.8	10.0	3.9	1.8	1.5

The following traffic adjustment factors are included in the QUADRO model to maintain consistency with the COBA models:

- Local E-Factor 1.17
- Local M-Factor 333.

As previously noted, it is anticipated that the volumes of traffic in the area would reduce during construction as a series of traffic reduction measures are introduced. The QUADRO model has therefore been tested with a range of traffic flows to test the sensitivity of the results to changes in the volume of traffic.

In addition, it should be noted that in the later phases of the three year construction programme, where the network has almost evolved into the proposed Scheme, the design traffic has been applied to some jobs where the traffic differs significantly from the base traffic and the effects of some traffic management jobs have been excluded from the assessment.

7.5.7 *Future Conditions*

For the purpose of the economic assessment, it has been assumed that construction of the scheme would be undertaken in 2017, 2018 and 2019, with the scheme opening in 2020. This timeframe has been adopted to provide a reasonable basis for the economic assessment of the scheme options.

Although significant changes in land use within the Belfast area are likely to occur which would affect traffic conditions within the study area, it is considered that the most likely forecast of long term traffic growth within the study area for the comparative assessment of the proposed Scheme Options can best be defined by the application of national forecasts of traffic growth. The National Road Traffic Forecasts (NRTF) of growth have therefore been adopted to provide a reasonable estimate of long-term future traffic flows within the area over the 60 year economic assessment period.

For the purpose of the main economic assessment, NRTF central traffic growth has been adopted. However, in the case of York Street, it should be noted that traffic within the area is generally constrained by the capacity of the surrounding road network. It is therefore possible that traffic growth could be constrained to the low national traffic growth forecasts. Given the inherent degree of uncertainty in predicting future traffic flows, the scheme Options have also been tested considering NRTF (1997) low and high growth projections from the year 2010 onwards.

In addition, a sensitivity test has also been undertaken based on increasing the volume of traffic on the network by 5% in the year 2015 to account for potential committed developments within the York Street area, followed thereafter by the application of NRTF central traffic growth. The results of these sensitivity tests are presented later in this report.

The traffic growth factors defined in COBA for the 2010 base year and future years up to 2034 under the central growth traffic forecasts for the Do-Minimum scenario are shown in **Table 7.5.6**.

TABLE 7.5.6 NRTF GROWTH FACTORS CENTRAL GROWTH	
Period (Years)	**Central Growth**
2010 to 2020 Opening Year	1.139
2010 to 2034 Design Year	1.249

7.6 Operational Assessment of Scheme Options

This section of the report provides a general description of the proposed options in terms of traffic operation and presents an operational assessment of the options considering traffic flows, journey times and network capacity.

At this stage, four options have been examined to improve conditions in the York Street area of Belfast.

7.6.1 *Description of Scheme Options*

7.6.1.1 *Option A*

7.6.1.1.1 *Overview*

A detailed plan showing Option A is shown in **Figure 7.6.1**.

7.6.1.1.2 *Strategic Movements – Westlink / M2 Motorway / M3 Motorway*

Option A would provide an uninterrupted link from Westlink to the M2 Motorway, and from the M2 Motorway to Westlink. This option would also provide an uninterrupted link from Westlink to the M3 Motorway, however from the M3 Motorway to Westlink traffic would pass through traffic signals at the intersection with Nelson Street and at the intersection with York Street as in the existing network, with two lanes to cater for traffic to Westlink as opposed to three lanes in the current arrangement. The existing link between the M2 and M3 Motorways would be retained.

7.6.1.1.3 *Local Movements – York Street*

York Street would be realigned to provide three continuous northbound lanes to cater for traffic travelling north between the interchange with Westlink / York Link and Dock Street.

This option would also provide an uninterrupted link from York Street to the M2.

The York Street to the M3 Motorway movement would not be accommodated with a direct link within the proposed junction arrangement.

7.6.1.1.4 *Local Movements – Nelson Street / Corporation Street*

Nelson Street between Dock Street and Great George's Street would be closed to traffic to accommodate a new link to the M3 Motorway. Consequently, traffic on Nelson Street would be displaced on to the surrounding road network.

This option would also provide a new link between Corporation Street and the Westlink.

7.6.1.1.5 ***Junction Arrangements***

The existing traffic signals at the York Street / Great George's Street junction would be retained to manage traffic demand at this junction, with the traffic turning left from York Street to Great George's Street passing through a new priority junction.

The existing traffic signals at the York Street / York Link junction would be retained, however traffic progressing to the M2 Motorway would no longer pass through the signals and would instead travel uninterrupted on a new link connecting York Street to the M2 Motorway.

The junction arrangement at the York Street / Dock Street junction would remain unchanged, with the exception of the addition of a new slip to accommodate traffic turning left from York Street on to Dock Street.

The existing traffic signals at the Dock Street / Nelson Street junction would be altered to accommodate a new one-way link to the M3 Motorway, in place of Nelson Street. A slip from Dock Street to the new one-way link to the M3 Motorway would also be provided to accommodate traffic turning left from Dock Street to the M3 Motorway.

With Nelson Street closed to traffic, the existing traffic signals at York Link would be removed.

The existing traffic signals at the Nelson Street / Great George's Street junction would be retained to accommodate two-way operation on Nelson Street (south) and a new access to the area in the centre of the York Street Interchange.

The existing traffic signals at the Nelson Street / Great Patrick Street junction would be retained, with the addition of a right turning lane on Dunbar Link to accommodate traffic turning right on to Nelson Street, which would become two-way between Great Georges Street and Great Patrick Street.

In addition, Option A would also introduce two new junctions. A signalised junction would be introduced on York Street to allow access to and from Galway House and a new priority junction would be introduced on Corporation Street to accommodate a new one-way link to the Westlink.

All other existing junction arrangements within the study area would remain unchanged.

7.6.1.2 *Option B*

7.6.1.2.1 ***Overview***

A detailed plan showing Option B is shown in **Figure 7.6.2**.

7.6.1.2.2 ***Strategic Movements – Westlink / M2 Motorway / M3 Motorway***

Option B would provide an uninterrupted link from Westlink to the M2 Motorway, and from the M2 Motorway to Westlink. This option would also provide an uninterrupted link from Westlink to the M3 Motorway, and from the M3 Motorway to Westlink. The existing link between the M2 and M3 Motorways would be retained.

7.6.1.2.3 ***Local Movements – York Street***

York Street would be realigned to provide three continuous northbound lanes to cater for traffic travelling north between the interchange with Westlink / York Link and Dock Street.

This option would also provide an uninterrupted link from York Street to the M2.

The York Street to the M3 Motorway movement would not be accommodated with a direct link within the proposed junction arrangement.

7.6.1.2.4 ***Local Movements – Nelson Street***

Nelson Street between Dock Street and Great George's Street would be closed to traffic to accommodate the new link to the M3 Motorway. Consequently, traffic on Nelson Street would be displaced on to the surrounding road network.

This option would also provide an uninterrupted link from Nelson Street, north of Dock Street, to Westlink.

7.6.1.2.5 ***Junction Arrangements***

The existing traffic signals at the York Street / Great George's Street junction would be retained to manage traffic demand at this junction, with the traffic turning left from York Street to Great George's Street passing through a new priority junction. The Great George's Street to Westlink movement would no longer pass through the traffic signals.

The existing traffic signals at the York Street / York Link junction would be retained, however traffic progressing to the M2 Motorway would no longer pass through the signals and would instead travel uninterrupted on a new link connecting York Street to the M2 Motorway.

The junction arrangement at York Street / Dock Street would remain unchanged, with the exception of the addition of a new slip to accommodate traffic turning left from York Street on to Dock Street.

The existing traffic signals at Dock Street / Nelson Street would be altered to accommodate a new one-way link to the M3 Motorway, in place of Nelson Street. A slip from Dock Street to the new one-way link to the M3 Motorway would also be provided to accommodate traffic turning left from Dock Street to the M3 Motorway.

With Nelson Street closed to traffic, the existing traffic signals at York Link and Great George's Street would be removed.

The existing traffic signals at the Corporation Street / Dock Street junction would be retained, however two-way operation would be in place on Garmoyle Street with the two right-hand lanes being converted from a southbound to a northbound direction.

The existing traffic signals at the Nelson Street / Great Patrick Street junction would be retained, with the addition of a right turning lane on Dunbar Link to accommodate traffic turning right on to Nelson Street, which would become two-way between Great Georges Street and Great Patrick Street.

In addition, Option B would also introduce two new junctions. A signalised junction on York Street would be introduced to allow access to and from Galway House. A signalised junction would also be introduced at the Nelson Street / Whitla Street junction, north of Dock Street, to accommodate a new one-way link to Westlink, with the direction of travel on Whitla Street changed from one-way to two-way operation.

All other existing junction arrangements within the study area would remain unchanged.

7.6.1.3 *Option C*

7.6.1.3.1 ***Overview***

A detailed plan showing Option C is shown in **Figure 7.6.3**.

7.6.1.3.2 ***Strategic Movements – Westlink / M2 Motorway / M3 Motorway***

Option C would provide an uninterrupted link from Westlink to the M2 Motorway, and from the M2 Motorway to Westlink. This option would also provide an uninterrupted link from Westlink to the M3 Motorway, and from the M3 Motorway to Westlink. The existing link between the M2 and M3 Motorways would be retained.

7.6.1.3.3 ***Local Movements – York Street***

York Street would be realigned to provide three continuous northbound lanes to cater for traffic travelling north between the interchange with Westlink / York Link and Dock Street.

This option would also provide an uninterrupted link from York Street to the M2.

The York Street to the M3 Motorway movement would not be accommodated with a direct link within the proposed junction arrangement.

7.6.1.3.4 ***Local Movements – Nelson Street / Corporation Street***

Nelson Street between Dock Street and Great George's Street would be closed to traffic to accommodate the new link to the M3 Motorway. Consequently, traffic on Nelson Street would be displaced on to the surrounding road network.

This option would also provide a new link between Corporation Street and the Westlink.

7.6.1.3.5 ***Junction Arrangements***

The existing traffic signals at the York Street / Great George's Street junction would be retained to manage traffic demand at this junction, with the traffic turning left from York Street to Great George's Street passing through a new priority junction. The Great George's Street to Westlink movement would no longer pass through the traffic signals.

The existing traffic signals at the York Street / York Link junction would be retained, however traffic progressing to the M2 Motorway would no longer pass through the signals and would instead travel uninterrupted on a new link connecting York Street to the M2 Motorway.

The junction arrangement at York Street / Dock Street would remain unchanged, with the exception of the addition of a new slip to accommodate traffic turning left from York Street on to Dock Street.

The existing traffic signals at the Dock Street / Nelson Street junction would be altered to accommodate a new one-way link to the M3 Motorway, in place of Nelson Street. A slip from Dock Street to the new one-way link to the M3 Motorway would also be provided to accommodate traffic turning left from Dock Street to the M3 Motorway.

With Nelson Street closed to traffic, the existing traffic signals at York Link and Great George's Street would be removed.

The existing traffic signals at the Nelson Street / Great Patrick Street junction would be retained, with the addition of a right turning lane on Dunbar Link to accommodate traffic turning right on to Nelson Street, which would become two-way between Great Georges Street and Great Patrick Street.

In addition, Option C would also introduce two new junctions. A signalised junction would be introduced on York Street to allow access to and from Galway House and a new priority junction would be introduced on Corporation Street to accommodate a new one-way link to the Westlink.

All other existing junction arrangements within the study area would remain unchanged.

7.6.1.4 *Option D*

7.6.1.4.1 ***Overview***

A detailed plan showing Option D is shown in **Figure 7.6.4**.

7.6.1.4.2 ***Strategic Movements – Westlink / M2 Motorway / M3 Motorway***

Option D would provide an uninterrupted link from Westlink to the M2 Motorway, and from the M2 Motorway to Westlink. Traffic from Westlink to the M3 Motorway would pass through the traffic signals at the intersection with York Street and at the intersection with Nelson Street, as in the existing network. An uninterrupted link from the M3 Motorway to Westlink would be provided. The existing link between the M2 and M3 Motorways would be retained.

7.6.1.4.3 ***Local Movements - York Street***

The existing traffic signals at the York Street / Great George's Street junction would be retained to manage traffic demand at this junction, with the traffic turning left from York Street to Great George's Street passing through a new priority junction. The Great George's Street to Westlink movement would no longer pass through the traffic signals.

Traffic on York Street travelling to the M2 Motorway would pass through the existing traffic signals at the intersection with Westlink.

The York Street to M3 Motorway movement would remain unchanged, with traffic passing through a priority junction at York Link and traffic signals at the Nelson Street / York Link junction, as in the existing network.

7.6.1.4.4 ***Local Movements – Nelson Street***

Nelson Street between Dock Street and York Link would remain open to traffic, however the section between York Link and Great George's Street would be closed to accommodate the new link from the M3 Motorway to Westlink. Consequently, traffic on Nelson Street would be displaced on to the surrounding road network.

This option would also provide an uninterrupted link from Nelson Street, north of Dock Street, to Westlink.

7.6.1.4.5 ***Junction Arrangements***

The existing traffic signals at the York Street / Great George's Street junction would be retained to manage traffic demand at this junction, with the traffic turning left from York Street to Great George's Street passing through a new priority junction. The Great George's Street to Westlink movement would no longer pass through the traffic signals.

The existing traffic signals at the York Street / York Link junction would be retained to manage traffic demand at this junction.

The junction arrangement at York Street / Dock Street would remain unchanged, with the exception of the addition of a new slip to accommodate traffic turning left from York Street on to Dock Street.

The existing traffic signals at the Dock Street / Nelson Street junction would also remain unchanged, with the exception of a new slip to accommodate traffic turning left from Dock Street to Nelson Street.

With Nelson Street closed to traffic between York Link and Great George's Street, the existing traffic signals at the York Link / Nelson Street junction would be reconfigured to accommodate the new traffic movements.

The existing traffic signals at the Corporation Street / Dock Street junction would be retained, however two-way operation would be in place on Garmoyle Street with the two right-hand lanes being converted from a southbound to a northbound direction.

The existing traffic signals at the Nelson Street / Great Patrick Street junction would be retained, with the addition of a right turning lane on Dunbar Link to accommodate traffic turning right on to Nelson Street, which would become two-way between Great Georges Street and Great Patrick Street.

The northbound Westlink on-slip at Clifton Street would be removed and subsequently the traffic signals at Clifton Street / Westlink would be reconfigured to accommodate the new traffic movements.

In addition, Option D would also introduce two new junctions. A signalised junction on York Street would be introduced to allow access to and from Galway House. A signalised junction would also be introduced at the Nelson Street / Whitla Street junction, north of Dock Street, to accommodate a new one-way link to Westlink. The direction of travel on Whitla Street would be changed from an eastbound direction to a westbound direction and the priority junction at the Garmoyle Street / Whitla Street junction would be removed. Lastly, a new signalised junction would be introduced on Corporation Street to accommodate a new link from Nelson Street to Corporation Street.

All other existing junction arrangements within the study area would remain unchanged.

7.6.2 ***Traffic Flows***

7.6.2.1 *Do-Minimum Network*

The options have been developed to improve the movement of strategic traffic through the junctions between Westlink, the M2 Motorway and the M3 Motorway. Through the development of the various computer models and an estimate of the likely changes in travel patterns resulting from the provision of the proposed scheme, taking into account the effects of displaced traffic for movements that are not accommodated by the new links, the likely changes in traffic volumes across the network can be estimated.

The observed 24-hour traffic flows for the Do-Minimum network in the 2010 base traffic year are shown in **Figure 7.6.5**.

Examination of the 2010 traffic flows indicates that the following traffic volumes, in vehicles per day (vpd), would pass through the junction:

- Some 18,200 vpd would approach the junction on York Street
- Some 39,100 vpd would approach the junction on Westlink
- Some 20,100 vpd would approach the junction on M2 southbound off-slip
- Some 12,700 vpd would approach the junction on Nelson Street
- Some 19,400 vpd would approach the junction on M3 westbound off-slip.

The estimated 24-hour traffic flows for the Do-Minimum network in the 2020 year of opening, under the NRTF central traffic growth scenario, are shown in **Figure 7.6.6**.

Examination of the traffic flows in 2020 under the NRTF central traffic growth scenario indicates the following traffic volumes, in vehicles per day (vpd), would pass through the junction:

- Some 20,700 vpd would approach the junction on York Street;
- Some 44,600 vpd would approach the junction on Westlink;
- Some 22,900 vpd would approach the junction on M2 southbound off-slip;
- Some 14,500 vpd would approach the junction on Nelson Street; and
- Some 22,100 vpd would approach the junction on M3 westbound off-slip.

The principal operational effect of the options is to provide improved transport links for strategic traffic movements by providing a grade-separated interchange that avoids the existing signalised junctions on the surface streets with a consequential reduction in delays and congestion for strategic traffic travelling between the Westlink and the M2 and M3 Motorways.

7.6.2.2 *Do-Something Networks*

The estimated 24-hour traffic flows for the options in the 2020 year of opening, under the NRTF central traffic growth scenario, are shown in **Figures 7.6.7 to 7.6.10**.

A comparison of the daily traffic flows estimated for each of the key approach roads to the junction in the 2020 year of opening under the central traffic growth scenario is shown in **Table 7.6.1**.

TABLE 7.6.1 KEY APPROACH ROAD TRAFFIC FLOWS 2020 YEAR OF OPENING AADT

Approach Road	Do-Minimum Network (vpd)	Do-Something Networks			
		Option A (vpd)	Option B (vpd)	Option C (vpd)	Option D (vpd)
York Street	20,700	15,800	20,900	21,600	27,000
Westlink	44,600	43,700	43,900	43,700	39,800
M2 S/b Off-Slip	22,900	20,900	21,000	20,700	18,700
Nelson Street (3)	14,500	7,800	7,800	7,800	6,500
M3 W/b Off-Slip	22,100	22,000	22,000	22,000	22,000

Note 1: Where an equivalent link is not available, the nearest comparable link(s) have been used.
Note 2: Traffic flows on Nelson Street are not directly comparable across all options due to road closures.
Note 3: Link accommodates only Nelson Street to M3 traffic under Do-Something Options.

In comparing the traffic flows across the various options, the following key issues should be taken into account:

- The closure of Nelson Street to through traffic in all options would result in traffic reassignment over a wide area;
- The absence of a direct link between York Street and the M3 Motorway in Options A, B and C would result in traffic reassignment over a wide area; and
- The closure of the Clifton Street on-slip in Option D would result in traffic reassignment over a wide area and possibly outside the modelled area.

Examination of the traffic flows in the above table for the Do-Minimum network and for Option B and Option C indicates that the volume of traffic on York Street is similar. Traffic flows for Option A on York Street are lower due to the introduction of two-way operation on Nelson Street between Great George's Street and Dunbar Link. Traffic flows for Option D on York Street are higher due to the York Street to M3 Motorway movement remaining unchanged, with traffic continuing to pass through a priority junction at York Link, and traffic signals at the Nelson Street / York Link junction to access the M3 Motorway.

The volume of traffic approaching from Westlink is similar across all options, with the exception of Option D where the flow decreases due to the closure of the Westlink north facing on-slip at Clifton Street which carries some 6,000 vehicles per day in the Do-Minimum network.

The volume of traffic approaching from the M2 southbound off-slip is similar across all options.

The volume of traffic on Nelson Street is similar across all options, with the exception of Option D where the flow decreases due to an increased number of vehicles using the M2 southbound off-slip at Duncrue Street. In all options Nelson Street would be closed to through traffic and would only accommodate traffic travelling to the M3 Motorway, with the exception of Option D where the traffic signals at the Nelson Street / York Link junction would be retained to accommodate a new link from Nelson Street to Corporation Street, as well as traffic travelling to the M3 Motorway.

The volume of traffic on the M3 Motorway westbound off-slip is constant across all options.

7.6.3 ***Journey Times***

7.6.3.1 *Introduction*

Savings in journey times are generally one of the most significant benefits resulting from the provision of a new transport improvement scheme. Although COBA reports link transit times along predefined routes in the modelled network, this information excludes junction delays, which in the case of the York Street Interchange is an important consideration when comparing the overall changes in journey time.

COBA considers changes in traffic conditions during the day by modelling the 8,760 hours in a year divided into different portions called Flow Groups (FGs).

Flow Groups 1-5 represent Weekday Hours, with FG4/5 representing the busiest 522 weekday hours of the year, FG3 representing the next busiest 522 weekday hours, FG2 representing the next busiest 2,088 weekday hours, and FG1 representing the remaining 3,132 weekday hours.

Flow Groups 6-10 represent Weekend Hours, with FG9/10 representing the busiest 208 weekend hours of the year, FG8 representing the next busiest 208 weekend hours, FG7 representing the next busiest 832 weekend hours, and FG6 representing the remaining 1,248 weekend hours.

To provide a direct comparison between journey times on the Do-Minimum and the Do-Something networks in the 2020 opening year, the average vehicle speeds for each link in the network and the corresponding junction delays along the route were extracted from the COBA models for light vehicles based on Flow Group 3 traffic flow conditions. As Flow Group 3 generally represents operating conditions adjacent to, but excluding, the busiest peak periods it is reasonable to assume that the time savings in Flow Group 4, which generally represents the peak period, would be higher.

7.6.3.2 *Journey Time Savings*

The comparison of journey times based on the directional routes between the strategic points, namely Westlink, the M2 Motorway and the M3 Motorway, for each of the options are shown in **Tables 7.6.2 and 7.6.3**. This includes details for COBA Flow Group 3, which is adjacent to the peak period, and for the 2020 opening year and 2034 design year.

TABLE 7.6.2 REDUCTIONS IN JOURNEY TIMES: FLOW GROUP 3 2020 YEAR OF OPENING

Route	Do-Minimum Network	Do-Something Networks			
		Option A (%)	Option B (%)	Option C (%)	Option D (%)
Westlink – M2	4.94	2	2	2	7
M2 – Westlink	7.54	31	33	31	34
Westlink – M3	4.50	21	21	21	13
M3 – Westlink	4.28	6	24	23	24
M2 – M3	4.12	0	0	0	0
M3 – M2	3.51	-4	-4	-4	-4

Note: Westlink = Node 100, M2 = Node 288 and M3 = Node 121.

TABLE 7.6.3 REDUCTIONS IN JOURNEY TIMES: FLOW GROUP 3 2034 DESIGN YEAR

Route	Do-Minimum Network	Do-Something Networks			
		Option A (%)	Option B (%)	Option C (%)	Option D (%)
Westlink – M2	5.18	1	1	1	6
M2 – Westlink	7.96	31	33	32	35
Westlink – M3	4.96	25	25	25	17
M3 – Westlink	4.52	6	25	24	26
M2 – M3	4.22	0	0	0	0
M3 – M2	3.74	-4	-4	-4	-4

Note: Westlink = Node 100, M2 = Node 288 and M3 = Node 121.

It should be noted that the information presented in the above tables assumes that traffic within the general area would increase from the base traffic year to the 2020 opening year and 2034 design year in line with NRTF central growth forecasts in both the Do-Minimum and Do-Something networks which may not be achievable given the local constraints.

Examination of the above journey time information for traffic conditions indicates that journey times from Westlink to the M2 Motorway would reduce by 2% to 7% in 2020 under Flow Group 3, decreasing to 1% to 6% in 2034. Option D provides the highest reduction in journey time.

In the reverse direction, journey times from the M2 Motorway to Westlink would reduce by 31% to 34% in 2020 under Flow Group 3, increasing slightly to 31% to 35% in 2034. Option D provides the highest reduction in journey time, however the reductions in journey times are generally consistent across all options.

Journey times from the Westlink to the M3 Motorway would reduce by 13% to 21% in 2020 under Flow Group 3, increasing to 17% to 25% in 2034. Options A, B and C provide the highest reduction in journey times.

In the reverse direction, journey times from the M3 Motorway to Westlink would reduce by 6% to 24% in 2020 under Flow Group 3. In 2034, journey times would reduce by 6% to 26% in 2034 under Flow Group 3. Options B, C and D provide the highest reduction in journey times.

This increase in journey times in Option A may be attributed to the fact that vehicles travelling from the M3 Motorway to Westlink would pass through traffic signals at both the intersection with Nelson Street and the intersection with York Street as in the existing network, with two lanes to cater for traffic to Westlink as opposed to three lanes in the current arrangement. Options B, C and D provide an uninterrupted link from the M3 motorway to the Westlink.

Although the proposed improvements do not include specific improvements to the M2 and M3 Motorways, the location of merge/diverge points can result in changes in operating conditions along the motorway. Journey times from the M2 motorway to the M3 motorway would remain the same in both 2020 and 2034 under Flow Group 3, however in the reverse direction journey times from the M3 Motorway to M2 Motorway would increase by 4% in both 2020 and 2034 under Flow Group 3.

7.6.4 *Network Capacity*

7.6.4.1 *Do-Minimum Network*

As part of the overall operational assessment of a proposed road improvement scheme, the COBA model identifies links and junctions where traffic demand exceeds operating capacity. Where demand exceeds capacity, delays and the corresponding costs increase significantly. In urban networks where a number of alternative routes are available, this can lead to an over-estimate in transport costs as traffic would be more likely to reassign on to other routes rather than incur high costs on the original route. Nevertheless, the number of over-capacity links and junctions provides a measure of operating conditions on the network.

Based on the information obtained from the COBA models, the links and junctions that are reported as being over-capacity have been identified to provide an indication of the traffic conditions on the various networks. The assessment considers the effects of normal variations in traffic demand that occur during the day, as defined by the various Flow Groups, and the effects of growth in traffic from the 2010 base year to the 2020 opening year and the 2034 design year.

The number of over-capacity links and junctions in the Do-Minimum network is summarised in **Table 7.6.4**.

TABLE 7.6.4 NUMBER OF OVERCAPACITY LINKS AND JUNCTIONS: DO MINIMUM NETWORK

Year	Flow Group	Do-Minimum Network	
		Link	Junction
2010	Flow Group 1/2	0	0
	Flow Group 3/4	8	5
	Flow Group 8/9	2	1
2020	Flow Group 1/2	0	0
	Flow Group 3/4	14	6
	Flow Group 8/9	5	2
2034	Flow Group 1/2	1	1
	Flow Group 3/4	22	9
	Flow Group 8/9	9	6

Examination of the above results indicates that traffic demand in 2010 Flow Group 3/4 would exceed capacity on 8 links and 5 junctions. By the 2020 opening year, these numbers would increase to 14 links and 6 junctions and to 22 links and 9 junctions in 2034.

The locations of the links and junctions that are over capacity under the central traffic growth forecasts are shown in **Figure 7.6.11**.

Examination of the over-capacity links and junctions under the 2010, 2020 and 2034 demand scenarios for the Do-Minimum network indicates that traffic flows on sections of the Westlink northbound carriageway, sections of the Westlink southbound carriageway, the three lane section of the M2 northbound on-slip between the York Street / York Link junction and the York Street / M2 on-slip junction and the M2 southbound off-slip at Nelson Street would all exceed capacity in 2010. Although the small section of the M3 Motorway between the on-slip and off-slips at Nelson Street is also shown as being over-capacity, this analysis is based on estimated traffic flows as the existing M2 / M3 Motorway links would not be affected by the proposed improvements.

Demand in 2010 at Clifton Street / Westlink northbound off-slip priority junctions, the York Street / Frederick Street priority junction, the York Street / Great George’s Street junction, the York Street / York Link junction and the York Street / M2 northbound on-slip priority junction would also exceed capacity.

By the 2020 opening year, demand at the Nelson Street / York Link junction would exceed capacity.

By the year 2034, demand at the Clifton Street / Westlink northbound off-slip junction, the Clifton Street / Frederick Street junction and the Nelson Street / Great George’s Street junction would all exceed capacity.

7.6.5 *Do-Something Network – Option A*

The number of over-capacity links and junctions in Option A is summarised in **Table 7.6.5**.

TABLE 7.6.5 NUMBER OF OVERCAPACITY LINKS AND JUNCTIONS: DO SOMETHING NETWORK OPTION A

Year	Flow Group	Do-Something Network (Option A)	
		Link	Junction
2010	Flow Group 1/2	0	0
	Flow Group 3/4	4	5
	Flow Group 8/9	0	2
2020	Flow Group 1/2	0	1
	Flow Group 3/4	12	6
	Flow Group 8/9	3	2
2034	Flow Group 1/2	0	2
	Flow Group 3/4	16	11
	Flow Group 8/9	6	5

Examination of the above results indicates that traffic demand in 2010 Flow Group 3/4 would exceed capacity on 4 links and 5 junctions. By the 2020 opening year, these numbers would increase to 12 links and 6 junctions and to 16 links and 11 junctions in 2034.

The locations of the links and junctions that are over capacity under the central traffic growth forecasts are shown in **Figure 7.6.12**.

Examination of the over-capacity links and junctions under the 2010, 2020 and 2034 demand scenarios for Option A indicates that traffic flows on sections of the Westlink northbound carriageway, sections of the Westlink southbound carriageway and the new Westlink to M2 / M3 Motorways link would all exceed capacity in 2010. Although the small section of the M3 Motorway between the on-slip and off-slips at Nelson Street is also shown as being over-capacity, this analysis is based on estimated traffic flows as the existing M2 / M3 Motorway links would not be affected by the proposed improvements.

Demand in 2010 at the Clifton Street / Westlink northbound off-slip priority junction, the Clifton Street / Frederick Street junction, the York Street (north) / Dock Street priority junction and the new priority junctions on Corporation Street and on the new link to Westlink where traffic from the M2 Motorway and Corporation Street meets would also exceed capacity.

By the 2020 opening year, demand at the Frederick Street / York Street junction would exceed capacity.

By the year 2034, demand at the Clifton Street / Westlink northbound off-slip junction, the Clifton Street / Westlink southbound off-slip priority junction, the North Queen Street / Brougham Street priority junction, the Nelson Street / Great George's Street junction and the Dock Street / M3 Motorway link priority junction would all exceed capacity.

7.6.6 *Do-Something Network – Option B*

The number of over-capacity links and junctions in Option B is summarised in **Table 7.6.6**.

TABLE 7.6.6 NUMBER OF OVERCAPACITY LINKS AND JUNCTIONS: DO SOMETHING NETWORK OPTION B

Year	Flow Group	Do-Something Network (Option B)	
		Link	Junction
2010	Flow Group 1/2	0	0
	Flow Group 3/4	5	4
	Flow Group 8/9	0	1
2020	Flow Group 1/2	0	0
	Flow Group 3/4	10	7
	Flow Group 8/9	3	1
2034	Flow Group 1/2	0	1
	Flow Group 3/4	16	10
	Flow Group 8/9	7	5

Examination of the above results indicates that traffic demand in 2010 Flow Group 3/4 would exceed capacity on 5 links and 4 junctions. By the 2020 opening year, these numbers would increase to 10 links and 7 junctions and to 16 links and 10 junctions in 2034.

The locations of the links and junctions that are over capacity under the central traffic growth forecasts are shown in **Figure 7.6.13**.

Examination of the over-capacity links and junctions under the 2010, 2020 and 2034 demand scenarios for Option B indicates that traffic flows on sections of the Westlink northbound carriageway, sections of the Westlink southbound carriageway, the new Westlink to M2 / M3 Motorways link and the northern section of North Queen Street would all exceed capacity in 2010. Although the small section of the M3 Motorway between the on-slip and off-slips at Nelson Street is also shown as being over-capacity, this analysis is based on estimated traffic flows as the existing M2 / M3 Motorway links would not be affected by the proposed improvements.

Demand in 2010 at the Clifton Street / Westlink northbound off-slip priority junction, the Clifton Street / Frederick Street junction, the York Street / Frederick Street priority junction, the York Street (north) / Dock Street priority junction and the priority junction on the new link to Westlink where traffic from the M2 Motorway and Garmoyle Street meets would also exceed capacity.

By the 2020 opening year, demand at the North Queen Street / Brougham Street priority junction and the Dock Street / Garmoyle Street junction would exceed capacity.

By the year 2034, demand at the Clifton Street / Westlink northbound off-slip junction, the North Queen Street / Frederick Street priority junction, and the new Dock Street / M3 Motorway link priority junction would all exceed capacity.

7.6.7 *Do-Something Network – Option C*

The number of over-capacity links and junctions in Option C is summarised in **Table 7.6.7**.

TABLE 7.6.7 NUMBER OF OVERCAPACITY LINKS AND JUNCTIONS: DO SOMETHING NETWORK OPTION C

Year	Flow Group	Do-Something Network (Option C)	
		Link	Junction
2010	Flow Group 1/2	0	0
	Flow Group 3/4	4	4
	Flow Group 8/9	0	1
2020	Flow Group 1/2	0	1
	Flow Group 3/4	12	8
	Flow Group 8/9	3	3
2034	Flow Group 1/2	0	1
	Flow Group 3/4	16	10
	Flow Group 8/9	5	5

Examination of the above results indicates that traffic demand in 2010 Flow Group 3/4 would exceed capacity on 4 links and 4 junctions. By the 2020 opening year, these numbers would increase to 12 links and 8 junctions and to 16 links and 10 junctions in 2034.

The locations of the links and junctions that are over capacity under the central traffic growth forecasts are shown in **Figure 7.6.14**.

Examination of the over-capacity links and junctions under the 2010, 2020 and 2034 demand scenarios for Option C indicates that traffic flows on sections of the Westlink northbound carriageway, sections of the Westlink southbound carriageway and the new Westlink to M2 / M3 Motorways link would all exceed capacity in 2010. Although the small section of the M3 Motorway between the on-slip and off-slips at Nelson Street is also shown as being over-capacity, this analysis is based on estimated traffic flows as the existing M2 / M3 Motorway links would not be affected by the proposed improvements.

Demand in 2010 at the Clifton Street / Westlink northbound off-slip priority junction, the York Street / Frederick Street priority junction and the new priority junctions on Corporation Street and on the new link to Westlink where traffic from the M2 Motorway and Corporation Street meets would also exceed capacity.

By the 2020 opening year, demand at the Clifton Street / Frederick Street junction, the Queen Street / Frederick Street priority junction, the North Queen Street / Brougham Street priority junction and the York Street (north) / Dock Street priority junction would exceed capacity.

By the year 2034, demand at the Clifton Street / Westlink northbound off-slip junction and the Dock Street / M3 Motorway link priority junction would all exceed capacity.

7.6.8 *Do-Something Network – Option D*

The number of over-capacity links and junctions in Option D is summarised in **Table 7.6.8**.

TABLE 7.6.8 NUMBER OF OVERCAPACITY LINKS AND JUNCTIONS: DO SOMETHING NETWORK OPTION D

Year	Flow Group	Do-Something Network (Option D)	
		Link	Junction
2010	Flow Group 1/2	0	1
	Flow Group 3/4	9	7
	Flow Group 8/9	0	4
2020	Flow Group 1/2	0	2
	Flow Group 3/4	11	12
	Flow Group 8/9	6	5
2034	Flow Group 1/2	0	4
	Flow Group 3/4	22	15
	Flow Group 8/9	10	7

Examination of the above results indicates that traffic demand in 2010 Flow Group 3/4 would exceed capacity on 9 links and 7 junctions. By the 2020 opening year, these numbers would increase to 11 links and 12 junctions and to 22 links and 15 junctions in 2034.

The locations of the links and junctions that are over capacity under the central traffic growth forecasts are shown in **Figure 7.6.15**.

Examination of the over-capacity links and junctions under the 2010, 2020 and 2034 demand scenarios for Option D indicates that traffic flows on sections of the Westlink northbound carriageway, sections of the Westlink southbound carriageway and the section of North Queen Street between the Brougham Street priority junction and Great George's Street would all exceed capacity in 2010. Although the small section of the M3 Motorway between the on-slip and off-slips at Nelson Street is also shown as being over-capacity, this analysis is based on estimated traffic flows as the existing M2 / M3 Motorway links would not be affected by the proposed improvements.

Demand in 2010 at the Clifton Street / Westlink northbound off-slip priority junction, the Clifton Street / Frederick Street junction, the York Street / Frederick Street priority junction the North Queen Street / Brougham Street priority junction, the York Street / York Link priority junction, the Dock Street / Garmoyle Street junction and the priority junction on the new link to Westlink where traffic from the M2 Motorway and Garmoyle Street meets would also exceed capacity.

By the 2020 opening year, demand at the Queen Street / Frederick Street priority junction, the York Street / M2 northbound on-slip priority junction, the Nelson Street / York Link junction, the York Street / Brougham Street priority junction and the York Street (north) / Dock Street priority junction would all exceed capacity.

By the year 2034, demand at the York Street / Westlink junction, the Brougham Street / Cityside Retail Park priority junction, and the new Dock Street / M3 Motorway link priority junction would all exceed capacity.

7.7 Road Safety

7.7.1 *Road Safety*

Given the inherent difficulties in predicting future accident rates and casualty severities over the 60-year economic assessment period, the COBA assessment has been based on the application of default accident rates and costs. These have been applied to both the Do-Minimum and Do-Something networks to provide a reasonable measure of the relative change in road traffic accident characteristics associated with the two networks.

The changes in the number of personal injury accidents and the corresponding casualty severities over the 60-year assessment period due to the provision of the improvement options at the York Street Interchange are shown in **Tables 7.7.1 to 7.7.4**. The associated Present Values of Benefit are also shown in the Tables.

It should be noted that due to the characteristics of some of the new links relative to the existing urban links, the COBA model indicates that the various improvement options would lead to road safety disbenefits. For example, whereas the northbound approach to York Street on the existing Westlink currently has a 50 mph speed limit with a default accident rate of 0.174 Personal Injury Accidents / Million Vehicle Kilometres (PIAs / mvkm), the majority of the Do-Something options reduce the speed limit on this section of the road network to 40 mph with a default accident rate of 1.004 PIAs / mvkm which results in a corresponding increase in accident numbers and associated disbenefits. This characteristic of the model should be taken into account when considering the road safety effects of the options.

7.7.2 *Do-Something Network – Option A*

The changes in the number of personal injury accidents and the corresponding casualty severities over the 60-year assessment period due to the provision of Option A are shown in **Tables 7.7.1A and 7.7.1B**.

TABLE 7.7.1A ACCIDENT NUMBERS AND COSTS: DO SOMETHING NETWORK OPTION A

Network	Number of Accidents			Accidents Total Cost (£m's)
	2020	2034	60-Year Total	
Do-Minimum	51.6	53.7	3,208.7	116.432
Do-Something	65.4	68.3	4,080.8	146.593
Benefits	**-13.8**	**-14.6**	**-872.2**	**-30.161**

TABLE 7.7.1B CASUALITES BY SEVERITY: DO SOMETHING NETWORK OPTION A

Network	Accident Severity			Total Accidents
	Fatal	Serious	Slight	
Do-Minimum	34.6	338.8	4,364.8	3,208.7
Do-Something	38.4	401.5	5,580.9	4,080.8
Benefits	**-3.8**	**-62.7**	**-1,216.2**	**-872.2**

From the above information, Option A would lead to an additional 872 personal injury accidents over the 60-year period, which equates to an economic disbenefit of -£30.2m.

7.7.3 *Do-Something Network – Option B*

The changes in the number of personal injury accidents and the corresponding casualty severities over the 60-year assessment period due to the provision of Option B are shown in **Tables 7.7.2A and 7.7.2B**.

TABLE 7.7.2A ACCIDENT NUMBERS AND COSTS: DO SOMETHING NETWORK OPTION B

Network	Number of Accidents			Accidents Total Cost (£m's)
	2020	2034	60-Year Total	
Do-Minimum	51.6	53.7	3,208.7	116.432
Do-Something	58.8	61.3	3,662.3	132.121
Benefits	**-7.2**	**-7.6**	**-453.6**	**-15.690**

TABLE 7.7.2B CASUALITES BY SEVERITY: DO SOMETHING NETWORK OPTION B

Network	Accident Severity			Total Accidents
	Fatal	Serious	Slight	
Do-Minimum	34.6	338.8	4,364.8	3,208.7
Do-Something	36.8	370.1	5,010.1	3,662.3
Benefits	**-2.2**	**-31.4**	**-645.3**	**-453.6**

From the above information, Option B would lead to an additional 454 personal injury accidents over the 60-year period, which equates to an economic disbenefit of -£15.7m.

7.7.4 *Do-Something Network – Option C*

The changes in the number of personal injury accidents and the corresponding casualty severities over the 60-year assessment period due to the provision of Option C are shown in **Tables 7.7.3A and 7.7.3B**.

TABLE 7.7.3A ACCIDENT NUMBERS AND COSTS: DO SOMETHING NETWORK OPTION C

Network	Number of Accidents			Accidents Total Cost (£m's)
	2020	2034	60-Year Total	
Do-Minimum	51.6	53.7	3,208.7	116.432
Do-Something	66.7	69.7	4,164.6	149.475
Benefits	**-15.1**	**-16.0**	**-955.9**	**-33.043**

TABLE 7.7.3B CASUALITES BY SEVERITY: DO SOMETHING NETWORK OPTION C

Network	Accident Severity			Total Accidents
	Fatal	Serious	Slight	
Do-Minimum	34.6	338.8	4,364.8	3,208.7
Do-Something	38.8	406.9	5,701.3	4,164.6
Benefits	**-4.2**	**-68.1**	**-1,336.5**	**-955.9**

From the above information, Option C would lead to an additional 956 personal injury accidents over the 60-year period, which equates to an economic disbenefit of -£33.0m.

7.7.5 *Do-Something Network – Option D*

The changes in the number of personal injury accidents and the corresponding casualty severities over the 60-year assessment period due to the provision of Option D are shown in **Tables 7.7.4A and 7.7.4B**.

TABLE 7.7.4A ACCIDENT NUMBERS AND COSTS: DO SOMETHING NETWORK OPTION D

Network	Number of Accidents			Accidents Total Cost (£m's)
	2020	2034	60-Year Total	
Do-Minimum	51.6	53.7	3,208.7	116.432
Do-Something	51.9	54.0	3,225.9	116.895
Benefits	**-0.3**	**-0.3**	**-17.2**	**-0.463**

TABLE 7.7.4B CASUALITES BY SEVERITY: DO SOMETHING NETWORK OPTION D

Network	Accident Severity			Total Accidents
	Fatal	Serious	Slight	
Do-Minimum	34.6	338.8	4,364.8	3,208.7
Do-Something	34.8	339.1	4,396.1	3,225.9
Benefits	**-0.1**	**-0.4**	**-31.3**	**-17.2**

From the above information, Option D would lead to an additional 17 personal injury accidents over the 60-year period, which equates to an economic disbenefit of -£0.5m.

The results of the COBA analysis, based on the application of default accident rates, indicate that the provision of the improvement options would lead to an increase in road safety costs over the 60-year economic life of the scheme for all four options.

7.8 Economic Assessment of Scheme Options

7.8.1 *COBA Appraisal*

The economic results from the COBA model for the each of the scheme options, based on the scheme costs defined previously including optimism bias and the application of the NRTF (1997) central traffic growth projection, are summarised in **Table 7.8.1**.

TABLE 7.8.1 COBA SCHEME OPTION APPRAISAL SUMMARY

	Do-Something Networks			
	Option A	**Option B**	**Option C**	**Option D**
Present Value of Benefits (PVB) (£m's)	82.001	109.986	100.470	-96.173
Present Value of Costs (PVC) (£m's)	47.211	52.123	54.143	53.699
Net Present Value (NPV) (£m's)	34.790	57.863	46.327	-149.872
Benefit to Cost Ratio (BCR)	1.737	2.110	1.856	-1.791

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

In accordance with current government guidelines on the reporting of transport economic efficiency, the results of the economic appraisal are presented in the market prices unit of account that was introduced in COBA11.

A more detailed presentation of the COBA results is shown in **Table 7.8.2** and indicates the transport economic efficiency, public accounts and monetised costs and benefits as defined in COBA11 Tables 15A to 15C.

TABLE 7.8.2 COBA SCHEME OPTION APPRAISAL				
	Do-Something Networks (£m's)			
	Option A	Option B	Option C	Option D
Consumers (User Benefits)				
Travel Time	57.973	65.668	68.652	-46.044
Approx. Link Transit Time	9.705	7.075	11.683	-18.515
Approx. Junction Delay	48.268	58.593	56.969	-27.529
Vehicle Operating Costs	0.049	-0.638	0.612	-4.136
Travel Time and VOC during construction (QUADRO)	0.000	0.000	0.000	0.000
Travel Time and VOC during maintenance (QUADRO)	0.000	0.000	0.000	0.000
Net Consumer User Benefits	**58.022**	**65.030**	**69.264**	**-50.180**
Business Users (User Benefits)				
Travel Time	54.366	61.239	64.283	-43.335
Approx. Link Transit Time	9.101	6.598	10.939	-17.426
Approx. Junction Delay	45.265	54.641	53.344	-25.909
Vehicle Operating Costs	-0.141	-0.583	0.112	-2.546
Travel Time and VOC during construction (QUADRO)	0.000	0.000	0.000	0.000
Travel Time and VOC during maintenance (QUADRO)	0.000	0.000	0.000	0.000
Subtotal	54.225	60.656	64.395	-45.881
Private Sector Provider Impacts (Operating Costs)	0.009	-0.086	0.071	-0.649
Net Business Impact	**54.234**	**60.570**	**64.466**	**-46.530**
Total Present Value of TEE Benefits	**112.256**	**125.600**	**133.730**	**-96.710**
Public Accounts				
Government Funding				
Operating Costs	0.114	0.151	0.128	0.142
Investment Costs	47.097	51.972	54.015	53.557
Present Value of Costs	47.211	52.123	54.143	53.699
Analysis of Monetised Costs and Benefits				
TEE Benefits				
Consumer User Benefits	58.022	65.030	69.264	-50.180
Business Benefits	54.225	60.656	64.395	-45.881

TABLE 7.8.2 COBA SCHEME OPTION APPRAISAL

	Do-Something Networks (£m's)			
	Option A	**Option B**	**Option C**	**Option D**
Private Sector Provider Impacts	0.009	-0.086	0.071	-0.649
Accident Benefits	-30.161	-15.690	-33.043	-0.463
Indirect Tax Revenues	-0.213	0.369	-0.620	3.414
Emissions Benefits	0.119	-0.293	0.403	-2.414
Present Value of Benefits	**82.001**	**109.986**	**100.470**	**-96.173**
Government Funding (Present Value of Costs)	**47.211**	**52.123**	**54.143**	**53.699**
Overall Impact				
Net Present Value	**34.790**	**57.863**	**46.327**	**-149.872**
Benefit to Cost Ratio	**1.737**	**2.110**	**1.856**	**-1.791**

Source: COBA11 Release 12 Tables 15A – 15C.
Note: Costs in 2002 Prices in £m discounted to 2002 at 3.5% for the first 30 years, 3% thereafter for 46 years, thereafter 2.5%.

Examination of the above information indicates that the principal benefits of Option A result from savings in transit time, which equates to £112.3m. However, due to the characteristics of the new links relative to the existing urban links, this option would also lead to road safety disbenefits of -£30.2m.

Examination of the above information indicates that the principal benefits of Option B result from savings in transit time, which equates to £126.9m. However, due to the characteristics of the new links relative to the existing urban links, this option would also lead to road safety disbenefits of -£15.7m.

Examination of the above information indicates that the principal benefits of Option C result from savings in transit time, which equates to £132.9m. However, due to the characteristics of the new links relative to the existing urban links, this option would also lead to road safety disbenefits of -£33.0m.

Examination of the above information indicates that Option D would result in disbenefits overall. These disbenefits result mainly from an increase in transit time, which equates to disbenefits of -£89.4m. In addition, due to the characteristics of the new links relative to the existing urban links, this option would also lead to road safety disbenefits of -£0.5m.

7.8.2 *QUADRO Appraisal*

The economic results from the QUADRO model for the each of the options, based on the application of the NRTF (1997) central traffic growth projection, are summarised in **Table 7.8.3**.

TABLE 7.8.3 QUADRO SCHEME OPTION APPRAISAL SUMMARY

	Do-Something Networks			
	Option A	Option B	Option C	Option D
Present Value of Benefits (PVB) (£m's)	-7.852	-18.087	-10.962	-13.720
Present Value of Costs (PVC) (£m's)	0.005	0.006	0.006	0.005
Net Present Value (NPV) (£m's)	-7.857	-18.094	-10.968	-13.725

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

In accordance with current government guidelines on the reporting of transport economic efficiency, the results of the economic appraisal are presented in the market prices unit of account that was introduced in QUADRO4.

The QUADRO models are based on default traffic flow profiles, a Max Q-Delay of 5 minutes and 24-hour working on the existing network on Monday to Sunday between 00:00 hours and 24:00 hours. No overnight or weekend closures have been modelled at this stage as these are likely to be less significant in economic terms due to the reduced volumes of traffic. It has also been assumed that a temporary speed limit of 30 mph would be in place over the network throughout the duration of the works.

As noted in this report, a number of traffic management and other initiatives will be promoted during construction and therefore a 10% reduction in traffic volumes during the construction of the scheme is thought to be reasonable, based on past experience of similar projects in the Belfast area.

A more detailed presentation of the QUADRO appraisal of the options is shown in **Table 7.8.4**.

The information is presented in a similar format to the COBA appraisals, allowing the results to be readily combined to determine the overall economic benefits of the options.

TABLE 7.8.4 QUADRO SCHEME OPTION APPRAISAL

	Do-Something Networks (£m's)			
	Option A	**Option B**	**Option C**	**Option D**
Do-Minimum Model				
Consumers - Net Consumer Impact	0.000	0.000	0.000	0.000
Business Users - User Costs	0.000	0.000	0.000	0.000
Private Sector Provider Impacts - Operating Costs	0.000	0.000	0.000	0.000
Accident Costs	0.000	0.000	0.000	0.000
Carbon Emission Costs	0.000	0.000	0.000	0.000
Maintenance Costs	0.000	0.000	0.000	0.000
Indirect Tax Revenues	0.000	0.000	0.000	0.000
Overall Impact	**0.000**	**0.000**	**0.000**	**0.000**
During Construction				
Consumers - Net Consumer Impact	3.784	8.904	5.399	6.941
Business Users - User Costs	3.752	8.715	5.240	6.499
Private Sector Provider Impacts - Operating Costs	0.000	0.000	0.000	0.000
Accident Costs	0.316	0.468	0.323	0.280
Carbon Emission Costs	0.000	0.000	0.000	0.000
Maintenance Costs	0.000	0.000	0.000	0.000
Indirect Tax Revenues	0.005	0.006	0.006	0.005
Overall Impact	**7.857**	**18.094**	**10.968**	**13.725**
Preferred Scheme				
Consumers - Net Consumer Impact	0.000	0.000	0.000	0.000
Business Users - User Costs	0.000	0.000	0.000	0.000
Private Sector Provider Impacts - Operating Costs	0.000	0.000	0.000	0.000
Accident Costs	0.000	0.000	0.000	0.000
Carbon Emission Costs	0.000	0.000	0.000	0.000
Maintenance Costs	0.000	0.000	0.000	0.000
Indirect Tax Revenues	0.000	0.000	0.000	0.000
Overall Impact	**0.000**	**0.000**	**0.000**	**0.000**
Overall Assessment (Net Present Value)				

TABLE 7.8.4 QUADRO SCHEME OPTION APPRAISAL

	Do-Something Networks (£m's)			
	Option A	**Option B**	**Option C**	**Option D**
Consumer User Benefits	-3.784	-8.904	-5.399	-6.941
Business Benefits	-3.752	-8.715	-5.240	-6.499
Private Sector Provider Benefits	0.000	0.000	0.000	0.000
Accident Benefits	-0.316	-0.468	-0.323	-0.280
Carbon Emission Benefits	0.000	0.000	0.000	0.000
Maintenance Costs	0.000	0.000	0.000	0.000
Indirect Tax Revenues	0.005	0.006	0.006	0.005
Overall Impact	**-7.857**	**-18.094**	**-10.968**	**-13.725**
Present Value of Benefits During Construction	-7.852	-18.087	-10.962	-13.720
Present Value of Benefits Future Maintenance	0.000	0.000	0.000	0.000
Present Value of Benefits	**-7.852**	**-18.087**	**-10.962**	**-13.720**
Present Value of Cost	**0.005**	**0.006**	**0.006**	**0.005**
Net Present Value	**-7.857**	**-18.094**	**-10.968**	**-13.725**

Source: QUADRO4 Release 10 Tables 2A – 2C.
Note: Costs in 2002 Prices in £m discounted to 2002 at 3.5% for the first 30 years, 3% thereafter 3.0% from the Current Year defined in QUADRO4.

As there is a tendency for project appraisers to be overly optimistic, optimism bias has been included in the QUADRO appraisal to increase the projected duration of the works by 10%. The results of the QUADRO appraisal including 10% optimism bias are shown in **Table 7.8.5**.

TABLE 7.8.5 QUADRO SCHEME OPTION APPRAISAL SUMMARY INCLUDING 10% OPTIMISM BIAS

	Do-Something Networks			
	Option A	**Option B**	**Option C**	**Option D**
Present Value of Benefits (PVB) (£m's)	-8.637	-19.896	-12.058	-15.092
Present Value of Costs (PVC) (£m's)	0.006	0.007	0.007	0.006
Net Present Value (NPV) (£m's)	-8.643	-19.903	-12.065	-15.098

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

7.8.3 *COBA / QUADRO Appraisal*

The economic results based on the combined COBA and QUADRO appraisals including the effects of optimism bias, the application of the NRTF central traffic growth and default accident characteristics are shown in **Table 7.8.6**.

TABLE 7.8.6 COMBINED COBA / QUADRO SCHEME OPTION APPRAISAL SUMMARY

	Do-Something Networks			
	Option A	**Option B**	**Option C**	**Option D**
Present Value of Benefits (PVB) (£m's)	73.364	90.090	88.412	-111.265
Present Value of Costs (PVC) (£m's)	47.217	52.130	54.150	53.705
Net Present Value (NPV) (£m's)	26.147	37.960	34.262	-164.970
Benefit to Cost Ratio (BCR)	1.554	1.728	1.633	-2.072

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

In accordance with current government guidelines on the reporting of transport economic efficiency, the results of the economic appraisal are presented in the market prices unit of account that was introduced in COBA11 and QUADRO 4.

The results from the combined COBA and QUADRO appraisal indicate that three of the four options would deliver a positive Net Present Value and Benefit to Cost Ratio. Option D would result in a negative Net Present Value and Benefit to Cost Ratio.

Based on the above information, in order of Benefit to Cost Ratios under the central traffic growth scenario, the schemes are as follows:

- Option B: NPV of £37.960m BCR of 1.728
- Option C: NPV of £34.262m BCR of 1.633
- Option A: NPV of £26.147m BCR of 1.554
- Option D: NPV of -£164.970m BCR of -2.072

7.9 Sensitivity Tests

7.9.1 *COBA Sensitivity Tests*

A series of sensitivity tests has been undertaken to examine the extent to which the results from the COBA economic appraisal vary under various scenarios.

The first sensitivity test examined the effects of changes in future traffic growth. The second sensitivity test examined the effects of a predicted increase in traffic flows due to a number of committed developments in the area by increasing the volume of traffic on the network by 5% in the year 2015. The third sensitivity test examined the effects of different approaches to modelling the operational characteristics of the merge on the link between the M2 Motorway and the Westlink from either Corporation Street or Garmoyle Street, depending on the option. The results of these sensitivity tests are reported in **Sections 7.9.1.1 to** below.

7.9.1.1 *Traffic Forecast Sensitivity Tests*

As there is an inherent degree of uncertainty in predicting long-term future traffic flows over the 60-year period of the economic assessment, the options have been tested considering NRTF (1997) low, central and high growth projections from the year 2010 onwards.

The results of the COBA sensitivity tests based on low, central and high growth projections are shown in **Tables 7.9.1 to 7.9.3**.

TABLE 7.9.1 COBA SCHEME OPTION APPRAISAL SUMMARY LOW GROWTH

	Do-Something Networks			
	Option A	Option B	Option C	Option D
Present Value of Benefits (PVB) (£m's)	58.599	86.215	73.962	-84.927
Present Value of Costs (PVC) (£m's)	47.211	52.123	54.143	53.699
Net Present Value (NPV) (£m's)	11.388	34.092	19.819	-138.627
Benefit to Cost Ratio (BCR)	1.241	1.654	1.366	-1.582

Note: Assessment is based on NRTF Low Growth with results expressed in 2002 prices.

TABLE 7.9.2 COBA SCHEME OPTION APPRAISAL SUMMARY CENTRAL GROWTH

	Do-Something Networks			
	Option A	Option B	Option C	Option D
Present Value of Benefits (PVB) (£m's)	82.001	109.986	100.470	-96.173
Present Value of Costs (PVC) (£m's)	47.211	52.123	54.143	53.699
Net Present Value (NPV) (£m's)	34.790	57.863	46.327	-149.872
Benefit to Cost Ratio (BCR)	1.737	2.110	1.856	-1.791

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

TABLE 7.9.3 COBA SCHEME OPTION APPRAISAL SUMMARY HIGH GROWTH

	Do-Something Networks			
	Option A	Option B	Option C	Option D
Present Value of Benefits (PVB) (£m's)	120.854	149.438	142.501	-84.547
Present Value of Costs (PVC) (£m's)	47.211	52.123	54.143	53.699
Net Present Value (NPV) (£m's)	73.643	97.316	88.359	-138.246
Benefit to Cost Ratio (BCR)	2.560	2.867	2.632	-1.574

Note: Assessment is based on NRTF High Growth with results expressed in 2002 prices.

The results of the sensitivity test indicate that the Net Present Value of the options improve as the level of future traffic growth increases. However, on Option D it should be noted that the Net Present Value under both the low and high traffic growth scenarios are similar which is due to the operational characteristics of the junctions located around the York Street signalised gyratory system.

7.9.1.2 *5% Committed Development Traffic Sensitivity Test*

There are a number of committed developments within the York Street area, including apartments and social housing adjacent to Great George's Street, retail units at Brougham Street and the mixed use waterfront Titanic Quarter development which comprises a mixture of accommodation, business, education, office and research and development floor space together with hotels, restaurants, cafes, bars and other leisure uses.

At this stage it is difficult to quantify the combined effects of the numerous committed developments in the area in terms of changes in traffic volumes, implementation programmes and certainty of deliverability. Therefore, to take account of the general increase in traffic flows due to these committed developments, a sensitivity test has been undertaken based on increasing the volume of traffic on the network by 5% in the year 2015 to account for potential committed developments within the York Street area, followed thereafter by the application of NRTF central traffic growth. The results of this sensitivity test, based on central growth projections, are shown in **Table 7.9.4**.

TABLE 7.9.4 COBA SCHEME OPTION APPRAISAL SUMMARY 5% COMMITTED DEVELOPMENT TRAFFIC

	Do-Something Networks			
	Option A	Option B	Option C	Option D
Present Value of Benefits (PVB) (£m's)	112.458	141.367	134.108	-87.666
Present Value of Costs (PVC) (£m's)	47.211	52.123	54.143	53.699
Net Present Value (NPV) (£m's)	65.248	89.244	79.965	-141.366
Benefit to Cost Ratio (BCR)	2.382	2.712	2.477	-1.633

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

The results of the sensitivity test indicate that a 5% increase in traffic flows in 2015 would result in higher Net Present Values and Benefit to Cost ratios across all four options.

7.9.1.3 *Modelling of Link Road Merge Sensitivity Test*

For the main COBA economic assessment, the proposed merge on the link between the M2 Motorway and the Westlink from either Corporation Street or Garmoyle Street depending on the option, has been modelled as a priority junction rather than a merge. This approach has been adopted as merges can only be modelled on motorway links. However, it is recognised that this approach would over-estimate the junction delay costs.

As a sensitivity test, the costs associated with this junction have been excluded from the assessment, although this approach would under-estimate the junction delay costs.

The results of this sensitivity test, based on central growth projections, are shown in **Table 7.9.5**.

TABLE 7.9.5 COBA SCHEME OPTION APPRAISAL SUMMARY MODELLING OF LINK ROAD MERGE

	Do-Something Networks			
	Option A	**Option B**	**Option C**	**Option D**
Present Value of Benefits (PVB) (£m's)	103.393	125.919	119.260	-82.037
Present Value of Costs (PVC) (£m's)	47.211	52.123	54.143	53.699
Net Present Value (NPV) (£m's)	56.182	73.796	65.117	-135.737
Benefit to Cost Ratio (BCR)	2.190	2.416	2.203	-1.528

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

The results of this sensitivity test indicate that excluding the junction delay costs associated with the proposed merge on the link between the M2 Motorway and the Westlink from either Corporation Street or Garmoyle Street depending on the option would result in higher Net Present Values and Benefit to Cost ratios across all four options. The actual junction delay costs associated with this junction are likely to be between these two scenarios.

7.9.2 *QUADRO Sensitivity Tests*

The QUADRO models have been tested with a range of different traffic scenarios including adopting no reduction in traffic for the scheme options during construction as well as a 25% reduction in traffic for the scheme options during construction. The results of these sensitivity tests are shown below.

7.9.2.1 *Sensitivity to Changes in Traffic Flow*

The QUADRO models are based on default hourly traffic flow profiles, a Max Q-Delay of 5 minutes and a 10% reduction in traffic.

To test the sensitivity of the assessment to changes in traffic flow, sensitivity tests have been undertaken adopting a 0% reduction in traffic flow and a 25% reduction in traffic flow. The results of these sensitivity tests are summarised in **Tables 7.9.6 and 7.9.7**.

TABLE 7.9.6 QUADRO SCHEME OPTION APPRAISAL SUMMARY 0% TRAFFIC FLOW REDUCTION

	Do-Something Networks			
	Option A	Option B	Option C	Option D
Present Value of Benefits (PVB) (£m's)	-13.917	-29.532	-17.541	-21.390
Present Value of Costs (PVC) (£m's)	0.007	0.009	0.008	0.008
Net Present Value (NPV) (£m's)	-13.924	-29.541	-17.550	-21.398

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

TABLE 7.9.7 QUADRO SCHEME OPTION APPRAISAL SUMMARY 25% TRAFFIC FLOW REDUCTION

	Do-Something Networks			
	Option A	Option B	Option C	Option D
Present Value of Benefits (PVB) (£m's)	-3.853	-10.397	-6.803	-8.731
Present Value of Costs (PVC) (£m's)	0.005	0.008	0.006	0.006
Net Present Value (NPV) (£m's)	-3.859	-10.405	-6.809	-8.737

Note: Assessment is based on NRTF Central Growth with results expressed in 2002 prices.

The results of these sensitivity tests indicate that reducing the traffic flows by 25% results in a lower Net Present Value which, when combined with the COBA results, would result in a higher Net Present Value for the options.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

URS has been commissioned by Roads Service to undertake a DMRB Stage 2 Scheme Assessment of the proposed York Street Interchange Strategic Road Improvement Scheme. The proposed scheme seeks to improve links on the Westlink, M2 and M3 that form part of the Regional Strategic Transport Network by introducing grade separation at the existing signalised York Street junction in Belfast.

8.2 Scheme Objectives

The objectives for the scheme were identified at the onset of the URS commission to be the Government's five main objectives for transport, i.e.:

- Environment - to protect the built and natural environment
- Safety - to improve safety
- Economy - to support sustainable economic activity and get good value for money
- Accessibility - to improve access to facilities for people with disabilities and those without a car and to reduce severance
- Integration - to ensure that all decisions are taken in the context of the Government's integrated transport policy.

In addition, the following scheme specific objectives have been identified:

- to remove a bottleneck on the strategic road network
- to deliver an affordable solution to reduce congestion on the strategic road network
- to improve reliability of strategic journey times for the travelling public
- to improve access to the regional gateways from the Eastern Seaboard Key Transport Corridor
- to maintain access to existing properties, community facilities and commercial interests
- to maintain access for pedestrians and cyclists
- to improve separation between strategic and local traffic.

8.3 Findings from Previous Assessments

The previous DMRB Stage 1 Scheme Assessment completed in March 2009 identified that the introduction of grade separation at the existing signalised junction would deliver positive benefit to cost ratios. In the published Preliminary Options Report summarising the findings from the assessment, six identified Preliminary Options were reported to deliver positive benefit to cost ratios, across a range of projected traffic growth scenarios. It should be noted that the economic assessment did not take account of the economic impact of queues and delays during construction. The assessment concluded that the scheme had sufficient merit to be taken forward, with four of the six Preliminary Options recommended for further development and assessment. Roads Service accepted the recommendations made by URS, with the scheme attaining its Roads Service Gateway 0 approval in March 2009.

8.4 Summary of Stage 2 Scheme Assessment

Section 1 of this Preferred Options Report reaffirms the scheme objectives as those developed at time of the Stage 1 Scheme Assessment. The findings from a review of the strategic context of the scheme, particularly in light of the recently published revised Regional Development Strategy (RDS), the revised Regional Transportation Strategy (RTS) and the New Approach to Regional Transportation are also reported. This review confirms that the proposed scheme clearly complements the Regional Strategies by improving connectivity within the region and removing a bottleneck on the Regional Strategic Transport Network.

Section 2 presents a summary of the existing conditions at the proposed site location, considering both engineering, environmental and traffic conditions. These baseline conditions are used to determine the subsequent impact of the scheme options and make informed comparisons.

Section 3 presents the options that have been subject to a Stage 2 Scheme Assessment in accordance with TD 37/93 of the DMRB. The presented options are refined versions of the Preliminary Options shortlisted in line with the recommendations of the Preliminary Options Report. The development of the options has been in line with various engineering requirements set out in Volume 6 of the DMRB.

In parallel with the engineering development of the options, a programme of stakeholder consultation was undertaken to establish the relevant requirements of stakeholders and incorporate these, where possible, within the engineering design. This included a period to allow the general public to view and make comment upon the emerging proposals for the scheme between June 2010 and July 2010, launched with a public consultation event on 1 and 2 June 2010. **Section 4** of this report provides a summary of the findings from this public consultation exercise.

The designs for the four options, termed Options A, B, C and D have been developed to a sufficient level to enable their subsequent engineering assessment, as reported in **Section 5** of this report. This included the development of solutions to the various structural, geotechnical, drainage and services challenges identified, with a subsequent assessment of potential construction techniques and sequencing to identify and resolve the challenge of construction of the scheme at the convergence point for three of the busiest roads in Northern Ireland.

In parallel with the engineering development of the options, an environmental impact assessment was also undertaken, which describes, assesses and gives weight to the predicted environmental effects (adverse and beneficial) that the four options would have and describes the measures proposed to reduce or eliminate those effects. Consultation with public bodies and others who may have an interest in how the scheme could affect the environment is also central to this assessment, helping to further illuminate the effect (adverse or beneficial) that the four options may have. The assessment of the impacts of each option is reported in **Section 6** of this report.

A traffic and economic assessment of the options was carried out following the development of the options to a commensurate level of detail. The traffic and economic assessment was carried out using the Cost Benefit Analysis (COBA) software, the accepted tool for the identification of costs and benefits of roads schemes mandated for use by Volume 13 of the DMRB. The development of the intricate computer models for each of the options under various traffic growth scenarios was informed by a programme of traffic surveys that encompassed not just the existing junction, but junctions and links in the surrounding area. These models were carefully developed and verified so that they would present an accurate record of both existing traffic patterns and the future changes in traffic patterns following completion of the scheme. In line with COBA, the costs associated with queues and delays at roadworks were identified and factored into the models, with a summary of the expected improvements in strategic journey times and overall Benefit to Cost Ratios (BCRs) reported in **Section 7** of this report.

To summarise the performance of each of the scheme options against the Government's five objectives for transport, Assessment Summary Tables have been prepared and are included in **Volume 3** of this report.

8.5 Conclusions

8.5.1 *Overall Economic Performance of the Scheme*

The economic assessment of the scheme options provides an opportunity to directly compare the options to ensure that the scheme as a whole offers a value for money solution to the bottleneck. Positive Net Present Values (NPVs) and BCRs are reported for Options A, B and C for all traffic growth scenarios.

For Option D, the closure of the Clifton Street on-slip is considered to generate significant economic costs, due to the forced reassignment of traffic onto the Inner Ring. The monetary value of the associated delays to reassigned traffic are reflected in the negative NPVs and BCRs reported for all traffic growth scenarios. Therefore, the assessed economic performance of Option D in itself provides sufficient reason to discount it as a viable option for the scheme.

If Option D is excluded from consideration, the results from the economic assessment demonstrate that if any of the three remaining options are selected as the Preferred Option for the scheme, the scheme will accordingly provide a value for money solution.

8.5.2 *Emerging Preferred Option*

8.5.2.1 *Introduction*

With the economic benefits of the scheme assessed and confirmed, a Preferred Option can be selected from the three economically viable options (Options A, B and C) remaining. The selection process should be based on the performance of the options against the identified Scheme Objectives. **Sections 8.5.2.2 to 8.5.2.6** summarise the performance of the remaining three options against the identified High Level objectives for the scheme, to be read in conjunction with the Assessment Summary Tables included in Volume 3 of this report. **Section 8.5.2.7** summarises the performance of the remaining three options against the identified Scheme Specific objectives.

8.5.2.2 *Assessment against High Level Scheme Objectives*

8.5.2.2.1 *Environment Objective*

The environmental assessment reports that no option has a distinct advantage over the others when considered as a whole across all of the various sub-objectives. Whilst some of the options may have marginal advantages over the others in specific sub-objectives, these are generally balanced against marginal disadvantages over the others in other sub-objectives.

Air Quality

Changes to Regional air quality would be insignificant with all four options.

With regards to Local air quality, all four options would lead to changes in pollutant concentrations at similar localities throughout the study area. Each option is estimated to result in an improvement at locations predicted to be at risk of exceeding annual mean NO_2

objective values in 2020. However, a slight worsening of air quality at properties surrounding the Garmoyle Street and Dock Street junction is expected and at receptors adjacent to some side roads not directly affected by any of the options.

The spatial extent and magnitude of the estimated changes in pollutant concentrations vary marginally between the options. Options A and C provide relatively similar benefits considered small to imperceptible in magnitude, with an overall Neutral effect on local air quality across the scheme area as a whole. However, Option B has a marginal advantage over Option A and Option C as it would provide a slightly larger level of improvement to those properties at risk of exceeding the annual mean NO_2 objective values and a reduced level of pollutant change at those receptors where the local air quality is predicted to worsen.

Cultural Heritage

From the assessment of cultural heritage effects, Option A would have the least adverse effect on the cultural heritage resource (archaeology, historic landscape features and historic buildings) and Option B the most adverse. However it must be noted that the difference in effects between options is minimal. Option A would be preferred over Option C given the smaller extent of excavations required for construction, thus reducing the potential for unknown buried archaeology being encountered.

Ecology and Nature Conservation

All options are considered to have a similar minimal ecological impact, with no designated sites of local, national or international ecological importance within the immediate study area. A Habitats Regulations Assessment (HRA) carried out also concluded that none of the proposals will have a significant effect on the integrity of Natura 2000 sites located beyond the immediate study area or their selection features.

Landscape Effects

All options will negatively affect both visual and cityscape aspects within the study area, with the new interchange becoming a dominant feature. However, an important distinction is made between landscape and visual impacts. The options which have the least impact on the present and future landscape are those options which present the largest intact parcels of land for future use and have the most potential to allow developments that would assist their absorption into the urban fabric, i.e. Option B of those the options remaining. However, this assessment is at odds with the options considered to present the lowest visual impact on the area, i.e. Options A and C, where links are lowered below view. It is considered that the options with the least visual impact are Options A and C, with Option A preferred.

Land Use

The land use assessment considers the impact on existing properties and the impact on potential development land, including planning applications, by required land-take. The demolition of properties required for Options A and C, even those already owned by Roads Service, puts Option B at a slight advantage. The assessment of the impact on further land use would also favour Option B on the basis that it has the least physical impact on identified Development Opportunity Sites. However, the assessment has recognised that the importance of the Development Opportunity Sites affected by the proposed scheme is generally low, considering the current overall lack of developer interest. Furthermore, the assessment notes that the assessed significance, in line with the DMRB, should not be solely related to land loss and severance. Since any development of such sites would be developer led, the option which retains the most land for development, i.e. Option B from those options remaining, does not guarantee that such land would remain viable or attractive for development. This is particularly important given the dominant feature that the associated overbridge in Option B would create immediately adjacent to these sites.

Noise and Vibration

The noise and vibration impacts of the scheme options concluded that there is little difference between the options in terms of noise changes. Nevertheless, in terms future operational noise impacts, Option B is marginally preferred over Options A and C and in terms of construction impacts, Option A is preferred over Options B and C. Initial calculations also indicate that no properties are likely to qualify for insulation under the Noise Insulation Regulations (Northern Ireland) 1995 for any options.

Vehicle Travellers

The assessment for vehicle travellers considers the potential for views from the road and the predicted increase or decrease in driver stress levels for each of the options. With regard to views from the new strategic links, Option B would be preferred as drivers would be elevated above the existing built environment and enjoy open views across North and West Belfast and towards the harbour area. In contrast, Options A and C due to their depressed nature will provide restricted views. However, for vehicle travellers on the existing surface street network, in particular York Street, Option B would create adverse changes to views with the introduction of the overbridges and their associated substructure.

The driver stress assessments completed for the options indicate that there is very little difference between the options. It is considered that those options that provide a full interchange, i.e. Options B and C, are preferred to Option A as they are expected to deliver the greatest overall benefit to vehicle travellers from reduced stress levels.

Road Drainage and the Water Environment

All options are considered to have an overall neutral impact on the water environment, although in strict accordance with the Water Framework Directive, Option B could be considered the least preferred as it would create a minimal increase in runoff that would discharge to the Mile Water. In contrast, Option B would be preferred ahead of Options A and C when considering the potential impacts during construction, as it requires the least excavation, therefore presenting the lowest risk of preferential pathway creation to the receiving water environment, though any adverse construction effects would be likely mitigated.

The Strategic Flood Map (NI) produced by DARD Rivers Agency indicates that the existing junction lies within the Q_{100} floodplain for the River Lagan and within the coastal Q_{200} floodplain for the Belfast Lough. The Q_{100} floodplain is defined as the extent of a flood event with a 1% annual probability of exceeding the peak floodwater level. The Q_{200} floodplain is defined as the extent of a flood event with a 0.5% annual probability of exceeding the peak floodwater level. Therefore, the existing junction is at risk of flooding if existing flood defences were breached or overtopped. It is noted that a considerable area of North Belfast, Belfast City Centre and East Belfast would also be affected.

With regard to Options A, B and C, all are susceptible to both river and sea flooding as they all contain depressed links in underpasses below the projected Q_{100} and Q_{200} flood levels. Opportunities exist to minimise the flood risk to the underpasses and these can be developed further for the selected Preferred Option.

Geology and Soils

From a geology and soils perspective, there are no features of geological interest and the soil has no profile. Therefore the importance of geology and soils assets within the study area is considered negligible. The scheme options are not considered to present any significant impact and therefore are all considered to have a generally neutral effect on solid and drift geology. The potential for contaminated land has been assessed, with the probability of encountering such deposits highest for the option with the largest excavation volumes, i.e. Option C.

8.5.2.3 *Accessibility Objective*

Pedestrians, Cyclists, Equestrians and Community Effects

For non-motorised users, the options that reduce the number of conflicts between strategic and local vehicle movements are preferred. In addition, full grade separation is preferred over partial grade separation as it is considered to facilitate freer flowing movements. For these reasons, Options B and C are preferred over Option A as they provide full interchange solutions. Option C is preferred over Option B as it is considered that the dominant overbridge structure in Option B will reduce the amenity along York Street, which NMU movements are predominantly along. This loss of amenity stems from the reduced natural lighting, obstructions to sightlines and perceived threats etc. No equestrian facilities have been identified and therefore no impacts have been considered. With regard to community facilities, none of value to local users would be lost to any of the options. The Northside Park and Ride facility would be impacted in all options, most significantly in Option C, however, this facility is earmarked for removal in the long term under separate plans published by the Department for Regional Development.

The potential introduction of two-way running on York Street to facilitate a southbound lane that could be used by cyclists, as described in Section 3.3.6, for Options A and C is noted. If this proposal is adopted, cycling connections to the city centre from North Belfast would be improved. As the proposal cannot be introduced on Option B, this would make Option C the preferred solution.

Community Severance

It is considered that the introduction of grade separated links will reduce severance issues with the reduced interaction between strategic and local flows at the junction. Therefore, the options that propose full grade separation, Options B and C, are preferred ahead of Option A, which only proposes partial grade separation. Option C is preferred over Option B due to the visual intrusion that the overbridge structures in Option B would create. This would reflect recent experience from the M1/Westlink scheme, where the overbridge structures initially proposed were changed to underpasses post public inquiry, due to the concerns raised by the local communities in relation to the visual intrusion of the structures and thus the perceived community severance.

Access to Public Transport

All options are considered to have a neutral effect on the existing rail network, with options presenting overall benefits to the bus network. The significance of benefits offered varies between the options, with Options B and C that provide full grade separation considered to deliver more benefit that Option A, which only provides partial grade separation.

The potential introduction of two-way running on York Street to facilitate a southbound lane for use by buses, as described in Section 3.3.6, for Options A and C is noted. If this proposal is adopted, bus services to the city centre from North Belfast would be improved. As the proposal cannot be introduced on Option B, this would make Option C the preferred solution.

8.5.2.4 *Integration Objective*

Transport Interchange

All options are expected to deliver benefits to transport interchange. For the existing Yorkgate train station, all options will deliver an improvement in journeys along York Street from the removal of conflicting strategic flows. The potential for future rail infrastructure improvements, specifically the double-tracking of the Dargan Bridge along with the provision of a transport interchange hub at Gamble Street would not be adversely affected by any of the options. It is noted that the Department for Regional Development's separate proposals for strategic Park and Ride sites propose the future relocation of the strategic Park and Ride facilities from Northside to a location to the north at the periphery of the city. Therefore, the identified impacts of each of the options on the site are not considered to impact greatly on its value. With regard to bus provision, the proposed options are not considered to adversely impact on any existing Quality Bus Corridors and in fact present an opportunity to improve them, in particular if the proposed reintroduction of two-way running on York Street is progressed.

Land Use-Planning

All options are considered to conform with the policies in the RDS, RTS, RTSNTP and BMTP. Furthermore, the options have been assessed against the objectives of all relevant planning policy statements and development plans with no significant impacts raised. With regard to impact on Development Opportunity Sites, Option B has the least physical impact, but it has been recognised that the required overbridge structure will have an impact on the attractiveness of the site, which is not considered in accordance with DMRB.

Other Government Policies

All options are supported by the proposals contained within the BMTP, which are in turn largely conformant with other Government Department's objectives for the Belfast Metropolitan Area.

8.5.2.5 *Safety Objective*

Accidents

From the traffic and economic assessment models, accident disbenefits have been assigned a monetary value for the estimation of the NPV of the option, with reference to a set of default accident rates built into the COBA modelling software that are related to speed limits. These default accident rates increase as speed limits decrease, based on the rationale that roads with lower speed limits are typically urban roads. Urban roads typically have a higher frequency of direct accesses and/or junctions provided to a lower design standard which increases the probability of road traffic collisions. In contrast, the default accident rate is lower on roads with higher speed limits. Roads with higher speed limits are typically peri-urban or rural that are designed to higher design standards in relation to the frequency and layout of direct accesses and/or junctions. The higher standards expected are reflected in the lower accident rate.

These default accident rates are mandated by the COBA software based on the speed limits and take no recognition of specific features of the junction layouts, including the layout of merges and diverges and provided weaving lengths. Based on the default accident rates, Options A and C, with 40mph speed limits on the strategic links, have higher accident disbenefits than Option B, which has higher 50mph speed limits on the links carried on overbridges. Between Option A and C, Option A has slightly lower accident disbenefits. Whilst these findings are valid for the estimation of NPVs and BCRs under the traffic and economic assessment, the analysis of the respective road geometry in the options provides a more useful means to compare the performance of the options against the safety objective.

Road Geometry

With regard to the assessed road geometry, an assessment has been made of the options with regard to the standards for safety and operation established by the DMRB. Given the physical constraints at the site, it is inevitable that not all of the standards can be met, with Departures from Standard necessary for all options to permit the proposed layouts.

A comparison of the number of Departures required for each option confirms that Option A is the layout that is most compliant with the safety standards set out in the DMRB, ahead of Option C, which has approximately 15% more Departures than Option A and Option B, which has approximately 30% more Departures than Option A. The fact that Option A has the least number of Departures is to be expected as it provides the fewest new road alignments, with the existing signalised junctions on Nelson Street and Great George's Street retained. If the numbers of Departures are further examined, to separate those required under TD 9/93, the number of TD 9/93 Departures for Option B (128) is higher than those for Option C (106) and Option A (91). The higher number of TD 9/93 Departures for Option B, relative to Option C, is primary due to the alignment of the M3 to Westlink overbridge (Link D) and to a lesser extent, the alignment of the M2 to Westlink overbridge (Link A).

With regard to the alignment of the M3 to Westlink link (Link D), the comparison of Departures indicates that a depressed alignment is relatively safer than its elevated alternative, with the depressed alternative offering a better horizontal alignment and higher minimum Stopping Sight Distance. The increased minimum Stopping Sight Distance is particularly important for road user safety.

Whilst the main horizontal radius proposed on Link A in Option B is approximately twice that of its counterpart in Option C, it remains substandard for the selected Design Speed of 85kph. It therefore requires significant offside verge widening to provide the full Desirable Minimum Stopping Sight Distance. With reference to Figure 6 of TD 9/93, for the Two Steps below Desirable Minimum radius of 300m provided, the verge width required would be approximately 15-20m. The provision of such wide offside verge would significantly increase the cost and complexity of the structure and would require the vertical alignment to be further raised, beyond the Absolute Maximum gradient of 6%, to maintain headroom to the underlying links. For this reason, the offside verge width has been restricted, with an accompanying reduction in Stopping Sight Distance to 90m in lane 2 over a distance of approximately 450m. Whilst the same issue is encountered in Options A and C, with the minimum Stopping Sight Distance in lane 2 reduced further to 70m, the extent of which this Stopping Sight Distance is substandard on the main horizontal radius is approximately 240m. The larger extent of substandard visibility on Link A in Option B, relative to Options A or C, is a contributing factor to the larger number of Departures required.

All of the remaining options also provide a weaving section on the Westlink between Clifton Street and York Street on both the northbound and southbound carriageways. A particularly important weaving section is created on the southbound carriageway (Link A) between the M3 (Link D) merge and the Clifton Street diverge, where the M3 to Westlink movement will take place. The safe operation of weaving sections is linked to a number of geometric factors, including the actual weaving length available to drivers and the number of lanes provided over the weaving section. Minimum standards for both parameters are established in TD 22/06 of the DMRB. Across the remaining options, it is expected that both weaving sections will not comply with these minimum standards, with Departures from Standard required. Whilst the layout of the weaving section on the northbound carriageway (Link B) is similar in all options, the layout of the important weaving section on the southbound carriageway varies between the options. For Option A, the proposed weaving length is 220m long, based on provision of the Absolute Minimum weaving length for the selected Design Speed of 70kph. For Option B, the proposed weaving length is also 220m, but this is below the Absolute Minimum weaving length for the higher Design Speed of 85kph (295m). For Option C, the proposed weaving length is 290m, approximately 30% more than that provided in Options A and B. The weaving length proposed exceeds the Absolute Minimum requirement for the selected Design Speed and is closer to the projected Desirable Minimum weaving length of 400m. The proposed length of the weaving section in Options A, B and C is likely to be subject to scrutiny at future Road Safety Audit.

Therefore, of options remaining, Option A appears the safest layout, although it only provides partial grade separation. Of the options remaining that provide full grade separation, Option C is preferred as it has fewer road geometry Departures than Option B.

Non-Motorised User Safety

The assessment of effects on non-motorised users concludes Option C and Option B are preferable to Option A as they remove the strategic traffic from the signalised junctions on York Street. Option C is preferred to Option B in terms of safety given the loss of amenity, which includes the perception of threat, that would be created if the overbridges in Option B were constructed. In addition, Option C can accommodate the potential reintroduction of two-way running on York Street which would enhance direct connections

8.5.2.6 *Economy Objective*

Benefit to Cost Ratios

With recourse to their assessed economic performance, Option B would present the most economically advantageous option, with a BCR range of between 1.7 and 2.9 over the three (Low/Central/High) NRTF traffic growth scenarios. These figures take into account the calculated costs of queues and delays during roadworks. By comparison, Option A has a BCR range of between 1.2 and 2.6 over the three traffic growth scenarios and Option C has a BCR range of between 1.4 and 2.6 over the three traffic growth scenarios.

Journey Time Savings

With reference to the Assessment Summary Table, a comparison of journey time savings in the opening year for the three remaining options confirms that all Options will provide a reduction in average journey times on the strategic routes in peak and off-peak periods.

The results indicate that Option B and Option C deliver higher reductions in journey times than Option A, due to the additional grade separation of the M3 to Westlink movement. The difference between Option B and Option C is mimimal, with Option B delivering a marginally higher improvement over Option C on the strategic routes in the 2034 Design Year scenario .

8.5.2.7 *Assessment against Scheme Specific Objectives*

8.5.2.7.1 ***Removal of a Bottleneck on the Strategic Road Network***

Of the Options A, B and C considered viable for the scheme, only Option B and C, through their full grade separation, are considered to remove the bottleneck that is the existing signalised junction at York Street.

8.5.2.7.2 ***Delivery of an Affordable Solution to Reduce Congestion on the Strategic Road Network***

The Options Range for the scheme, based on the three remaining options (Options A, B and C), is £89.3 to £102.5M. This range is based on developed capital works cost estimates for each option that reflect their respective engineering challenges.

Option A is the most affordable solution as it has the lowest cost estimate. However, as demonstrated in the traffic and economic assessment, the additional capital investment to provide Option B or C would, through the introduction of full grade separation, deliver increased value for money.

8.5.2.7.3 ***Reliability of Strategic Journey Times***

Options A, B and C will deliver improvements in journey times on the strategic routes within the scope of the scheme. The potential improvements are higher in Option B and Option C, compared to Option A through the delivery of full grade separation for the strategic movements.

8.5.2.7.4 ***Improved Access to the Regional Gateways from the Eastern Seaboard KTC***

All of the remaining options will deliver improved access to the regional gateways by the reported reduction in journey times on the three strategic roads. Access arrangements from the Port of Belfast to the Westlink are considered more direct for Option A and Option C when compared to Option B. In addition, the proposed means of access from the Port of Belfast to the Westlink in Option B requires a reduction in capacity on the existing Garmoyle Street and Whitla Street to introduce the required two-way operation.

8.5.2.7.5 ***Maintain Access to Existing Properties, Community Facilities and Commercial Interests***

Access is maintained to all existing residential and commercial properties in the remaining options, although under revised arrangements due to changes in local traffic movements. The only community facility that would be lost would be the existing Northside Park and Ride facility.

8.5.2.7.6 ***Maintain Access for Pedestrians and Cyclists***

Present access arrangements for pedestrians and cyclists are maintained in the remaining options. Option B and Option C which deliver full grade separation are considered preferable to Option A, with Option C preferred to Option B for the amenity of non-motorised users.

The potential reintroduction of two-way running on York Street, to provide a southbound lane for use by public transport and cyclists is noted. If adopted for the Preferred Option, this would provide a significant enhancement to access to the city centre for these transport modes from North Belfast. The two-way running concept is considered feasible for Option C only, making it preferable to Option B in this regard.

8.5.2.7.7 ***Improved Separation between Strategic and Local Traffic***

All remaining options will improve separation between strategic and local traffic to varying degrees, with the options that deliver full grade separation of strategic flows considered preferable.

8.5.2.8 *Public Preference*

The views of the public were sought on the proposals in June/July 2011 through the public consultation period. As reported in **Section 4**, the public are keen to see improvements at

York Street and consider full grade separation preferable to partial grade separation. The public's identification of Option C as their preferred option for the scheme reflects this view.

The views of the local community have also been considered when reviewing the advantages and disadvantages of the remaining options. These views have been echoed by other organisations with aspirations for social regeneration in the area. The view of these parties is that Option C is the option most in line with their aspirations for social regeneration in the area, subject to modifications that include the increased enclosure of the underpasses with roof slabs. Whilst these proposed modifications are not considered feasible for significant engineering reasons, it is considered that Option C as it stands remains the option most in line with their stated preferences.

8.6 Recommendations

Taking into consideration all of the above factors, it is recommended that Option C is selected as the Preferred Option by Roads Service. The option should be further developed in line with the engineering standards set out in the DMRB to a level sufficient for a Stage 3 Scheme Assessment in line with TD 37/93 of the DMRB.

In developing the option further, the following engineering and operational issues should be given further consideration:

- The potential reintroduction of two-way running on York Street to provide a southbound lane. The use of the southbound lane should reflect Roads Service transport policy for the Belfast City Centre.
- The protection of the underpass, so that it remains operational in times of a Q_{100} river flood event or a Q_{200} coastal flood event.
- The links and junctions identified to be over-capacity in the 2034 design year by the traffic and economic assessment.
- The proposed drainage system and outfall arrangements, in consultation with NI Water.
- The operational capacity of the interchange, through specialist micro-simulation modelling.
- The engineering solutions to the proposed underpasses and bridges, through consultation with specialist contractors.
- The proposed replacement of the retaining walls on Little George's Street and Great George's Street.
- The proposed diversion of existing utilities, through consultation with the various utility providers.
- The temporary traffic management measures required to build the scheme whilst mitigating disruption to road users.