Roads Service Consultancy

Consultancy Services (Partner) for the Assistance in the Delivery of Roads Service Programmes

Stage 1 Scheme Assessment Report

Volume 1: Main Report

Armagh North & West Link

Issue No. 2

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1.0 Introduction

Owen Williams were commissioned in 2005 by Roads Service to assess the suitability of a route corridor as previously published in the Armagh Area Plan (2004).

Armagh is within easy travelling time of the region's ports and airports and the major urban centres of Belfast, Lisburn and Craigavon, as shown on figure 1.1. The city is also becoming a centre for tourism as it builds on its ecclesiastical, historical, architectural and archaeological base.

Armagh City occupies a strategic location in the south of the Province with good road connections to Dublin, Galway and the Irish Midlands. These links are important for the creation of an integrated sustainable transport network for the island of Ireland as a whole and could result in further economic development and additional employment generation in the city and district.

Figure 1.1 - Location of Armagh

1.1 Background to Scheme

The proposed North and West link road project is identified in the Armagh Area Plan 2004 and is also categorised as a Strategic Road Improvement (SRI) project within the Regional Strategic Transport Network (RSTN) Transport Plan 2015. Its objective is to facilitate the more efficient movement of traffic through Armagh City and relieve congestion on associated key routes. It also plans to provide a more uniform level of service for a range of road users and will also relieve the effect of heavy traffic through an historical city centre.

This proposed link will extend through the North and West sides of Armagh City and link the A3 Portadown Road (in the Northeast of Armagh) to the A29 and ultimately the A3 Monaghan Road (in the Southwest of Armagh). The Armagh North and West link is in the Preparation Pool as outlined in the RSTN Transport Plan 2015.

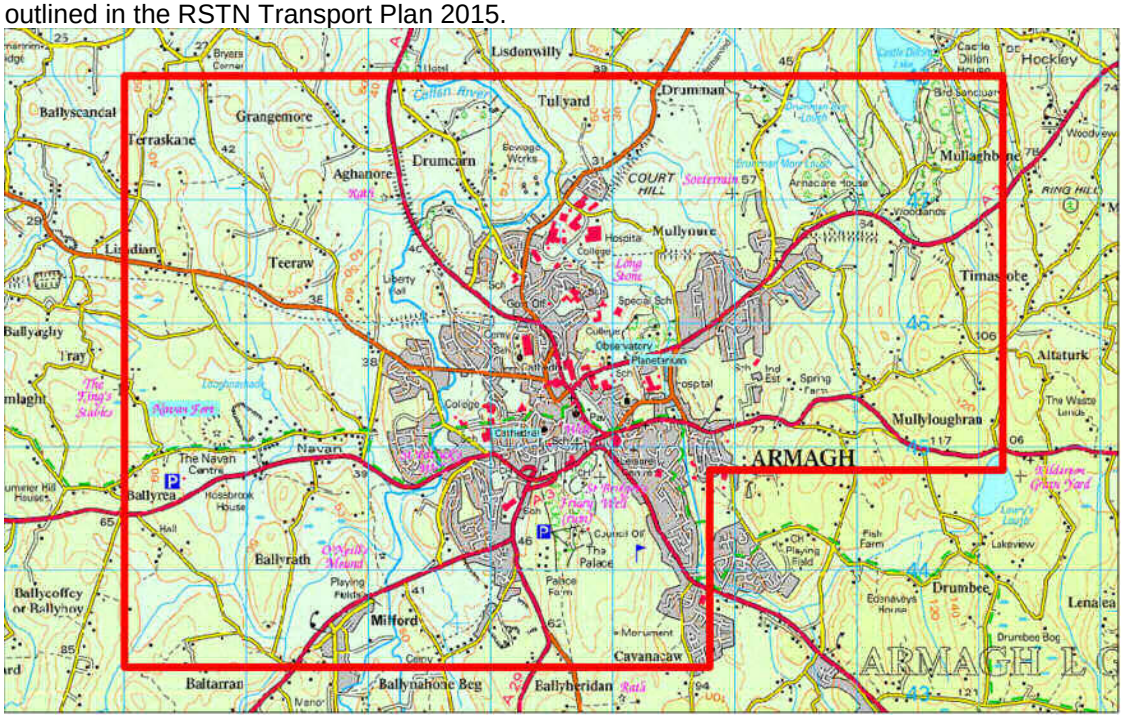

Figure 1.2 – Study Area

The Regional Transportation Strategy 2002-2012 (RTS) was published in July 2002. The purpose of the RTS is to improve access to regional, national and international markets thereby contributing to sustainable patterns of development and movement and to promote integration between different modes of travel. The RTSN Transport Plan 2015 is based on guidance set out in the RTS and has been developed using the funding levels envisaged within it.

1.2 Existing Conditions and Problems

To the west of the city strategic traffic currently travels along the route from A28 Friary Road through the signalised junction at Barrack Street, along the Mall West then Railway Street and Lonsdale Road to A29 Moy Road. This route is heavily trafficked and suffers from significant levels of congestion during peak periods, particularly in the vicinity of the signalised junction at Newry Road/Friary Road and the adjacent signals at the Mall West/Gaol Square. As a result of the congestion and traffic queues on this route a proportion of local traffic uses an alternative 'rat-run' via Irish Street, Callan Street and Dawson Street to reach Lonsdale Road. These streets are not suitable for large volumes of traffic as they are generally narrow and suffer from

the impacts of on-street parking. Traffic entering Armagh from the northeast travels along the A3 Portadown Road, where traffic conditions are relatively free moving, to the Drumadd Road roundabout then along College Hill to the mini-roundabout at the Mall West. Traffic congestion is often apparent on this stretch of the route during peak periods, particularly in the vicinity of the Royal School and at the mini-roundabout junction with queues extending past the Court House and beyond the junction with the Mall East.

A number of junctions in the city centre suffer from congestion during peak periods – this particularly applies to the signalised junctions at the Mall West/Gaol Square/Barrack Street/Newry Road/Friary Road, the Mall West/College Hill, Railway Street/Lonsdale Road and the roundabout at Moy Road/Loughgall Road.

2.0 Appraisal Methodology

2.1 Appraisal Introduction

2.1.1 Background to Transport Appraisal Guidance

The origins of Transport Appraisal Guidance (TAG) can be traced back to "The Green Book, Appraisal and Evaluation in Central Government". The Green Book places appraisal in the context of policy development, discussing the whole process.

The Green Book aims to make the appraisal process throughout Government more consistent and transparent, ensuring that no course of action is adopted without first having the answer to these questions:

Are there better ways to achieve the objectives?

Does it provide value for money?

Although The Green Book is used as an appraisal process throughout Government, transport appraisal is always likely to be complex, with interactions at many levels with other policy areas. The Government produced a White Paper "A New Deal for Transport: Better for Everyone." (DETR, 1998), which set in place the policy context for dealing with transport and highlights the complexity of transport problems and the interaction with other policy areas.

The White paper framed the move away from 'predict and provide' solutions to transport problems and put at the core an integrated transport policy. Appraisal of problems is key to the efficient delivery of this policy. The decisions made as part of the delivery need to be based on a full range of options and a comprehensive analysis of the impacts using a consistent approach. To this end, the White Paper introduced the New Approach to Appraisal (NATA) to appraise and inform the prioritisation of transport investment proposals.

Two years after NATA's original launch in 1998, Guidance on the Methodology for Multi-Modal Studies (GOMMMS) was produced as a primary source of guidance for the development and approval of surface transport.

The aim of the Government's Multi-Modal Studies (MMS) was to investigate problems on or with all modes of transport and to seek solutions to those problems. The output from the Studies was a number of different options aimed at addressing the problems within the study area. The analysis of options needed to be sufficiently detailed to ensure that robust decisions could be made. The results of the Studies have been or will be used by the Regional Planning Bodies in developing and reviewing Regional Transport Strategies.

GOMMMS, prepared by the DfT, made it clear that MMS are intended to be investigations of problems on, or with, all modes of transport and require an analysis of options to be sufficiently detailed to ensure that robust decisions can be made. The end result of this is a Preferred Transport Plan which is a collection of strategies and interventions to solve individual problems or groups of problems to the satisfaction of national, regional and local objectives.

In particular, GOMMMS required options and strategies to be appraised against the five national objectives. The completion of Appraisal Summary Tables (AST's), in accordance with GOMMMS, played an important role in the study process ensuring consistency of appraisal across studies.

In 2003 the advice originally set out in GOMMMS, NATA and their key supporting documents was fully incorporated into the Transport Analysis Guidance website – WebTAG.

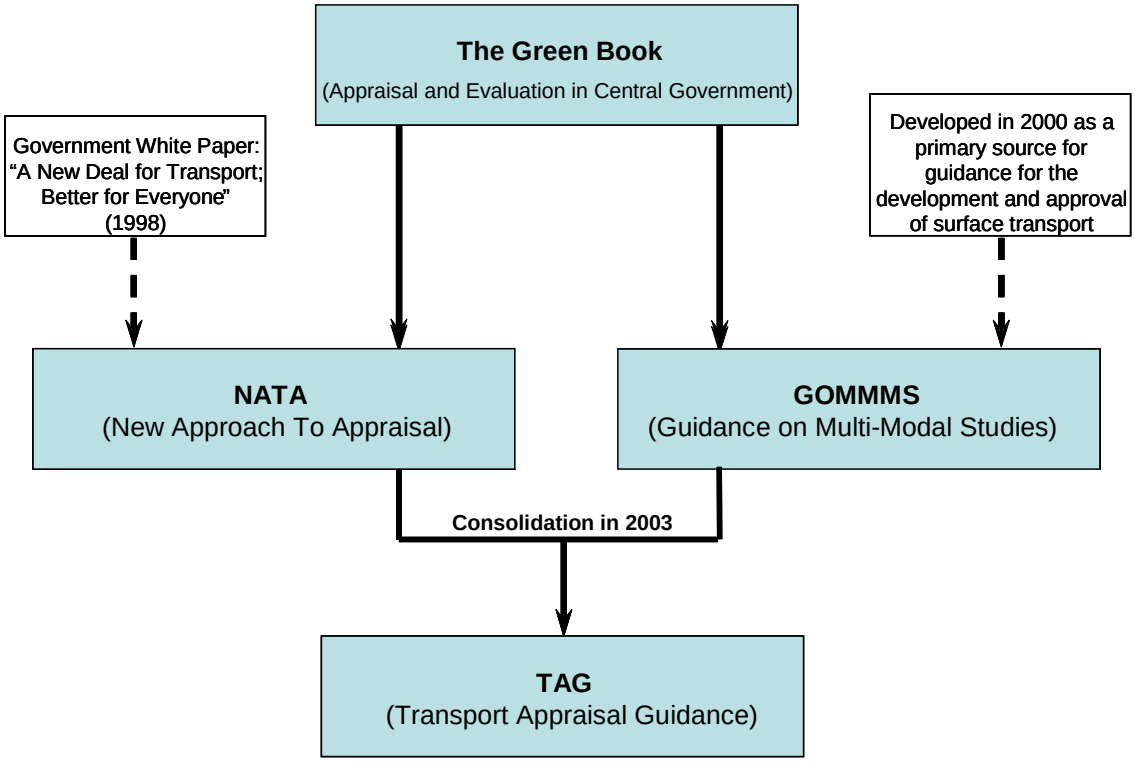

Figure 2.1 - The Origins of Transport Appraisal Guidance (TAG)

2.1.2 TAG Methodology

Transport Appraisal is performed to provide input to efficient policy development and resource allocation across Government. To be effective, transport appraisal must deal consistently with competing proposals; be even-handed across modes and take account of a wide range of effects.

As recommended in the Green Book, transport appraisal must be carried out as part of the overall process. The form and basis of the appraisal strongly affects the way in which all other stages of the process are carried out. It is expected that appraisals will be comprehensive but proportionate.

Solution Identification

In all cases, the process of identifying solutions should be broadly similar and:

> Be easily comprehensible, to those commissioning, steering and undertaking the work; and where possible to the wider public;

Avoid leading to a particular outcome simply by virtue of the method or process adopted;

Enable a wide range of solutions and the synergy between combinations of components to be investigated in a cost effective manner;

Enable a preferred solution to be developed which addresses the objectives and problems at which it is aimed; and

Provide a means by which the acceptability of the solution to the public can be tested and taken into account.

Study

Typically, a study should include:

Agreement on a set of objectives which the solution should seek to satisfy;

Analysis of present and future problems on, or relating to, the transport system;

Exploration of potential solutions for solving the problems and meeting the objectives;

Appraisal of options, seeking combinations which perform better as a whole than the sum of the individual components; and

Selection and phasing of the preferred solution, taking account of the views of the public and transport providers.

Appraisal

The approach to appraisal in WebTAG to be adopted in transport studies embraces fully the principles of NATA. The appraisal process has four appraisal 'strands', illustrated in Fig 2.2

An Appraisal Summary Table (AST) that displays the degree to which the five Central Government Objectives for transport (environment, safety, economy, accessibility and integration) would be achieved. A judgement should be made from the AST about the overall value-for-money for each route corridor in achieving the Government's objectives. The information provided in the AST and its more detailed supporting documents will enable a consistent view to be taken about the value of the route corridors. It should be noted, however, that for this study, the environment objective will be appraised in accordance with the Design of Roads and Bridges Manual (DMRB) Volume 11. This follows advice given by the Roads Service HQ.

An assessment of the degree to which the local and regional objectives of the study would be achieved is likely to be of interest to the regional and local authorities, as well as local residents.

An assessment of the extent to which problems identified would be ameliorated by the route corridors achieved is also likely to be of particular interest to the regional and local authorities as well as local residents and transport providers. The changes in conditions which lead to a change in problem severity will be subsumed by the changes already taken into account in the assessment of the achievement of objectives; to that extent, therefore there will be multiple-counting between this appraisal strand and the previous two. However, while changes in problems are only part of the total effects of a

route corridor, they are arguably the most important changes. After all, as the process has started by identifying the problems, it seems sensible to check to see what the route corridor would do for those problems

Supporting analyses of distribution and equity, affordability and financial sustainability, and practicality and public acceptability are likely to be of interest to both Central Government and the regional and local authorities, as well as local residents. Local transport providers will be particularly interested in the impacts on the financial sustainability of their operations.

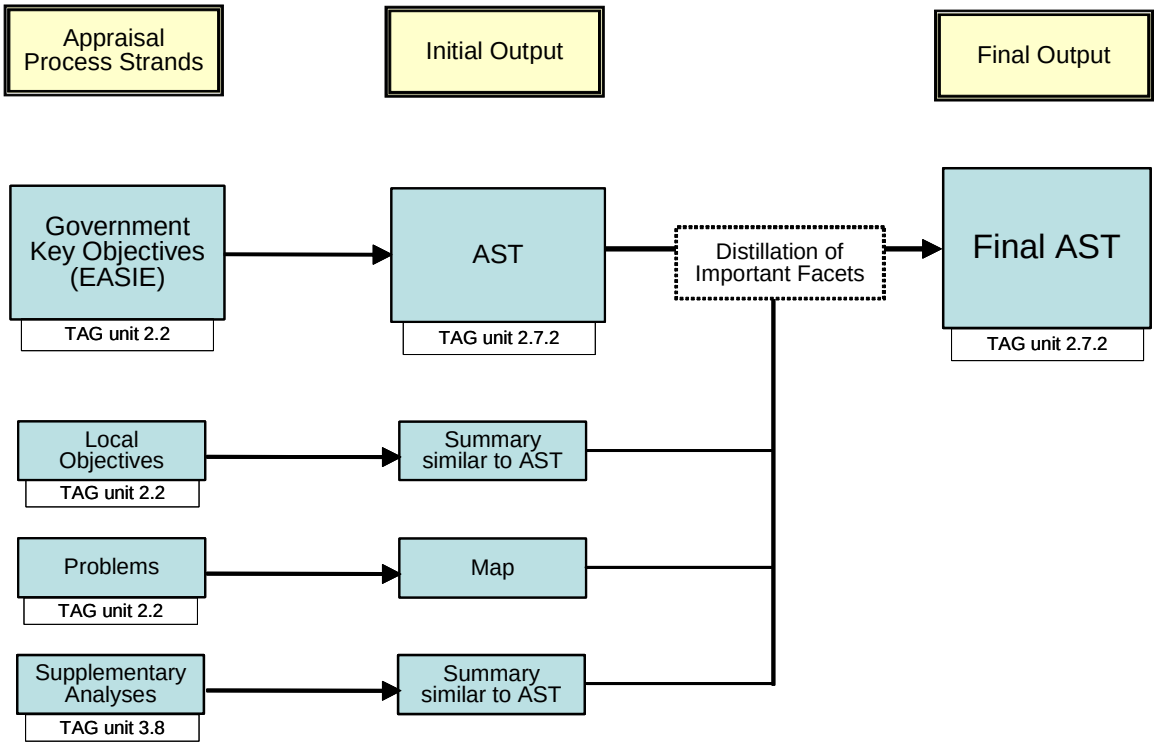

Figure 2.2 - Overview of the Appraisal Process

2.2 Study Area

Armagh is the principal city in County Armagh and is located approximately 35 miles from Belfast. The city of Armagh has several main routes radiating through the city, including the A3 linking Craigavon with Monaghan, the A28 linking Newry with the west of the province and the A29 linking Dungannon with the south of the district. The area has good road communications with Belfast via the A3/M1 and with Warrenpoint, which is one of the five commercial ports serving Northern Ireland, via the A28/A2.

The city itself is on an eminence, with the Church of Ireland Cathedral in the centre crowning the summit. Some of the streets form an irregular circuit around the cathedral, and on the slope of the hill; all the others, leading into the town from the surrounding area terminate in this circuit, except three, which continue to the summit, and lead to the cathedral enclosure.
The Study Area for this scheme extends from the A3 Portadown Road, in the northeast of Armagh, to the A3 Monaghan Road in the southwest of the City. To the north of the City the area extends to the town lands of Drumman, Lisanally, Drumcarn, Aghanore and Tullyelmer;

whilst to the west its extents include Lurgyvallen, Legagilly, Drumcoote, Ballycrummy and Tullymore. The study area is shown in Figure 1.2.

Land within the city itself is predominantly utilised for mixed residential, commercial and amenity/recreational land uses. Land to the north and west of the Route Corridors consists largely of arable and improved grassland, with a series of open fields of irregular shape and size. These are shown to be traversed by a series of small watercourses and drainage ditches.

The general topography of the area beyond the city is generally of an undulating nature characterised by drumlins i.e. low amplitude hills of glacial origin. Ordnance survey mapping of the area shows drumlins with peak elevations of approximately 60ft (18m) above ordnance datum (AOD). Some of the more significant drumlins are located adjacent to Drummanmore Road, the B77 Loughgall Road, Drumcairn Road and the B115 Cathedral Road.

Throughout the study area there are a number of archaeological sites, which are shown as forts or raths, and these are usually located on the high points of drumlins.

The low-lying areas between the drumlins collect surface water resulting in numerous minor watercourses and field drains which feed into the Callan and the Ballynahone Rivers.

2.3 Modelling

This section of the report describes the different scenarios for which traffic forecasts have been produced for the Armagh North/West Link appraisal. Modelling of the route corridors for the N&W Links scheme was undertaken using the strategic modelling program TRIPS. Mouchel Parkman produced a base model in 2005, which was subsequently updated to provide a greater degree of validation following discussions with Roads Service in 2006. A copy of this Base Model was provided to Owen Williams, along with copies of the revised Local Model Validation Report (LMVR), to enable modelling of forecast scenarios.

All of the final forecasts have been developed using a 'fixed trip matrix' approach. Full growth generation matrices have been assigned to proposed network route corridors to forecast traffic model outputs for each year of assessment. Convergence and stability with guidance from DMRB standards was achieved with continuous checks on each forecast model to ensure that this was achieved. Further details will be mentioned later in the report.

Forecast Year and Time Periods

The time period used for modelling the traffic forecasts have been retained from the AM Peak Hour (08:15 – 09:15) base model 2004 figures and forecasts years have therefore been selected to correspond with design scheme requirements, namely opening year (2009) and opening year +15 years (2024).

Five networks have been produced for Future Year Network Scenarios:

Do minimum – incorporating planned network improvements (i.e. Mall West/Mall East/College Street traffic signals, Victoria Street/Mall East Traffic Signals and The Armagh East Link);

Route Corridor 1 - incorporating planned Do minimum improvements and the North/West Link route corridor one alignment;

Route Corridor 2 - incorporating planned Do minimum improvements and the North/West Link route corridor two alignment;

Route Corridor 3 - incorporating planned Do minimum improvements and the North/West Link route corridor three alignment; and

Route Corridor 4 - incorporating planned Do minimum improvements and the North/West Link route corridor four alignment.

Traffic Growth

In line with appraisal guidance, traffic growth from the base year 2004 has been included. For the purposes of this assessment the growth forecasts have been forecast as full-growth for each future year. This full growth matrix represents conditions that would prevail in future if vehicle users did not adjust their trip patterns in response to changes in road congestion and their ease of travel.

Forecast Trip Matrices

Full growth matrices have been derived from the 2004 base year validated AM peak model, but with adjustments made to take account of the following:

Background growth of existing trips after 2004 in response to car ownership, demographic and economic factors, as predicted in the Northern Ireland Strategic Transport Model (NISTRM); and

Zone-specific land use development plans as identified by the planning authority.

Full growth matrices have been input to the TRIPS future year modelling process and assigned to each of the networks.

Matrix Building Method

Future year matrices have been produced by applying separate forecasting techniques to different parts of the 2004 base matrix and by then combining the constituent parts. Key stages in the matrix forecasting, for each year and time period, were as follows:

Separation of base 2004 matrix into local internal-to-internal, internal-to-external, external-to-internal and strategic external-to-external traffic matrices;

Calculation of NISTRM background growth factors.

Application of NISTRM background growth to the separated matrices;

Derivation of trip origins and destinations at key land use developments;

Distribution of trips at key land use developments; and

Addition of land use development trips to the matrices after factoring for background growth.

NISTRM Background Growth

The base year 2004 matrices were projected to future year NISTRM background growth equivalents, by applying NISTRM, trip end factors. The factors applied are shown in Table 2.1.

Forecast Period	Peak	Movement	Trip End Factor
2004 - 2009	AM	Internal-to-External	1.085
		External-to-Internal	1.033
		External-to-External	1.077
		Internal-to-Internal	1.059
2004 - 2024	AM	Internal-to-External	1.387
		External-to-Internal	1.138
		External-to-External	1.346
		Internal-to-Internal	1.265

Table 2.1 – NISTRM Future Year Growth Factors from 2004

Site Specific Development Trips

Development trip predictions were produced for twenty-eight land use sites that are planned/identified within the traffic model area. The development sites were selected on advice from Roads Service/Planning Service. Planning status of the sites is variable, with some being approved, whilst others are potential (identified in the draft Area Plan), but not approved. The twenty-eight sites, at which development is predicted, are identified in 3 groups

Committed Developments – 787 dwellings

Pending Developments – 347 dwellings and 7.5 ha industrial

Area Draft Plan Zonings – 3257 dwellings and 4.7 ha industrial.

The locations of these development areas are shown in Drawing 400370-SK-033 in Appendix B.

TRIPS Model Assignment

The full-growth trip matrices, as identified earlier, were assigned to the networks to produce forecast traffic model outputs for each assessment year.

Model Reliability

Careful checks have been made to ensure that each of the forecast models achieved 'stability and convergence' in line with DMRB guidance. Flow stability is assessed by monitoring the proportion of assigned link flows that were within 5% of the volume recorded during the preceding model iteration; DMRB guidance indicates that 95% of flows should be within 5% of the previous iteration. Cost minimisation and optimum trip routing is checked by monitoring 'Delta' (the percentage difference between the travel costs on the assigned routes and on the minimum cost routes); DMRB guidance indicates that 'Delta' should be less than 1%. Outputs from the models indicate that the convergence criteria were easily achieved for each of the forecast model runs.

2.4 Information and Data

In general the information and data used in this appraisal have been obtained from a variety of published sources, traffic surveys, model outputs and information from various organisations. Information from earlier studies was also reviewed.

Documents

Armagh Area Plan 1973

Armagh Area Plan 2004

Armagh Area Plan 2018: Issues Paper

Armagh Area Plan 2018: Strategic Topic Research Summary Report

Regional Development Strategy for N.I. (RDS) 2025

Regional Transport Strategy (RTS)

Regional Strategic Transport Network (RSTN) Transport Plan 2015

Design Manual for Roads and Bridges (DMRB)

Planning Policy Statement 13 (PPS13) Transportation and Land Use

Planning Policy Statement 15 (PPS15) Planning and Flood Risk

PSNI Sanitised Accident Data from Roads Service

Armagh West-North Link: Scheme Appraisal Report (Scott Wilson/Ferguson McIlveen 2004)

Organisations

Roads Service Southern Division

The Department for Regional Development

The Planning Service

RPS Environmental Engineers

Maps and Drawings

Ordnance Survey Maps

Utility Maps

Websites

Transport Appraisal Guidance (WebTAG)

MOSAIC utility website

3.0 Route Corridors

3.1 Description of Route Corridors

There has been one 'Do-Minimum' Option and four 'Do-Something' Options appraised, and each are described in the following sections.

As described earlier, one of the main objectives of this study was to assess the suitability of the North and West Link alignment as published in the Armagh Area Plan 2004. It was decided to extend the study area further out to provide a more detailed assessment of potential corridors. A Public Information Day held in March 2006 provided more justification for this broader study area. A Constraints Map was created that plotted all potential constraints to the area. Four Route Corridors were selected based on their impact on the study area. These can be seen on Figure 3.1.

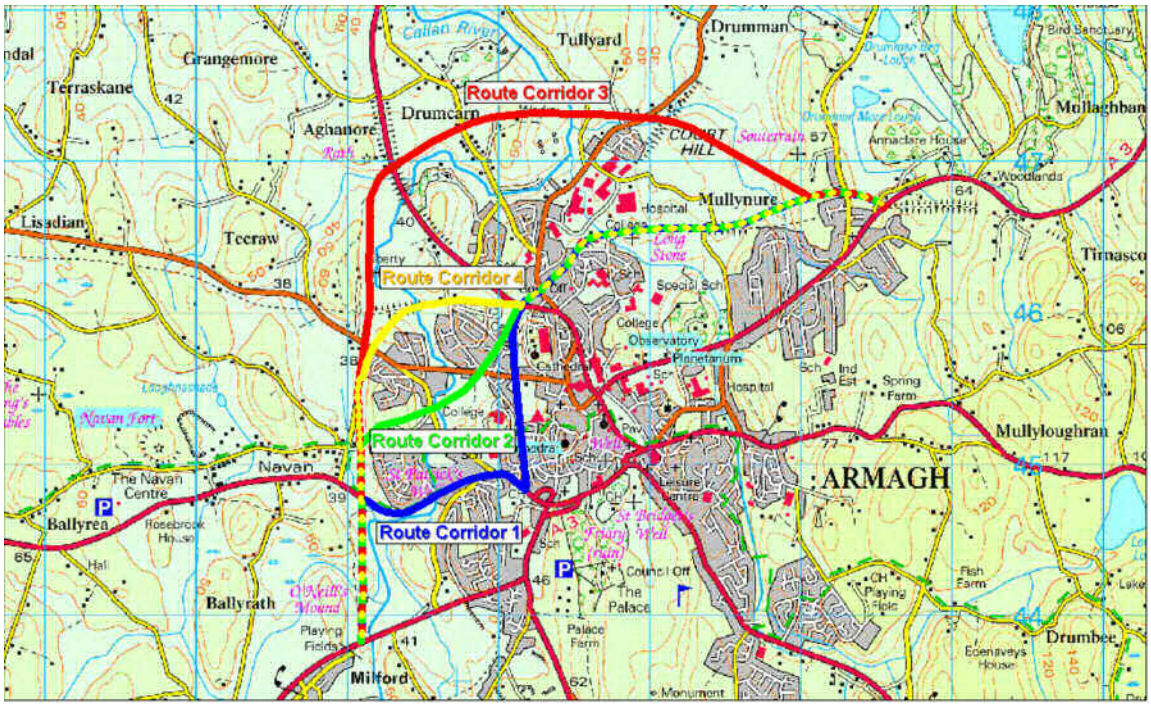

Figure 3.1 - Route Corridor Locations

3.1.1 'Do-Minimum' Scenario

The Do-Minimum Scenario is the first step in assessing any scheme at a future year. It assumes that the full pattern of development has been constructed, but with no provision for the link road. This allows the future pressures on the network to be established.

Information on likely developments was obtained from Planning Service, while potential junction improvements in the city were extracted from a previous report prepared by Faber Maunsell in 2003. Elements that were included are as follows:

Introduction of traffic signals at Mall West/College Hill;

Introduction of traffic signals at Mall East/Victoria Street; and

Armagh East Link

3.1.2 Route Corridor 1

Route Corridor 1 provides 6km of single carriageway connecting the A3 Monaghan Road south/west of Armagh with the A3 Portadown Road.

The corridor commences at Monaghan Road using the existing network along Killylea Road, with junctions at Friary Road, Navan Street, Windmill Hill, Cathedral Road, Moy Road, Loughgall Road, Mullinure Lane and Portadown Road. Table 3.1 below provides a summary of the 'junction strategy' applied to the modelling. Locations of these can seen on drawing 400370-SK-030-01 in Appendix B.

JUNCTION LOCATION	JUNCTION TYPE
Monaghan Road	Priority
Killylea Road	Priority
Friary Road	Traffic signals
Navan Street	Traffic signals
Windmill Hill	Traffic signals
Moy Road	Roundabout
Loughgall Road	Roundabout
Mullinure Lane	Priority
Portadown Road	Roundabout

Table 3.1 - Route Corridor 1 Junction Strategy

3.1.3 Route Corridor 2

Route Corridor 2 provides 5.4km of single carriageway connecting the A3 Monaghan Road with the A3 Portadown Road.

The corridor commences at Monaghan Road with junctions at Killylea Road, Cathedral Road, Desart Lane Lower, Moy Road, Loughgall Road, Mullinure Lane and Portadown Road. Table 3.2 below provides a summary of the 'junction strategy' for Route Corridor 2. Locations of these can seen on drawing 400370-SK-030-02 in Appendix B.

JUNCTION LOCATION	JUNCTION TYPE
Monaghan Road	Priority
Killylea Road	Roundabout
Cathedral Road	Roundabout
Desart Lane Lower	Priority
Moy Road	Roundabout
Loughgall Road	Roundabout
Mullinure Lane	Priority
Portadown Road	Roundabout

Table 3.2 - Route Corridor 2 Junction Strategy

3.1.4 Route Corridor 3

Route Corridor 3 provides 6.6km of single carriageway connecting the A3 Monaghan Road south/west of Armagh with the A3 Portadown.

The corridor commences at Monaghan Road with junctions at Killylea Road, Cathedral Road, Moy Road, Drumcairn Road, Lisdonwilly Road, Loughgall Road and Portadown Road. Table 3.3 below provides a summary of the 'junction strategy' for Route Corridor 3. Locations of these can seen on drawing 400370-SK-030-03 in Appendix B.

JUNCTION LOCATION	JUNCTION TYPE
Monaghan Road	Priority
Killylea Road	Roundabout
Cathedral Road	Roundabout
Moy Road	Roundabout
Drumcairn Road	Priority
Lisdonwilly Road	Priority
Loughgall Road	Roundabout
Portadown Road	Roundabout

Table 3.3 - Route Corridor 3 Junction Strategy

3.1.5 Route Corridor 4

Route Corridor 4 provides 5.7km of single carriageway connecting the A3 Monaghan Road with the A3 Portadown Road.

The corridor commences at Monaghan Road with junctions at Killylea Road, Cathedral Road, Moy Road, Loughgall Road, Mullinure Lane and Portadown Road. Table 3.4 below provides a summary of the 'junction strategy used in the modelling of Route Corridor 4. Locations of these can seen on drawing 400370-SK-030-04 in Appendix B.

JUNCTION LOCATION	JUNCTION TYPE
Monaghan Road	Priority
Killylea Road	Roundabout
Cathedral Road	Roundabout
Moy Road	Roundabout
Drumcairn Road	Priority
Lisdonwilly Road	Priority
Loughgall Road	Roundabout
Portadown Road	Roundabout

Table 3.4 - Route Corridor 4 Junction Strategy

3.2 Engineering Assessment Criteria

The Engineering feasibility of each of the four corridors has been assessed taking account of the following key aspects:

Geometric alignment;

Geotechnical;

Structural;

Drainage; and

Effect on public utilities.

3.2.1 Geometric Alignment Assessment Criteria

Analysis of the geometric alignments for each of the corridors has been undertaken in excess of the requirements of a DMRB Stage 1 Scheme Assessment Report. This has been done to enable a full assessment of the geometric characteristics of each route corridor in an engineering context.

For the purpose of the preliminary geometric alignment MX modelling of embankments and cuttings of 1 in 3 have been used. Detailed design in later stages will seek to rationalise these.

The geometric alignment appraisal of all new link roads is subject to a number of influencing factors. These factors therefore act as the assessment criteria for geometric alignment and include:

Design Speed;

Design Limitations;

Topographical Constraints; and

Physical Constraints;

All of these, when considered, are likely to identify the need for Departures or Relaxations from the Design Standard TD 9/93 (Highway Link Design) as contained in Volume 6 – Part 1 of the Design Manual for Roads and Bridges. As the strict application of desirable minimum design standards is likely to lead to disproportionately high construction costs or adversely impact the environment without significantly improving safety the implementation of relaxations and departures to the standards may prove to be beneficial.

Each of the Route Corridors have been assessed using the above mentioned criteria, details of which can be found in Sections 3.3.2, 3.4.2, 3.5.2, and 3.6.2 for Route Corridors 1,2,3, and 4 respectively.

Preliminary Horizontal and Vertical Alignments have been drafted for each of the Route Corridors using the MXROAD software. These aim to provide solutions with safe levels of stopping sight distance, horizontal curvature, vertical curvature, overtaking sight distance, and drainage. While doing this, identification of areas where embankments and cuttings will be

required has been possible. In addition, a walk-over survey of the route corridors has been completed.

As the Route Corridors are located within both urban and rural environs each corridor is subject to varying degrees of alignment and layout constraints. These constraints which include the surrounding topography, the built environment, and the frequency of proposed junctions and accesses have been assessed to produce an appropriate design speed for each of the Route Corridors. A junction strategy has also been devised based on the available traffic flow information.

Typical preliminary carriageway cross-sections have been drafted based on the envisaged design speeds, predicted traffic flows, non-motorised user requirements, and the preliminary vertical alignment design.

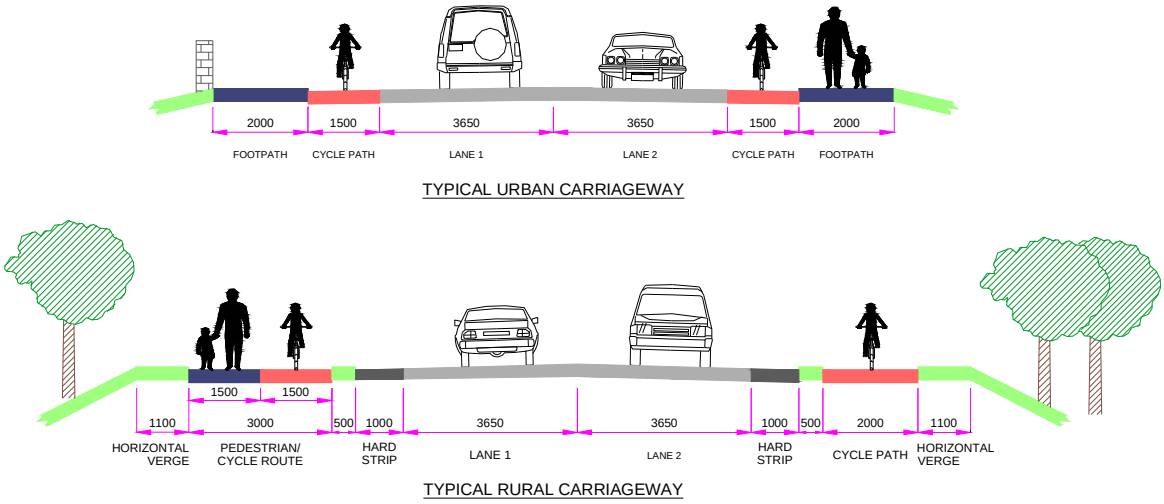

Figure 3.2 - Typical Carriageway cross-sections

A full appraisal of the integration of non-motorised users has not been carried out at Stage 1 and will be further investigated during Stage 2.

3.2.2 Geotechnical Assessment Criteria

This section of the report presents the findings of a desk study that was undertaken to establish the geotechnical and geo-environmental constraints and risks along each of the preliminary route corridors. Available information has been assessed, collated and interpreted to provide advice in relation to these constraints.

The geotechnical sections will be assessing:

Topography;

Solid Geology (interpreted from GSNI, Armagh Sheet 47, Scale 1:50,000, Solid Edition)

Geomorphology (interpreted from GSNI, Armagh Sheet 47, Scale 1:50,000, Drift Edition)

Man-made features

A preliminary engineering assessment based on the available information available has also been given for each route corridor.

The following sources of information have been consulted in order to characterise the study area and help identify potential ground related hazards. A detailed walkover survey was undertaken in June 2006.

Geological Publications

Geological Survey of Northern Ireland (GSNI):

1:250,000 scale Solid Geology (2nd Edition, 1997);

1:250,000 scale Quaternary Geological Map of Northern Ireland;

1: 250,000 scale Groundwater Vulnerability Map of Northern Ireland;

1:250,000 scale Hydrogeological Map of Northern Ireland;

1: 50,000 scale Solid Edition – Armagh, Sheet 47;

1: 50,000 scale Drift Edition – Armagh, Sheet 47;

Geological Survey of Northern Ireland (GSNI) historical records

Borehole Records;

Mineral Extraction;

Hydrogeology;

Abandoned mines records.

Historical Mapping

Ordnance Survey of Northern Ireland

Historical OS plans and aerial photography of the area.

Statutory Consultees

The Environment & Heritage Service (EHS):

Contaminated Land Database;

Water Quality Management Unit;

Health & Environmental Services Dept;

Industrial Heritage Records.

Geomorphology

Geomorphology is the study of the Earth's surface features and the processes that form them. The entire study area has been influenced largely by glacial activity resulting in the formation of numerous north-south orientated drumlin features located along the various route corridors. Ice action has resulted in the widespread deposition of glacial tills (boulder clay) within the study area.

The drift deposits within the study area are predominantly indicated to be glacial till with patches of alluvium scattered throughout generally associated with existing watercourses such as the Callan River and the Ballynahone River and its tributaries.

The low-lying areas between the drumlins collect the surface water runoff resulting in various minor watercourses and field drains which feed into the Callan and the Ballynahone Rivers. Deposits of alluvium will therefore exist along the floodplain of such watercourses, some of which may have since dried up due to subsequent climate changes over various geological periods.

In addition, a few areas of bedrock (at or near the ground surface) are indicated to be in close proximity to a number of route corridors and this is discussed in sections 3.3.3, 3.4.3, 3.5.3, and 3.6.3.

Man-made features

Man-made features generally consist of structures or areas that have previously formed, or do form, part of the built environment. From Table 3.5 below it can be seen that such features can take the form of anything from disused quarry/ponds to sewage works.

Following consultation with the Environment & Heritage Service (EHS), 39 sites within the general study area are designated as potentially contaminated in the Land Quality database held by the EHS and identified from historical mapping is given in Table 3.5 below.

Man-made constraints are identified on drawing 400370-SK-111 in Appendix B. Sites have been designated as low, medium, high risk or unknown, using the grading criteria established by the Environment & Heritage Service. Unfortunately, there is no detailed information available as to the current status of these sites.

Information received from Geological Survey of Northern Ireland (GSNI) has confirmed that there are presently no active mineral extraction, quarries or pits within the study area.

Reference Number	EHS Site Number	Potential Risk Category	Description
1	AH218/060	High	Disused Quarry / Mineral Workings
2	AH199/040	Low / Medium	Quarry / Pond
3	AH218/037	High	Kiln / Disused Mineral Workings
4	AH199/037	Low / Medium	Quarry / Pond
5	AH218/038	High	Disused Quarry / Mineral Workings
6	AH218/007	Medium	Disused Rail Line
7	AH218/041	Medium	Disused Limestone Quarry
8	AH218/025	Medium	Disused Rail Line
9	AH218/026	Medium	Disused Rail Line
10	AH218/043	High	Kiln / Disused Mineral Workings
11	AH218/057	Medium	Corn Mill
12	AH218/039	High	Sewage Works
13	AH218/040	High	Scrap Engineers
14	AH218/064	Medium	Linen Mill
15	AH218/006	Medium	Disused Rail Line
16	AH218/027	Medium	Disused Rail Line
17	AH218/059	Medium	Linen Mill
18	AH218/030	Medium	Disused Rail Line
19	AH218/025	Medium	Textiles
20	AH218/036	High	Railway Depot
21	AH218/029	Medium	Food Preparation & Processing
22	AH218/056	Medium	Corn / Flour Mill
23	AH218/065	Medium	Flour Mill
24	AH218/005	Medium	Disused Rail Line
25	AH218/058	High	Gas Works
26	AH218/028	High	Petrol Station / Fuel Storage
27	AH218/066	Medium	Linen Mill
28	AH218/016	High	Petrol Station / Fuel Storage
29	AH218/004	Medium	Disused Rail Line
30	AH218/017	Medium	Disused Rail Line
31	AH218/072	Low / Medium	Marble Quarry
32	AH218/042	High	Sewage Works
33	AH218/034	High	Disused Quarry and Kiln
34	AH218/069	Medium	Reclaimed Land / Former Gravel Pit
35	AH218/055	Medium	Reclaimed Land / Former Gravel Pit
36	AH218/033	High	Mineral Workings
37	AH218/015	High	Sewage Works
38	AH218/014	High	Petrol Station / Fuel Storage
39	AH218/070	High	Reclaimed Land / Former Quarry

Table 3.5 - Sites of potential contamination

Contamination

The identification or discovery of contaminated material within the footprint of any alignment may have huge cost implications on the overall scheme. Depending on the level and extent of any contamination this material may need to be remediated or completely removed and disposed off at a licensed tip, the cost of which may run into hundreds of thousands of pounds.

Peat or Peaty Type Soils

If significant quantities of peat are found to be located along any alignment this will have programme and costs implications on the scheme. This material is generally a poor engineering material and is difficult to construct upon. It has low strength, is highly compressible both initially and in the long term, has a high water content and when encountered in excavations would require care to be taken during removal. Special techniques, such as surcharging can be used to build on peat but this can be expensive and may require an advanced contract prior to any main construction contract.

Rock

If shallow bedrock is encountered within any of the major cuttings within the scheme then this material may have to be excavated, either by mechanical means, explosives or a combination of both. Again, this will impact programme and scheme costs.

When using explosives for rock excavation, boreholes are firstly drilled down through the rock with explosives being placed within the bored holes. It is important that the amount of explosives placed within the holes must be enough to facilitate the excavation of rock with mechanical methods but not too much as this could result in severe shattering and reduce the strength of the rock mass.

3.2.3 **Structural Assessment Criteria**

Each of the route corridors will involve the construction of a number of major and minor structures, including, bridges, underpasses, cattle creeps and culverts. Some also involve the modification of existing structures, to allow for the wider cross section of the new carriageway. The structural elements associated with route corridors 1 to 4 are dealt with individually in sections 3.3 to 3.6 consecutively.

Existing structures have in general been visually assessed for signs of distress and where possible previous assessment results have been obtained from the Roads Service Bridge Management Database. The age of the structures has been established were possible and estimated if such information is not available.

Some route corridors involve modification/demolition of listed structures; obviously any proposals of such action will need to be preceded by detailed consultations with EHS and other interested parties. Each of the existing structures affected by the corridors are discussed individually in the structural elements section of the appropriate route corridor.

Proposals for new structures have been made on the basis of site visits and a visual assessment of the topography of the area. In the case of underpasses the span of the bridge required has often been dictated by the width of route passing under it. In the case of River bridges the span and height of the bridge has been dictated by Rivers Agency.

3.2.4 Drainage Assessment Criteria

The drainage assessment was performed using information gathered from:

OS Maps;

Statutory Authorities;

A Walkover Survey and Site Visit; and

Preliminary Horizontal and Vertical Alignments.

From the OS Maps and information provided by the Rivers Agency, it has been noted that there are two main watercourses within the study area, namely the Callan River and the Ballynahone River. These rivers flow in a northerly direction and pass through both rural and urban areas. As well as these, there are several minor watercourses which flow through mainly rural areas to the north and west of the study area. The land surrounding these watercourses is designated floodplain (Drawing No. 400370-SK-109-01, in Appendix B), and could potentially contain poor ground conditions and high ground water levels.

After preliminary consultation with the Rivers Agency, it was advised that any development should be restricted to land above the 100 year (Q100) flood levels. Also, if there were any development within the floodplain region, mitigation measures should be provided to reduce any increase in flood risk to the surrounding area.

The walkover survey highlighted existing watercourses and drainage structures such as culverts, and what condition they were in.

The preliminary horizontal and vertical alignments highlighted areas in which embankments and cuttings would be made and also where drainage infrastructure such as culverts, outfall points and Sustainable Urban Drainage Systems (SUDS) may be provided or required.

3.2.5 Public Utility Assessment Criteria

Following consultation with relevant statutory authorities, information regarding underground and overhead service locations have been detailed on Drawing Nos. 400370-SK-109 (01, 02 and 03).

Ordnance Survey maps, together with the MOSAIC website and service information provided by the relevant statutory authorities has been used to identify the location of the utilities that may be affected by each proposed route corridor. It should be noted that due to the nature of this assessment, i.e. by route corridor, it would be inappropriate to be too specific about utility interference within each route corridor. Instead, it would be more appropriate to highlight the utilities which would experience the greatest conflict with the proposed route corridors, and incur the greatest cost to relocate or divert.

Within this study, the following statutory authorities were consulted:

Rivers Agency

British Telecom (BT)

Eircom

Northern Ireland Electricity (NIE)

NTL

Roads Service Street Lighting

Water Service

Cable and Wireless

As advised by all statutory authorities, information provided by the statutory authorities may only be taken as a guideline, and service location accuracy can not be guaranteed.

3.2.6 Traffic Appraisal Criteria

The method for construction of models to assess the North & West Link route corridors is described earlier in Section 2.3. From these models a city centre 'cordon' area has been selected in order to produce summary statistics as indicators of performance against certain assessment criteria. Performance indicators and the criteria to which they relate are shown in Table 3.6 below.

Performance Indicator from TRIPS Model	Appraisal Criteria to be Assessed
Traffic inflows at key junctions	Network efficiency and safety
Vehicle trips within city centre cordon	Environmental quality and severance
Total travel time in city centre	Network efficiency
Total travel distance in city centre	Network efficiency and energy consumption
Delay at key junctions	Network congestion and efficiency
Saturation of key junctions	Network congestion and efficiency

Table 3.6 - Traffic Model Outputs for Assessing Different Appraisal Criteria

For the purposes of this assessment the cordon has been defined as crossing the following roads (see Figure 3.3):

Railway Street

Moy Road

Alexander Road

Lisanally Road

College Hill

Victoria Street

Barrack Hill

Barrack Street Bridge

Dobbin Street Lane

Upper Irish Street

Navan Street

Culdee Drive

Windmill Hill

Cathedral Road

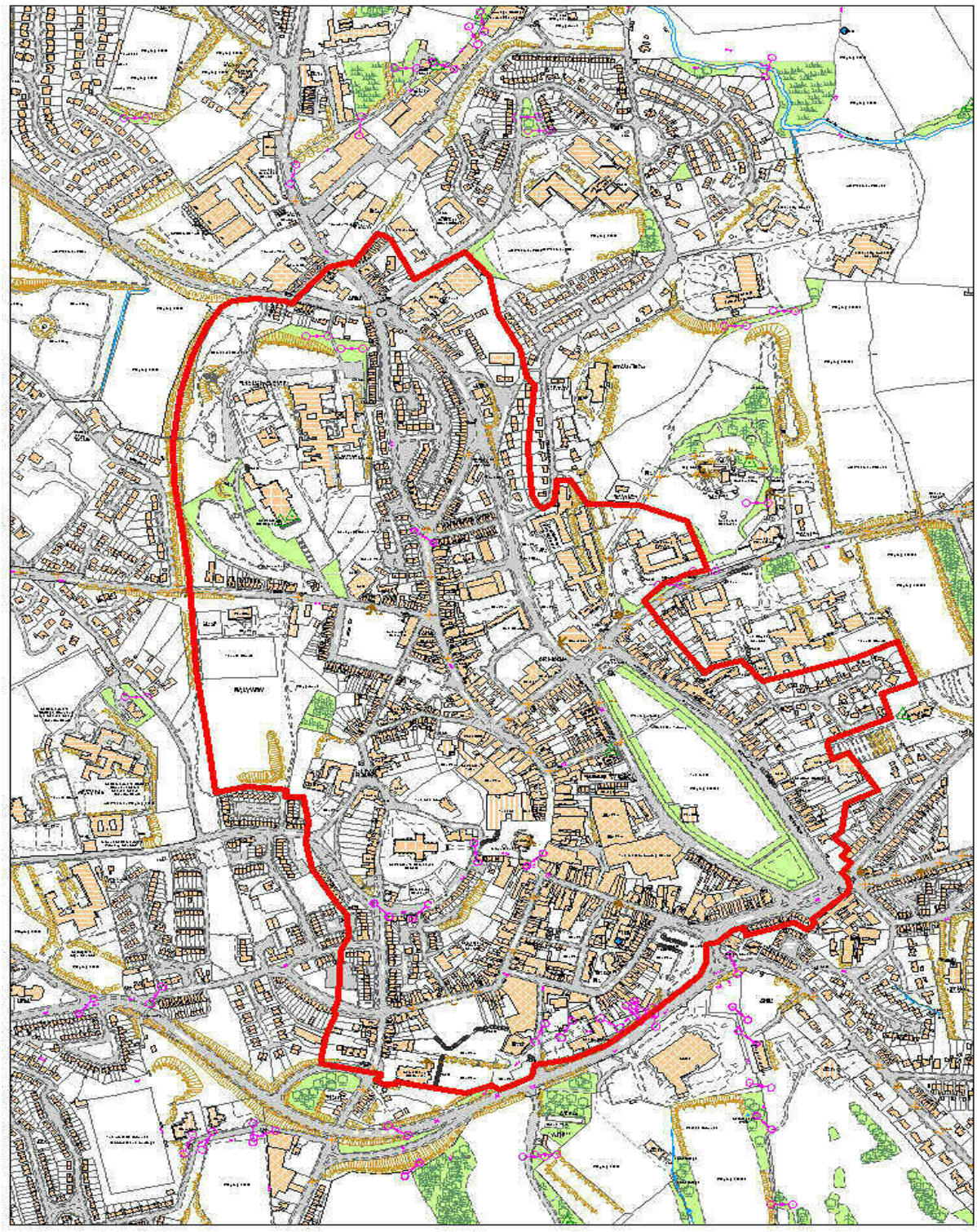

Figure 3.3 - City Centre Cordon

Summary statistics and commentary are provided for each of the corridors (as a comparison with the Do Minimum) in the following sections. The base year traffic model for Armagh

indicates that approximately 14% of AM Peak traffic along the Portadown Road continues through to the south west periphery of Armagh and approximately 19% of the AM Peak traffic from the south west of Armagh is destined for the Portadown Road (assumed to be going to Portadown and beyond). This is the amount of 'strategic' traffic utilising the entire link road that could potentially be removed from the city centre. Further 'local' traffic will be removed due to either the northern section or western section being used in isolation.

3.3 Route Corridor 1

3.3.1 Description of Route

The alignment details of Route Corridor 1 are shown on drawing 400370-SK-030-01 in Appendix B.

Route Corridor 1 comprises the original route corridor identified in the Armagh Area Plan (AAP) 2004, a section of the existing A28 Friary Road/A28 Killylea Road and a further proposed link between the A28 Killylea Road and the A3 Monaghan Road.

Route Corridor 1 leaves the A3 Portadown Rd on the Northeast edge of Armagh City and continues west across or possibly under Drummanmore Road, passing the northern side of Drummanhill cul-de-sac and crossing a small watercourse north of Drumman Heights before progressing towards Mullinure Lane. Along this stretch it passes through largely agricultural land.

At Mullinure Lane it converges with the disused Newry-Armagh railway line and follows this line to Station Road after traversing Ballynahone River at Lisanally Lane. From here it continues along Station Road and adjacent to a number of commercial/industrial properties before traversing both Railway Street and the A29 Moy Road.

After the A29 Moy Road it continues south along the disused railway line on the western side of St. Patrick's Roman Catholic Cathedral towards and possibly under the B115 Cathedral Road.

From the B115 Cathedral Road the route travels south along the disused railway line parallel with the residential areas of Convent Road and Druids Villas. In doing this it traverses Windmill Hill and Navan Street before linking with the A28 Friary Road at a point approximately 75m west of the Friary Road/Irish Street link.

This corridor then utilises the existing road network of the A28 Friary Road and the A28 Killylea Rd, crossing the Callan River and continuing to a point approximately 180m east of the Ballycrummy Road/Killylea Road junction. From here it travels south through agricultural land between the A28 Killylea Road and the A3 Monaghan Road. Along this stretch it crosses a small watercourse adjacent to Killylea Road and another at O'Neill's Mound before it eventually meets with the A3 Monaghan Road at a point approximately 150m east of Milford village.

The total approximate length of Route Corridor 1 is 6km.

3.3.2 Geometric Alignment

Design Speed

The Design Manual for Roads and Bridges (DMRB) Volume 6 – Section 1 – Highway Link Design (TD 9/93) outlines the basic principles to be used when determining the design speed and geometric alignment of single and dual carriageway roads in both urban and rural areas.

As Route Corridor 1 is located within both urban and rural environs it is subject to varying degrees of alignment and layout constraints. Having assessed these constraints which include the surrounding topography, frequency of proposed junctions and accesses it is envisaged that Route Corridor 1 will have varying design speeds along its length. These are likely to be 60mph (100A) along the rural sections and 40mph (70A) or 30mph (60B) along the urban sections of the corridor.

Design Limitations

The table below details the relevant limitations of Stopping Sight Distance, Horizontal Curvature, Vertical Curvature, Overtaking Sight Distance, and Gradients to design speeds of 100A, 70A, and 60B.

Design Speed	100A	70A	60B
Stopping Sight Distance (m)			
Desirable Minimum	215	120	90
One Step below Desirable Minimum	160	90	70
Horizontal Curvature (m)			
Minimum Radius without elimination of Adverse Camber and Transitions	2040	1020	720
Minimum Radius with Superelevation of 2.5%	1440	720	510
Minimum Radius with Superelevation of 3.5%	1020	510	360
Desirable Minimum Radius with Superelevation of 5%	720	360	255
Vertical Curvature			
Desirable Minimum Crest K Value	100	30	17
One Step Below Desirable Minimum Crest K Value	55	17	10
Absolute Minimum Sag K Value	26	20	13
Overtaking Sight Distances			
Full Overtaking Sight Distance FOSD (m)	580	410	345
FOSD Overtaking K Value	400	200	142
Desirable Max Gradient			
All Purpose Single Carriageways	6%	6%	6%

Table 3.7 - Design Parameters

Topographical Constraints

The landform along Route Corridor 1 is such that cuttings and embankments will be required in some areas to enable construction of a safe carriageway alignment with acceptable standards of horizontal and vertical curvature as detailed in Table 3.7. Such areas are largely confined to the rural northern section of the corridor between Lisanally Lane and Portadown Road, and the rural section to the southwest of the corridor adjacent to O'Neill's mound. The northern section follows a section of the disused railway line from Station Road to Mullinure Lane, where the existing railway cuttings and ballast could potentially be utilised (see Plate 3.1).

Plate 3.1 - Disused railway cuttings between Station Road and Mullinure Lane

It is envisaged that a significant cutting will be required to the north of Drumman Heights in order to provide an acceptable vertical alignment and carriageway gradient on the approach to Portadown Road (see Plate 3.2)

Plate 3.2 - Rural Area between Lisanally Lane and Portadown Road (North of Drumman Heights)

A portion of this corridor lies on the industrial Station Road where a flat terrain is encountered. The potential alignment will likely require the closure of a secondary access to Alexander Park.

Existing cuttings may require structural support or slope stabilisation if a wider cross section is applied.

Plate 3.3 - Cuttings on Station Road

Plate 3.4 - Example of Retaining Structure

The section of this route corridor between Friary Road and Loughgall Road lies on the disused railway line which, by its very nature, lies at a constant, albeit slight, gradient. The portion of this disused railway line adjacent to Navan Street appears to have been filled since the closure of the railway with material of unknown characteristics. Existing cuttings, in particular those adjacent to St. Patrick's Roman Catholic Cathedral may require structural support or slope stabilisation.

Watercourses, including the Ballynahone and Callan Rivers, as well as a number of smaller tributaries, are traversed by this route corridor Avoidance of these is virtually impossible. Legislation relating to construction works in the vicinity of watercourses could prove to be a further constraint. Section 3.3.5 of this report gives account of drainage factors influencing Route Corridor 1.

Physical Constraints

The geometric alignment of Route Corridor 1 is influenced by a number of physical constraints. Existing public utilities as detailed on drawings 400370-SK-109-01, 400370-SK-109-02, and 400370-SK-109-03 are considered fully in section 3.3.6 of this report.

The requirement to link with the existing highway infrastructure has a strong influence on the geometric characteristics of Route Corridor 1. In particular, the entry gradients to the existing highway network should be a maximum of 6% as detailed in TD 9/93. This is of significant importance at the links to Portadown Road and Friary Road where the existing carriageways lie below and above the surrounding landform respectively. In addition, difficulties might arise where Route Corridor 1 crosses both Cathedral Road and Drummanmore Road. The preferred junction types at both these crossings, which have yet to be fully determined, may injuriously impact the surrounding properties and amenities. In particular, 4 residential properties on Desart Lane Lower and Cathedral Road; and the tennis courts at Cathedral Road Recreation Centre, could potentially be affected.

A further constraint caused by the need to link with the existing highway network is the continuation of traffic movements during the construction phase. The existing bridge over the

disused railway line at Cathedral Road could create problems for traffic movements on and around Cathedral Road during construction if demolition or upgrading is required.

The proposed Junction Strategy for Route Corridor 1 can be found in section 3.1.3 of this report.

The condition of the existing road network must be considered when assessing the geometric characteristics of each route corridor. Road classification, structural integrity, surface condition, drainage, and maintenance of the existing carriageways are of key importance to the proposed corridors. As the above information is not readily available for all classifications of road, further investigation is required.

A desktop study of available deflectograph results suggests that the majority of the section of Killylea Road, utilised within Route Corridor 1, has an envisaged lifespan in excess of 5 years from 2005 with the 400m stretch of this carriageway approaching Irish Street having an envisaged lifespan of 15 years from 2005. In contrast to this, the 500m stretch commencing at Ballycrummy Road and spanning eastwards, has a low lifespan and potentially requires up to 75mm overlay. As expected, skid resistance values along this stretch of carriageway are lowest on the lower radii corners and approaches to junctions with some cases being below the investigatory level described in HD 28/04.

Proposed developments and local planning issues are further constraining factors which have a bearing on the geometric alignment and associated junctions. Details of these can be found in section 4.14 - Land Use.

The constraint of the existing built environment is largely concentrated on the western section of this route corridor. Station Road with its commercial and industrial properties incorporates a carriageway width ranging from 5.9m to 8.1m. Pedestrian footpaths are currently present on one verge for most of its length, while a short stretch has these on both verges. Due to the high concentration of properties fronting on to Station Road, which includes a tile showroom, a tyre centre, an electrical supplies store, and a diner, the provision of access roads must be considered. These would accommodate continued service to the necessary properties, while reducing the number of direct accesses onto the new link road. One possible location for a service road would be to the northwest of Station Road, adjacent to Gillis House. An approximate total of 12-16 properties in the Station Road, Alexander Park, and Alexander Avenue areas could be injuriously affected.

To the south of Station Road and spanning from Moy Road to Loughgall Road/Railway Street is a Timber Merchants. As Route Corridor 1 passes through this area it is likely that the Timber Merchants storage yard and sheds will be affected (see plate 3.22).

The sections along Killylea Road and Friary Road also utilise the existing carriageway. The current cross section of these roads incorporates lane widths of between 3.4m and 3.7m and pedestrian footpaths on each verge of widths between 1.0m and 3.5m. Section 3.3.4 gives details on how the existing bridge on the Killylea Road could be widened to incorporate the new carriageway cross-section. The front gardens of approximately 28 properties fronting on to Killylea Road may be affected if carriageway widening is required.

Plate 3.5 - Killylea Road/Friary Road

Further constraints include the largely residential areas of Willowbank, Convent Road, and Druids Villas, where 6 residential properties are likely to be impacted. These areas further constrain the siting of the proposed carriageway as well as pose potential problems during the construction phase. Furthermore, a number of schools located in the Windmill Hill and Callan Street areas will require maintained access throughout the construction phase.

Another constraint is the disused railway line, on which elements of the northern and western sections of this route corridor lie. The geometric attributes of this railway line constrain both the horizontal and vertical alignment of the proposed carriageway.

Departures and Relaxations

Due to the various constraints encountered by this Route Corridor, it is likely that relaxations and possible departures from standards will be required for the geometric alignment.

Particular areas where departures and relaxations might be required for the alignment of Route Corridor 1 include Station Road, where the existing horizontal alignment would be sub-standard if transferred to the new link road, and the rural northern section, where the undulating land form poses a potential problem to the vertical alignment, specifically to the north of Drumman Heights. Furthermore, the horizontal geometry of the existing Friary Road/Killylea Road is likely to be sub-standard if utilised as part of Route Corridor 1.

3.3.3 **Geotechnical Elements**

Topography

This route corridor will commence at a new junction on the existing A3 Portadown Road and will extend offline in a westerly direction towards Drummanmore Road. The Drummanmore Road is positioned near the top of a drumlin which results in a significant ground level difference needing to be overcome.

As the route continues west through agricultural land extending beyond Drummanmore Road bypassing Drummanhill cul-de-sac it will likely need to enter into a cut for approximately 350m, cutting through a large drumlin feature (low amplitude hills of glacial origin) at a maximum depth of approximately 10m. See Plate 3.6 below.

Where the corridor converges with the disused railway line at Mullinure Lane the abutments of an old railway bridge are evident. At this location the old railway line is raised on embankment but as it extends to the west it enters into a cutting for approximately 250m. The indentations of the old railway sleepers, which have now been removed, can still be seen in the old ballast, as indicated on the Plate 3.7 below. It is thought that the line was decommissioned in 1958.

Plate 3.6 - View of Drumlin north of Drummanmore Heights looking eastwards

Plate 3.7 - View of old railway ballast west of Mullinure Lane

It is considered unlikely that any potential route would be constructed upon the existing railway line to the east of Mullinure Lane as it is constructed on quite high narrow embankments with steep side slopes.

For the next 1.5km the corridor will follow or lie relatively close to the disused railway line extending in a westerly and then south-westerly direction towards Station Road and traversing the Ballynahone River at Lisanally Lane.

At Station Road and for the next 2.0km the route generally passes through urban land, predominantly at grade level, which is a mixed use of residential and commercial properties.

As the route extends beyond Station Road it intersects Railway Street / B77 Loughgall Road and the A29 Moy Road. From this location the corridor continues southwards again following the disused railway line on a small embankment bypassing St. Patrick's RC Cathedral to the immediate west and playing fields and residential properties to the east and passing beneath the B115 Cathedral Road.

Plate 3.8 - View of old railway line on the approach to Cathedral Road

From Cathedral Road the route continues south through a residential area running parallel with Convent Road and Druids Villas beyond which it intersects Windmill Hill and Navan Street. This general area is relatively flat and the ground level within the housing estate is fairly constant. The road level through this area will be at grade level apart from where it meets the existing A28, which is raised up on embankment (see Plate 3.10). Where the route intersects Navan Street the existing road is supported on an old masonry arch railway bridge, which has been infilled below (see Plate 3.9 below).

Plate 3.9 - Infilled masonry arch bridge at Navan Street

Plate 3.10 - View of embankment which carries the A28 south of Navan Street

From this location the corridor proceeds in a westerly direction utilising the existing road network of the A28 Friary Road and the A28 Killylea Road crossing the Callan River and continuing to a point approximately 180m east of the Ballycrummy Road / Killylea Road junction.

At this location the corridor continues offline in a southerly direction linking the A28 Killylea Road and the A3 Monaghan Road. As the corridor progresses through agricultural land it cuts through the eastern flank of a drumlin feature, it then crosses a floodplain of several small watercourses, which are tributaries of the Callan River, before meeting the existing A3 Monaghan Road.

Solid Geology

This corridor commences along the A3 Portadown Road and proceeds in a westerly direction for an approximate distance of 1.9km across an area of bedrock known locally as the Armagh Group of which there are two types of sediments both carboniferous in age (Visean: Chadian – Brigantian). The first type is known as the 'ARMA' Formation and is described as fossiliferous, pale to dark grey, bedded marine limestone's and thin shales, pale yellow to grey grainstones, with calcareous grits, sandstones and siltstones. Stratigraphically below and geographically to the west is the Drumman More Sandstone Formation which is described as virtually unfossiliferous, pale grey, non-calcareous, micaceous, fine to medium sandstone with

carbonised plant fragments with thin black mudstones, and thin coal beds which contain abundant miospores. These formations are bounded by a number of SE-NW trending faults.

Just east of where the disused Armagh to Portadown railway line crosses the Ballynahone River the route enters the Callan Group of rocks which includes three formations of Permian Age, namely the Dobbin Sandstone Formation, the Mall Member and the Drumarg Conglomerate Formation, continuing across it in westerly and then south-westerly direction for approximately 2km, crossing a number of SE-NW trending faults, two of which are thrown down in a southerly direction, with another one to the north and one to the west.

The Dobbin Formation is described as soft, red, fine grained, micaceous sandstone. The Mall member is described as soft, grey, sandy, limey rock, probably equivalent to magnesian limestone and the Drumarg Formation is described as purple-red, bedded, conglomerates and coarse-grained sandstones.

One borehole previously excavated close to where the corridor crosses the Ballynahone River encountered slightly weathered fragments of yellow sandstone at a depth of 10.2 below existing ground level. It is thought that this material is sediments from the ARMA Formation. Extracts from the ground investigations, and a map showing locations of boreholes (drawing 400370-SK-113) can be found in Appendix B.

One borehole and one trial pit excavated in close proximity to Station Road revealed bedrock at depths of between 6.1 and 6.8m below ground level. This material was described as weak red brown sandstone. It is assumed that this bedrock is part of the Dobbin Sandstone Formation.

Where the route joins the A28 Friary Road it crosses a narrow strip of the Mall Member before re-entering the Dobbin Sandstone Formation and the Drumarg Conglomerate Formation. From this location the corridor turns and proceeds in a westerly and then southerly direction for approximately 1.5km where it re-enters the 'ARMA' Formation crossing a number of north / south trending faults.

One historical borehole log revealed very firm sandstone at a depth of 35m below ground level at Culdee Drive south of Windmill Hill. It is assumed that this bedrock is part of the Dobbin Sandstone Formation.

To the south of this location between the A28 Friary Road and Navan Street one other borehole revealed red sandstone at a depth of 7.3m below ground level. Again this material is part of the Dobbin Sandstone Formation.

A plan showing the location of this proposed route corridor is shown on drawing 400370-SK-112 in Appendix B.

Geomorphology

This corridor commences along the A3 Portadown Road and proceeds offline in a westerly then southerly direction for an approximate distance of 4.5km through glacial till deposits.

In close proximity to where the A28 Killylea Road crosses the Callan River the corridor crosses an area of alluvium for approximately 1.5km firstly in a westerly direction and secondly in a southerly direction as the route turns south at a point approximately 180m east of the Ballycrummy Road / Killylea Road junction, before continuing south towards the existing A3

Monaghan Road, generally crossing alluvial deposits located alongside the course of the Callan River, its tributaries and other minor watercourses.
A plan showing the location of this proposed route corridor is shown on drawing 400370-SK-110 in Appendix B.

Man-made Features

This corridor directly impacts upon five sites as shown on drawing 400370-SK-111 in Appendix B, which EHS have highlighted as being potentially contaminated. Three of these sites relate to the old disused railway lines, which have been designated a medium risk level, and one at the area on Station Road where the old railway depot was previous located. This site has been designated a high risk level in terms of potential contamination.

One other site has also been designated a high risk category and this relates to a location on Culdee Drive, south of Windmill Hill which was previously a gas works site. These types of sites can potentially be very contaminated and this will need to be investigated during the main ground investigation if this is chosen as the preferred route corridor.

Preliminary Engineering Assessment

The available geological information indicates that a number of areas with differing geotechnical properties will be crossed by this corridor.

Made ground was found to be present in depths up to 6.5 below existing ground level (at Navan Street) in various exploratory holes located within close proximity to this corridor. This material appears to be “inert” demolition rubble mixed with varying compositions of clay fill. The geotechnical properties of made ground are variable and unpredictable and this type of material is generally located within brownfield sites / urban areas.

At this stage the nature of this material is unknown both geotechnically and chemically but would generally be unsuitable for re-use. As the grading and density of the materials used for this backfilling is not known the potential for total excessive settlements, gas generation, or ground and groundwater contamination cannot be adequately assessed at this stage.

It is not expected that significant quantities of peat or peaty type soils will be encountered during construction but some elements were noted from the reviewed site investigation information. These materials have very low strengths and would be marked by high compressibility both initially and in the long term. This material is generally unacceptable for engineering works. The material also has a high water content and where encountered in excavations would require care to be taken during removal.

Soft alluvial soils, typically normally consolidated or lightly consolidated clays with varying proportions of organic material, silts and sands, will be encountered in areas around the floodplain of the Callan and Ballynahone Rivers and other smaller watercourses possibly up to 5m in thickness. This material is relatively recent in origin and it can be marked by low shear strength and high compressibility. It can also consist of high organics content and can have poor drainage properties. This material can be sensitive to disturbance and prove difficult to build upon and consequently may prove to be unacceptable in places. This material is often found with or mixed with layers of peat. Careful consideration will need to be given in areas where large embankments are proposed in areas containing such material.

The reviewed exploratory hole records also revealed glacial till (boulder clay) generally consisting of gravely clayey silts, the consistencies of which ranged from soft to very stiff with the softer material generally being encountered at shallow depths.

Close to the surface these gravely clayey silts were found to be in a state of ongoing weathering and would generally be marked by high moisture contents, hence poor strength properties. As these layers increase with depth the undrained shear strength will improve thus indicating the increasing acceptability of the soil as an engineering material. Construction works in the upper regions of this material designated soft could result in settlement problems and therefore should be avoided unless the movement can be built into any design. Typically these materials would benefit from good undrained shear strengths, low compressibility and good bearing pressures.

Bedrock was not encountered in any of the exploratory holes reviewed for this corridor and the geological drift map does not show any shallow bedrock outcrops within close proximity to the corridor. Historical borehole and trial pit information can be found in Appendix B.

Groundwater will be high in areas within the floodplains of the two main rivers. Interceptor drainage will be required at the pre-earthworks stage to pick up and divert existing natural drainage channels. Consideration will need to be given to groundwater control and close support or battering back any excavations passing below groundwater levels particularly within granular deposits.

Within these areas the ground will be poorly drained and very soft in places therefore short term Californian Bearing Ratio (CBR) values for construction purposes will be poor and manoeuvrability will be problematic for wheeled plant. Access will need to be restricted to tracked plant only until adequate granular starter layers are in place to permit general trafficking. Thickness of imported granular starter materials may be reduced by the use of basal grid reinforcement.

Short-term CBR values for construction purposes in areas where sub grade is composed of competent glacial tills should be in access of 10%.

Cuttings

There are a number of cuttings along this corridor and to date there is no available site investigation information as to the exact nature of this material at these locations but it is expected that it will consist of glacial till and possibly bedrock.

Adequate drainage provision will be required to improve conditions and to draw down water levels where the water table is found to be high. Hydrological and hydrogeological studies may need to be undertaken in areas of proposed cuttings to assess the requirements for natural drainage.

Detailed slope stability analysis will need to be carried out in areas of cutting to assess potential stability of side slopes. During the main ground investigation the material to be excavated from areas of cut will need be assessed for reusability purposes.

Embankments

Sections of this corridor could potentially be constructed on embankments with an approximate height of 20 metres, primarily to provide a satisfactory vertical alignment and to raise the carriageway above low points such as rivers and areas of river floodplain, and it is these areas that will consist of soft alluvial deposits, which will prove difficult to construct upon.

With such high embankments proposed over these types of ground conditions, geotechnical, economic and programme constraints may not permit straightforward construction techniques to be employed. Measures may be required to modify the construction sequence, the form of embankment and the properties of the underlying ground, individually or in a combination. Techniques such as advance earthworks, special fills, staged construction, reinforcement, ground improvement and or reduced side slopes should be considered when evaluating methods of embankment construction.

The soil conditions at the proposed embankment locations over alluvial deposits will need to be assessed in detail during the ground investigation and detailed design process.

3.3.4 Structural Elements

Route Corridor 1 will require the construction of two significant bridge structures (underpasses; one at cathedral road and another at Drummanmore Road), three box culverts (conveying the road over small water courses) and one footbridge (replacing an existing foot bridge, which crosses the old railway cutting between Cathedral Road and Moy Road). Up to two cattle creeps may also be required, but this will be dependant upon land ownership details, livestock movements and other matters yet to be resolved. The existing bridge conveying the Killylea Road over the Callan River may also need to be widened. Table 3.8 below details the structures affected by Route Corridor 1.

Bridge Number	Location	Function	Assessment Rating		Comments
			HA	HB	
40143	Killylea Road	Crosses River Callan	40t	45 Units	Masonry Arch structure, to be widened
41804	Friary Road	Pedestrian underpass	40t	30 Units	Box culvert, local opinion is that structure should be removed
41698	Cathedral Road	Disused Railway bridge	40t	45 Units	Listed structure: EHS to be consulted about possible removal
-	North west of St Patrick's Cathedral	Footbridge over disused railway cutting	Unknown		Steel structure, may have to be replaced route corridor 1 is chosen
-	East of Civic Amenity yard	Culvert, Ballynahone River	Unknown	Unknown	Culvert (around 100m long), confined space inspection required to determine condition of structure
-	East of Civic Amenity yard	Railway underpass	Unknown	Unknown	Structure to be replaced

Table 3.8 - Existing structures

The structures associated with the railway are thought to have been constructed along with the railway itself, in the mid to late 1800's. The age of the arch bridge over the River Callan on the Killylea Road is unknown, but an estimate of 1900 is contained on the bridge management database. This bridge appears to be in sound condition from a visual inspection of the structure, but the parapets are substandard.

The railway arches (at cathedral road, and east of the civic amenity yard) are in good visual condition, but more detailed assessment will be required on any structures that are to be maintained.

An old masonry arch bridge exists on the line of the disused Armagh-Newry railway approximately 500m east of Mullinure Lane. This structure is accessed from the top of Mellifont Close and is the entry point for agricultural land to the north of the disused railway. This is off the Area Plan Line but its purpose as an access will have to be taken into consideration when assessing the route alignment at design stage.

The listed structure at Cathedral road will possibly need to be removed if Route Corridor 1 is chosen. This will involve detailed consultations with EHS regarding the feasibility of such a proposal and what procedures would be involved in taking it forward.

Minor structures: Box culverts crossing small water courses

Route Corridor 1 crosses three small water courses, it is proposed that precast concrete box culverts will be used to bridge such features. Exact sizing of such culverts has yet to be confirmed by Rivers Agency, however it has been assumed that they are 2m wide by 1.5m deep. Plate 3.11 shows a stream beside the Killylea Road, typical of the size of watercourse to be crossed using box culverts. Plate 3.12 shows an existing culvert under Moy Road.

Plate 3.11 - Stream near the Killylea Road- Typical minor watercourse, to be crossed by box culvert

Plate 3.12 - Existing culvert under Moy Road: Route Corridor 3 crosses this stream

Drummanmore Road (Proposed Underpass)

Drummanmore Road is not a heavily trafficked route (see plate 3.13), therefore closing the route temporarily during the construction phase may be feasible. The new route is 15.3m wide where it passes under the Drummanmore Road, necessitating a span of 15.3m or greater. The new structure is likely to be a prestressed concrete bridge with integral abutments.

Plate 3.13 - View along Drummanmore Road

It may be feasible to temporarily close the Drummanmore Road during construction. This will need to be looked at during the detailed design stage.

Subway under existing Railway embankment

Near the Ballynahone river culvert there is an old brick arch subway under the railway (see plate 3.14). The ownership and status of this arch is unconfirmed, however if the access it provides was to be maintained it would likely need to be replaced.

Plate 3.14 - Brick arch subway under railway embankment, near Ballynahone River

Culvert crossing Ballynahone River (Existing)

The route crosses the Ballynahone River (near the commencement of the old railway embankment). The existing culvert at this location (see plate 3.15) would require a structural inspection and assessment, with a view to retaining it.

Plate 3.15 - Existing culvert at Ballynahone River

Cathedral Road (Listed Railway bridge)

The arch bridge conveying cathedral road over the disused railway cutting (see plate 3.16) lies in the path of Route Corridor 1. The existing span of the bridge is 4.82m, which is somewhat less than the width proposed for the new route (14.3m wide). The bridge is a listed structure, however if this route corridor is chosen, it is likely that the bridge will have to be demolished.

Plate 3.16 - Listed Masonry arch bridge conveying Cathedral road over disused railway cutting

Callan River Bridge on Killylea Road (Bridge Widening)

At present it is a 9.25m span masonry arch bridge (see plate 3.17) with a deck width of 10.97m, incorporating a narrow footway on either side of the carriageway. The new route would

necessitate the widening of this bridge out to 14.3m. It is proposed that such widening would be achieved by cantilevering of either side of the existing bridge. Plate 3.18 shows a similar structure located at Cushendun. Such works are not likely to cause any adverse affects to the structure as it was reported to be in good condition when last inspected in Aug 2006 and passes assessment under full HA and 45units of HB loading.

Plate 3.17 - Bridge conveying Killylea Road over River Callan

Plate 3.18 - Arch bridge at Cushendun, widened using a cantilevered structure, similar to what is proposed for the Callan River Bridge on the Killylea Road

Cattle Creeps

Guidance on the provision of cattle creeps is given in Roads Service Policy and Procedure Guide: RSPPG_S028. This guide lists criteria such as:

Daily movement of stock;

Herd Size;

Proportion of land either side of carriageway; and

Number of lanes on new carriageway.

Such criteria have yet to be confirmed and as such the number of cattle creeps is unknown at this stage. When more details of the above are available, the overall dimensions of such an underpass can be confirmed.

3.3.5 Drainage Aspects

Proposed Drainage System

It is envisaged that for Route Corridor 1 a traditional closed linear storm drainage system, incorporating gulley pots, drainage pipes and manholes would be used (Figure 3.4), and that the existing drainage system on Station Road, Friary Road and Killylea Road could be utilised within this Route Corridor. This type of drainage system is quite common particularly in urban areas and embankment conditions. In areas where there is little or no longitudinal gradient, such as roundabouts, combined kerb and drainage units would be installed. (Figure 3.5)

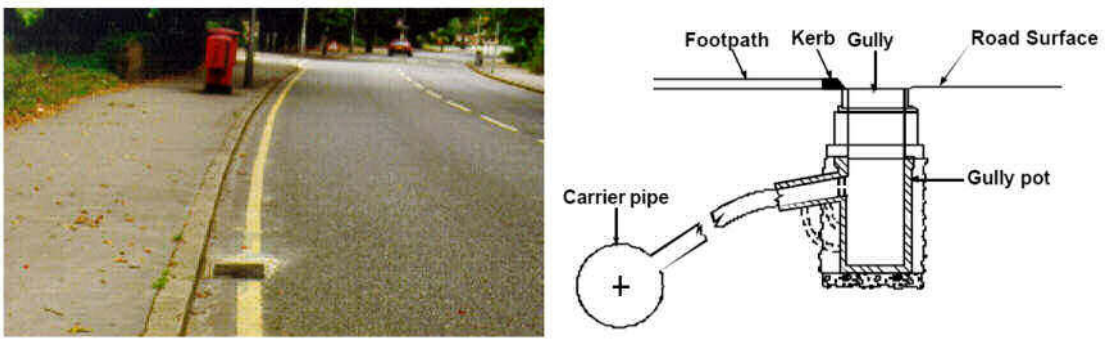

Fig 3.4 - Typical kerb and gully drain layout

Figure 3.5 - Typical combined kerb and drainage unit

Culverts

Within this Route Corridor there is one existing culvert at Lisanally Lane (See Ballynahone River Culvert on drawing No. 400370-SK-038, in Appendix B) and three proposed culverts. These are situated 480m west of the Drummanmore Road/Drummanhill junction, 180m southeast of the Killylea Road/Ballycrummy Road junction and 340m north of the Monaghan Road, near O'Neill's mound. The route of the existing watercourses (Plate 3.19) may be affected by the works, but would be maintained by way of suitably sized culverts under the proposed corridor.

Plate 3.19 - Minor watercourse located west of Drummanmore Road

The watercourses which require culverts are included in existing floodplains within the study area. The construction of embankments and culverts across floodplains may cause obstructions to watercourse flows (afflux) which would change the shape of the existing floodplain and possibly affect adjacent properties. Detailed design at a future stage would examine these effects and accommodate watercourses and floodplains into the proposed option.

Embankments

There are several major embankments along this Route Corridor. One is located between the Portadown Road and Drummanmore Road and two others are located between Drummanmore Road and Mullinure Lane. Careful consideration should be given to the type of drainage below the embankment footprint, as construction can prove problematic due to difficulties with the

dissipation of porewater pressure below the embankments. Steps to mitigate against this could include staged construction of the embankment, surcharging and/or the installation of vertical band drains.

Cuttings

There are also several cuttings included in the preliminary corridors. There are two major cuttings, one immediately west of Drummanmore Road, and the other just east of Lisanally Lane. Details of ground conditions and possible drainage provision for high groundwater levels have been mentioned in section 3.3.3. Adequate slope face drainage provision would be required in the form of slip drains or relief drains.

Sustainable Urban Drainage Systems (SUDS)

It is anticipated that SUDS will be utilised within this Route Corridor, the type of which depends on space constraints. In the rural sections of the Route Corridor, i.e. between Portadown Road and Lisanally Lane and between Killylea Road and Monaghan Road, it is more feasible to use SUDS such as retention ponds and infiltration basins (Figure 3.6). In urban areas, i.e. between Lisanally Lane and Killylea Road, devices such as soakaways (Figure 3.7) would be more practicable. Within the linear closed drainage system sealed drains would convey the storm water run-off under the proposed roadside verges to a series of retention ponds. Within the rural areas, to the northeast and southwest of the study area, a number of suitably placed retentions ponds could be located to store, treat and attenuate the run-off before this is outfalled to receiving waters. Ideally, any retention ponds should be located outside existing floodplains. It is planned that these types of ponds, when matured, would contribute to the landscape and nature conservation of the surrounding area.

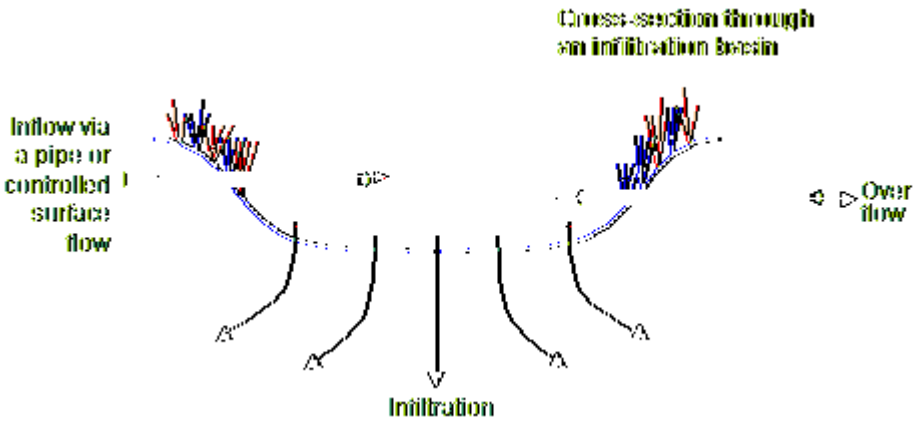

Fig 3.6 - Diagram of an infiltration basin

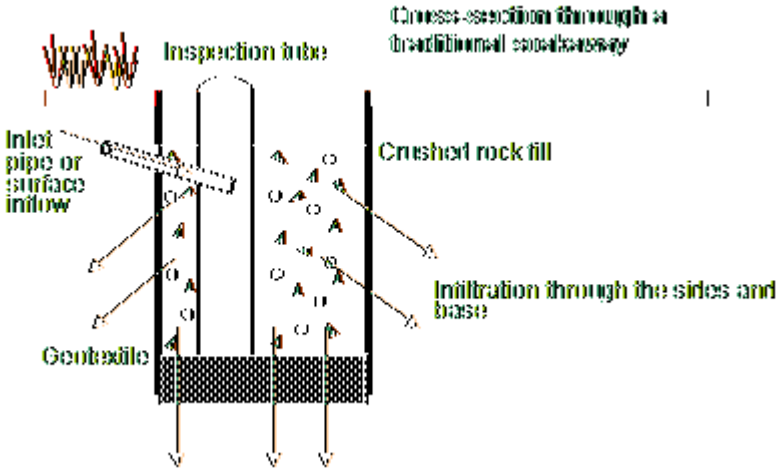

Figure 3.7 - Diagram of a traditional soakaway

Existing Drainage

Two sections of Route Corridor 1 will replace existing roads, namely Station Road and Friary Road/Killylea Road. At Station Road there is an existing 225mm gravity foul sewer. At Friary Road/Killylea Road there are existing 300mm pump and gravity foul sewers. Depending upon the outcome of detailed drainage design, these existing sewer pipes may be utilised or may need to be replaced.

3.3.6 **Public Utilities**

By examining the services drawings (Drawing Nos. 400370-SK-109-01, 400370-SK-109-02, and 400370-SK-109-03), it has been noted that there are numerous occasions where the location of existing service utilities will affect the proposed route corridor.

The urban nature of this corridor suggests that there will be a greater density of public utilities/services affected than for the other more rural corridors. Service diversions have the potential to affect large numbers of people, not necessarily within close proximity to the site works.

Between Portadown Road and Station Road there are several incidences of 11kV overhead NIE cables crossing the route corridor and three occasions where BT lines pass through the route corridor. Moving of these may be needed depending on the final alignment, however it is not envisaged that these will cause any undue concern.

There are also three watermains located within the route corridor. The small diameter mains that run along Drummanmore Road and Station Road can be accommodated by good construction management. There is a 9” main that runs along Mullinure Lane. This has the potential to affect a number of houses should it be damaged. Liaison with Water Service should ensure that adequate mitigation measures are put in place.

From Station Road to Killylea Road the route corridor passes through an urban environment containing both industrial and residential areas. This inevitably means that there is a greater density of services within this area.

As would be expected in urban areas there is a greater occurrence of streetlights in this area. These do not pose as significant a problem as similar densities of other services. Street Lighting will be provided along the new urban sections of link road. Liaison with Roads Service Divisional Street Lighting Department will ensure that adequate provisions are made to ensure that moving or decommissioning of street lighting plant is carried out with least disruption.

A High Risk 33kV overhead cable runs alongside the disused railway line between Portadown Road and Station Road. Upon reaching the Armagh North Substation the cable is ducted along Station Road and onwards to the City Centre.

There is an Eircom cable that runs out from the City centre along the Moy Road. These and British Telecom cables do not present any major concern as construction methods can easily accommodate these.

There is a large diameter sewer running along the section of the corridor from Cathedral Road to Friar Road. This runs through an area that has been highlighted as being of made ground. This could potentially have an effect on the construction costs but this will be understood more at the detailed design stage.

Between Killylea Road and Monaghan Road there are no major causes for concern with regards to utilities.

3.3.7 **Traffic**

The outputs from the model indicate that route corridor 1 is predicted to encourage approximately 26% of the total city centre trips away from the city centre and onto the new link road in the year of opening 2009, with a slight reduction in the design year 2024 (approximately 23%).

Examination of the key junctions summary statistics also indicate that all of the key junctions in the city will experience an increase in capacity when compared with the Do Minimum scenario. With the construction of route corridor 1 the average junction saturation in the city centre is reduced by 17%.

Noticeable improvements are achieved at some junctions, in particular at Portadown Road/Mullinure Lane where junction saturation is reduced from 96% to 71% and at Railway Street/Lonsdale Road where junction saturation is reduced from 99% to 40%. Only two junctions (Loughgall Road/Station Road and Irish Street/Navan Street) exhibit increases in junction saturation, however both these junctions remain below the effective operational threshold of 85%.

In addition, each of the various links of the new link road are shown to be well within the ‘Practical Link Capacity’ in the future year 2024. Model output summary tables are included in Appendix D.

3.3.8 Summary

Route Corridor 1 is based on the alignment as published in the Armagh Area Plan 2004, and is the second longest at approximately 6.0km.

Geometric Summary

This corridor runs through the greatest amount of urban area. There are a large number of constraints involving access/egress for both vehicles and pedestrians alike. Station Road is the main area to be affected due to space constraints in physically fitting a carriageway along it. There are also access issues with Desart Lane and Convent Road. The alignment of the corridor along the disused railway line south of Cathedral Road will affect pedestrian movements to and from the city centre, particularly of school children.

From a geometric alignment perspective, Route Corridor 1 performs well against Topographical Constraints. This is largely due to the fact that significant portions of this corridor either follow the disused railway line or utilise sections of the existing road network. Subsequently, this corridor performs badly against the criteria of Physical Constraints and Departures & Relaxations for the same reasons. The existing built environment is significantly affected by this corridor, particularly in the Station Road, Convent Road, and Druids Villas areas and a total of up to 12 properties will potentially be directly affected over the length of the corridor. There is the potential that 34 accesses may be affected. Furthermore, utilising the existing carriageway at Friary Road/Killylea Road is likely to dictate the need for Departures & Relaxations as the existing horizontal alignment is sub-standard in some areas.

Geotechnical Summary

This corridor has the potential to come into contact with five contaminated sites. EHS have classified two of these as High Risk with the other three being classified as Medium Risk.

Due to this corridor utilising the largest amount of existing roads infrastructure, the amount of earthworks required is the least amongst the four corridors. The section between the Friary Road and Cathedral Road is made ground of unknown origin. This could potentially be contaminated, although to what degree will only be known after a detailed geotechnical investigation. This is due to the site previously being used as a gasworks. Made ground was also discovered along the southern section of Station Road. This is generally found to a depth of 0.5m.

Based on preliminary examination this corridor potentially has the best earthworks balance.

Structural Summary

This corridor, as with all four, will require two large structures. The first, common to all four corridors, is the underpass at Drummanmore Road. There may be the potential to raise the existing road slightly to reduce the cut required to allow the link road passage beneath it.

The second significant structure will be at the point where the link road intersects the Cathedral Road. The disused railway line runs beneath this section of the Cathedral Road. The existing masonry arch bridge is currently listed. It may prove necessary to remove this structure in order to achieve the desirable span required to allow the link road passage beneath Cathedral Road.

Culverts are common across all four corridors. The largest one is currently at Ballynahone River (at the northern end of Station Road). A structural assessment would be required to assess its suitability with regard to retaining it.

Any requirements for pedestrian crossings by way of subways or footbridges will bring with them additional associated costs. The magnitude of such works will only be realised at the detailed design stage.

Drainage Summary

This corridor has the potential to utilise a large proportion of the existing infrastructure as it is the most urban of corridors. The utilisation of existing infrastructure will have to be modelled to ensure there is sufficient capacity. There is the opportunity to aesthetically enhance urban areas by the construction of soakaways.

The rural section of the corridor to the north will require construction in an area of floodplain but this adversity is common to all the other corridors, in one way or another. Construction on embankment in this area will have obvious drainage implications.

The design of embankments and cuttings will be carried out in close liaison with drainage experts to ensure that appropriate measures are taken to engineer out potential problems.

Traffic Summary

This corridor provides the most significant improvement in performance at city centre junctions, hence delivering the greatest reduction in congestion. Outputs from a preliminary traffic model predict that 26% of the total city centre trips will be encouraged to use this new route in 2009 with this reducing to 23% in 2024. This reduction is due to the corridor being the second longest and also it having a lower speed limit. There is also an extra junction needed along this corridor when compared with the other three corridors.

Summary of Effects of Public Utilities

The large sewer running along the disused railway line between Moy Road and Friary Road may have to be moved to accommodate the preferred alignment of the new link road. The High Risk NIE cable is common to Corridors 1, 2, and 4. Early NIE involvement will ensure that any works can be successfully programmed into the construction phase. NIE involvement will also a more robust cost for any diversionary work.

The Engineering Assessment Tables (EAT) in Appendix A show the scoring of the above sub-objectives in tabular form. This is further summarised in Section 10.0.

3.4 Route Corridor 2

3.4.1 Description of Route

The alignment details of Route Corridor 2 are shown on drawing 400370-SK-030-02 in Appendix B.

Route Corridor 2 leaves the A3 Portadown Rd on the Northeast edge of Armagh City and continues west across or possibly under Drummanmore Road, passing the northern side of Drummanhill cul-de-sac and crossing a small watercourse north of Drumman Heights before progressing towards Mullinure Lane. Along this stretch it passes through largely agricultural land.

At Mullinure Lane it converges with the disused Newry-Armagh railway line and follows this line to Station Road after traversing the Ballynahone River at Lisanally Lane. From here it continues along Station Road and adjacent to commercial/industrial properties before crossing both Railway Street and the A29 Moy Road.

After the A29 Moy Road it continues to the Western Side of residential properties at Daires Willows and Cathedral Mews before traversing the B115 Cathedral Road at the Convent Road/Desart Lane Junction. At this junction it continues through the new residential development of Glen Mhacha.

From here it progresses in a south westerly direction towards Callanbridge Road and across Callan River before approaching Navan Fort Road. After Navan Fort Road it travels south between Mullacreevie Park and Ballycrummy Road, crossing the A28 Killylea Road at a point approximately 180m east of the Ballycrummy Road/Killylea Road junction. From this point it travels south through agricultural land between the A28 Killylea Road and the A3 Monaghan Road. Along this stretch it crosses a small watercourse adjacent to Killylea Road and another at O'Neill's Mound before eventually tying in with the A3 Monaghan Road at a point approximately 150m east of Milford village.

The total approximate length of Route Corridor 2 is 5.4km.

3.4.2 Geometric Alignment

Design Speed

The Design Manual for Roads and Bridges (DMRB) Volume 6 – Section 1 – Highway Link Design (TD 9/93) outlines the basic principles to be used when determining the design speed and geometric alignment of single and dual carriageway roads in both urban and rural areas.

As Route Corridor 2 is located within both urban and rural environs it is subject to varying degrees of alignment and layout constraints. Having assessed these constraints which include the surrounding topography, frequency of proposed junctions and accesses it is envisaged that Route Corridor 2 will have varying design speeds along its length. As with Route Corridor 1 these are likely to be 60mph (100A) along the rural sections and 40mph (70A) or 30mph (60B) along the urban sections of the corridor.

Design Limitations

The table below details the relevant limitations of Stopping Sight Distance, Horizontal Curvature, Vertical Curvature, Overtaking Sight Distance, and Gradients for design speeds of 100A, 70A, and 60B.

Design Speed	100A	70A	60B
Stopping Sight Distance (m)			
Desirable Minimum	215	120	90
One Step below Desirable Minimum	160	90	70
Horizontal Curvature (m)			
Minimum Radius without elimination of Adverse Camber and Transitions	2040	1020	720
Minimum Radius with Superelevation of 2.5%	1440	720	510
Minimum Radius with Superelevation of 3.5%	1020	510	360
Desirable Minimum Radius with Superelevation of 5%	720	360	255
Vertical Curvature			
Desirable Minimum Crest K Value	100	30	17
One Step Below Desirable Minimum Crest K Value	55	17	10
Absolute Minimum Sag K Value	26	20	13
Overtaking Sight Distances			
Full Overtaking Sight Distance FOSD (m)	580	410	345
FOSD Overtaking K Value	400	200	142
Desirable Max Gradient			
All Purpose Single Carriageways	6%	6%	6%

Table 3.9 - Design Parameters

Topographical Constraints

As with all the Route Corridors, sections of Route Corridor 2 lie along areas of undulating landform. Therefore, in order to construct a carriageway with acceptable standards of horizontal and vertical curvature as described in the above table, cuttings and embankments will be required. These areas are largely confined to the northern section of the corridor between Lisanally Lane and Portadown Road and the southwest section in the vicinity of O'Neill's Mound. The northern section follows a portion of the disused railway line from Station Road to Mullinure Lane, where the existing railway cuttings and ballast could potentially be utilised.

It is envisaged that a significant cutting will be required to the north of Drumman Heights in order to provide an acceptable vertical alignment and carriageway gradient on the approach to Portadown Road.

A portion of Route Corridor 2 follows Station Road where a relatively uniform terrain is encountered however, construction of a carriageway with an acceptable horizontal alignment may dictate the need for structural support or slope stabilisation to the existing cuttings, (See Plate 3.20). The potential alignment will likely require the closure of a secondary access to Alexander Park.

Plate 3.20 - View along Station Road

The section of Route Corridor 2 between Loughgall Road and Cathedral Road follows a path through a largely urban area of relatively smooth terrain (See Plates 3.20 and 3.21).

Plate 3.21 - View from Cathedral Road at Desart Lane

Plate 3.22 - McKinney's Timber Yard (adjacent to Moy Road/Loughgall Road)

In contrast to this, the section that skirts the northern edge of Mullacreevie Park encounters a large localised hill upon which Mullacreevie Park has been constructed.

Watercourses, including the Ballynahone and Callan Rivers, as well as a number of smaller tributaries, are traversed by this route corridor as avoidance of these is virtually impossible. Legislation relating to construction works in the vicinity of watercourses could prove to be a further constraint. Section 3.4.5 of this report gives account of drainage factors influencing Route Corridor 2.

Physical Constraints

The geometric alignment of Route Corridor 2 is influenced by numerous physical constraints. Existing public utilities, as detailed on drawings 400370-SK-109-01, 400370-SK-109-02, and 400370-SK-109-03, are considered fully in section 3.4.6 of this report.

The requirement to link with the existing highway infrastructure has a strong influence on the geometric characteristics of Route Corridor 2. In particular, the entry gradients to the existing highway network should be a maximum of 6% as detailed in TD 9/93.

This is of greater importance where Route Corridor 2 traverses Portadown Road, Navan Fort Road, and Killylea Road, as the adjacent landform at each of these locations lies above the existing carriageway levels.
In addition, difficulties might arise where Route Corridor 2 crosses both Drummanmore Road and Callanbridge Road. The preferred junction types at both these crossings, which have yet to be fully determined, may injuriously impact the surrounding properties. In particular, the residential dwellings at Callanbridge Road/Ard Ri Park and Drummanmore Road could be affected.
A further constraint caused by the need to link with the existing highway network is the maintenance of traffic movements throughout the construction phase. Areas where this is of particular importance include Mullinure Lane, Station Road, Cathedral Road, and Desart Lane Lower.

The proposed Junction Strategy for Route Corridor 2 can be found in section 3.1.3 of this report.

The condition of the existing road network must be considered when assessing the geometric characteristics of each route corridor. Road classification, structural integrity, surface condition, drainage, and maintenance of the existing carriageways are of key importance to the proposed corridors. As the above information is not readily available for all classifications of road, further investigation is required.

Proposed developments and local planning issues are further constraining factors which have a bearing on the geometric alignment and associated junctions. Details of these can be found in section 4.14 - Land Use.

The constraint of the existing built environment is largely concentrated on the western section of this route corridor. Station Road, with its commercial and industrial properties, incorporates a carriageway width ranging from 5.9m to 8.1m. Pedestrian footpaths are currently present on one verge for most of its length, while a short stretch has these on both verges. Due to the high concentration of properties fronting on to Station Road, which includes a tile showroom, a tyre centre, an electrical supplies store, and a diner, the provision of access roads must be considered. These would accommodate continued service to the necessary properties, while reducing the number of direct accesses onto the new link road. One possible location for a service road would be to the northwest of Station Road, adjacent to Gillis House. An approximate total of 12-16 properties in the Station Road, Alexander Park, and Alexander Avenue areas could be affected.

To the south of Station Road and spanning from Moy Road to Loughgall Road/Railway Street is a Timber Merchants. As Route Corridor 2 passes through this area it is very likely that the Timber Merchants storage yard and shed will be affected (see plate 3.22).

The section of Route Corridor 2 between Killylea Road and Loughgall Road is constrained by the residential properties at Willowbank on Desart Lane Lower and those around the Cathedral Road/Convent Road junction, namely the recently constructed Glen Mhacha, where at least 12 properties would be injuriously affected. College Farm Nursery School, along with one other property at Willowbank, are likely to be injuriously affected if this route corridor was chosen.
The residential properties on Callanbridge Road, along with those at Ard Ri Park, Ard Ri Gardens, and Mullacreevie Park influence the geometric characteristics of this route corridor.
In addition, agricultural buildings and a standing stone adjacent to Ballycrummy Road constrain this corridor.

The playing fields between Willowbank and Moy Road are also directly traversed by this route corridor.

Another constraint is the disused railway line, on which elements of the northern section of this route corridor lie. The geometric attributes of this railway line constrains both the horizontal and vertical alignment of the proposed carriageway.

Departures and Relaxations

Due to the various constraints encountered by this Route Corridor it is likely that relaxations and possible departures from standards will be required for the geometric alignment.

Particular areas where departures and relaxations might be applied to the alignment of Route Corridor 2 include Station Road, where the existing horizontal alignment would be substandard if it were transferred to the new road, the rural northern section, where the undulating landform poses a potential problem to the vertical alignment, and the section to the north of Mullacreevie Park.

3.4.3 Geotechnical Elements

Topography

This route corridor will commence at a new junction on the existing A3 Portadown Road and will extend offline in a westerly direction towards Drummanmore Road predominantly on embankment at a maximum height of around 10.0m bypassing the disused railway line located to the immediate south.

As the route continues west through agricultural land extending beyond Drummanmore Road bypassing Drummanhill cul-de-sac it will likely need to enter into a cut for approximately 350m, cutting through a large drumlin feature (low amplitude hills of glacial origin) at a maximum depth of approximately 10m.

Where the corridor converges with the disused railway line at Mullinure Lane the abutments of an old railway bridge are evident. At this location the old railway line is raised on embankment but as it extends to the west it enters into a cutting for approximately 250m. The indentations of the old railway sleepers, which have now been removed, can still be seen in the old ballast. It is thought that the line was decommissioned in 1958.

It is considered unlikely that any potential route would be constructed upon the existing railway line to the east of Mullinure Lane as it is constructed on quite high narrow embankments with steep side slopes.

For the next 1.5km the corridor will follow or lie relatively close to the disused railway line extending in a westerly and then south-westerly direction towards Station Road and traversing the Ballynahone River at Lisanally Lane.

At Station Road and for the next 2.0km the route generally passes through urban land, predominantly at grade level, which is a mixed use of residential and commercial properties.

As the route extends beyond Station Road it intersects Railway Street / B77 Loughgall Road and the A29 Moy Road.

From the intersection with Moy Road the corridor continues in a southwesterly direction intersecting a newly constructed housing development before crossing the Callan River and Callanbridge Road where the corridor cuts deeply into a large drumlin for approximately 500m up to a maximum depth of approximately 25m below existing ground level, between two residential housing estates (see Plate 3.23). It is possible that the side slope on the southern side of the cutting will impact upon the existing road entering Mullacreevie Park depending on the exact location of the final alignment within the route corridor. Detailed slope stability analysis will be required at this location to assess the impact of the cutting on the residential properties located at the top of each side slope.

Plate 3.23 - View from top of drumlin towards Callanbridge Road looking northeast.

At the base of this large drumlin the route continues in a southerly direction intersecting Navan Fort Road. It travels between Ballycrummy Road and Mullacreevie Park crossing a minor watercourse before intersecting the A28 Killylea Road at a point approximately 200m east of the Ballycrummy Road / Killylea Road junction.

At this location the corridor continues offline in a southerly direction linking the A28 Killylea Road and the A3 Monaghan Road. As the corridor progresses through agricultural land it cuts through the eastern flank of a drumlin feature, it then crosses a floodplain of several small watercourses, which are tributaries of the Callan River, before meeting the existing A3 Monaghan Road.

Solid Geology

This corridor commences along the A3 Portadown Road and proceeds in a westerly direction for an approximate distance of 1.9km across an area of bedrock known locally as the Armagh Group of which there are two types of sediments both carboniferous in age (Visean: Chadian – Brigantian). The first type is known as the 'ARMA' Formation and is described as fossiliferous, pale to dark grey, bedded marine limestone's and thin shales, pale yellow to grey grainstones, with calcareous grits, sandstones and siltstones. Stratigraphically below and geographically to the west is the Drumman More Sandstone Formation which is described as virtually unfossiliferous, pale grey, non-calcareous, micaceous, fine to medium sandstone with carbonised plant fragments with thin black mudstones, and thin coal beds which contain abundant miospores. These formations are bounded by a number of SE-NW trending faults.

Just east of where the disused Armagh to Portadown railway line crosses the Ballynahone River the route enters the Callan Group of rocks which includes three formations of Permian Age, namely the Dobbin Sandstone Formation, the Mall Member and the Drumarg Conglomerate

Formation, continuing across it in westerly and then south-westerly direction for approximately 2km, crossing a number of SE-NW trending faults, two of which are lie in a southerly direction and one to the north and one to the west.

The Dobbin Formation is described as soft, red, fine grained, micaceous sandstone. The Mall member is described as soft, grey, sandy, limey rock, probably equivalent to magnesian limestone and the Drumarg Formation is described as purple-red, bedded, conglomerates and coarse-grained sandstones.

One borehole previously excavated close to where the corridor crosses the Ballynahone River encountered slightly weathered fragments of yellow sandstone at a depth of 10.2 below existing ground level. It is thought that this material is sediments from the ARMA Formation. Extracts from the ground investigations, and a map showing locations of boreholes (drawing 400370-SK-113) can be found in Appendix B.

One borehole and one trial pit excavated in close proximity to Station Road revealed bedrock at depths of between 6.1 and 6.8m below ground level. This material was described as weak red brown sandstone. It is assumed that this bedrock is part of the Dobbin Sandstone Formation.

Where the route joins the A28 Friary Road it crosses a narrow strip of the Mall Member before re-entering the Dobbin Sandstone Formation and the Drumarg Conglomerate Formation. From this location the corridor turns and proceeds in a westerly and then southerly direction for approximately 1.5km where it re-enters the 'ARMA' Formation crossing a number of north / south trending faults.

One historical borehole log revealed very firm sandstone at a depth of 35m below ground level at Culdee Drive south of Windmill Hill. It is assumed that this bedrock is part of the Dobbin Sandstone Formation.

Approximately 100m south of where Cathedral Road crosses the Callan River the route crosses a narrow strip of the Mall Member before re-entering the Dobbin Sandstone Formation.

The route continues southwest for approximately 200m through the Dobbin Sandstone Formation before crossing several north / south trending faults and entering the ARMA Formation at a point where the Callan River passes close to Callan Bridge Road.

The corridor continues south across the ARMA Formation for approximately 2.0km at a point where it meets the existing A3 Monaghan Road.

A plan showing the location of this proposed route corridor is shown on drawing 400370-SK-112 in Appendix B.

Geomorphology

This corridor commences along the A3 Portadown Road and proceeds offline in a westerly then south-westerly direction for an approximate distance of 3.6km through glacial till deposits.

It crosses a narrow tract of alluvium alongside the Callan River close to Callan Bridge Road, before crossing glacial till deposits for a further distance of approximately 0.8km.

From a point just east of the Ballycrummy Road / Killylea Road junction the route crosses further alluvial deposits for an approximate distance of 1km continuing south towards the

existing A3 Monaghan Road, generally crossing the alluvial deposits located alongside the course of the Callan River, its tributaries and other minor watercourses.
A plan showing the location of this proposed route corridor is shown on drawing 400370-SK-110 in Appendix B.

Man-made Features

Three potentially contaminated sites as indicated on drawing 400370-SK-111 in Appendix B, directly impact upon this route corridor. Two of these sites relate to the old disused railway lines, which have been designated as a medium risk level, and one at the area on Station Road where the old railway depot was previous located. This site has been designated a high-risk level in terms of potential contamination.

Preliminary Engineering Assessment

Similarly with Route Corridor 1, the reviewed geological information indicates that a number of different units with differing geotechnical properties will be crossed by this corridor.

Made ground was found to be present in depths up to 1.0m below existing ground level (at Navan Street) in various exploratory holes located within this route corridor. This material appears to be “inert” demolition rubble mixed with varying compositions of clay fill. The geotechnical properties of made ground are variable and unpredictable and this type of material is generally located within brownfield sites / urban areas.

At this stage the nature of this material is unknown both geotechnically and chemically but would generally be unsuitable for re-use. As the grading and density of the materials used for this backfilling is not known the potential for total excessive settlements, gas generation, or ground and groundwater contamination cannot be adequately assessed at this stage.

Soft alluvial soils, typically normally consolidated or lightly consolidated clays with varying proportions of organic material, silts and sands, will be encountered in areas around the floodplain of the Callan and Ballynahone Rivers and other smaller watercourses possibly up to 5m in thickness. This material is relatively recent in origin and it can be marked by low shear strength and high compressibility. It can also consist of high organics content and can have poor drainage properties. This material can be sensitive to disturbance and prove difficult to build upon and consequently may prove to be unacceptable in places. This material is often found with or mixed with layers of peat. Careful consideration will need to be given in areas where large embankments are proposed in areas containing such material.

The reviewed exploratory hole records also revealed glacial till (boulder clay) generally consisting of gravely clayey silts, the consistencies of which ranged from soft to very stiff with the softer material generally being encountered at shallow depths. This material is the most prominent throughout the route corridor and will generally be found in all areas as indicated by the geological maps for the area.

Close to the surface these gravely clayey silts were found to be in a state of ongoing weathering and would generally be marked by high moisture contents, hence poor strength properties. As these layers increase with depth the undrained shear strength will improve thus indicating the increasing acceptability of the soil as an engineering material. Construction works in the upper regions of this material designated soft could result in settlement problems and therefore should

be avoided unless the movement can be built into any design. Typically these materials would benefit from good undrained shear strengths, low compressibility and good bearing pressures.

Bedrock was not encountered in any of the exploratory holes reviewed for this route corridor and the geological drift map does not show any shallow bedrock outcrops within close proximity. Historical borehole and trial pit information can be found in Appendix B

It is expected that groundwater will be high in areas within the floodplain of the Ballynahone and Callan Rivers. Interceptor drainage will be required at the pre-earthworks stage to pick up and divert existing natural drainage channels. Consideration will need to be given to groundwater control and close support or battering back any excavations passing below groundwater levels particularly within granular deposits.

Cuttings

There are a number of cuttings along this corridor, the most significant being at Drummanmore Road and south of the A28 Killylea Road, and to date there is no available site investigation information as to the exact nature of this material at these locations but it is expected that it will consist of glacial till and possibly bedrock.

Adequate drainage provision will be required to improve conditions and to draw down water levels where the water table is found to be high. Hydrological and hydrogeological studies may need to be undertaken in areas of proposed cuttings to assess the requirements for natural drainage.

Detailed slope stability analysis will need to be carried out in areas of cutting to assess potential stability of side slopes. During the main ground investigation the material to be excavated from areas of cut will need be assessed for reusability purposes.

Embankments

Sections of this corridor could potentially be constructed on embankments with an approximate height of 18 metres (north of Drumman Heights), primarily to provide a satisfactory vertical alignment and to raise the carriageway above low points such as rivers and areas of river floodplain, and it is these areas that will consist of soft alluvial deposits, which will prove difficult to construct upon.

With such high embankments proposed over these types of ground conditions, geotechnical, economic and programme constraints may not permit straightforward construction techniques to be employed. Measures may be required to modify the construction sequence, the form of embankment and the properties of the underlying ground, individually or in a combination. Techniques such as advance earthworks, special fills, staged construction, reinforcement, ground improvement and or reduced side slopes should be considered when evaluating methods of embankment construction.

The soil conditions at the proposed embankment locations over alluvial deposits will need to be assessed in detail during the ground investigation and detailed design process.

3.4.4 **Structural Elements**

Any route within corridor 2 will involve the construction of two significant structures (a bridge over the Callan River and an underpass at Drummanmore Road), 3 box culverts and up to two

cattle creeps. The box culverts and underpass at Drummanmore Road have been discussed in section 3.3.4 above. The existing culvert over the Ballynahone River and the Pedestrian underpass beside it are also discussed in Section 3.3.4.

Bridge over Callan River (Near Callan Bridge Road)

Route Corridor 2 crosses the Callan River (see plate 3.24 and 3.26) immediately after crossing the Callan Bridge Road. The size of opening that is required for river flow at this point has been confirmed by Rivers Agency as 30m at right angles to the channel and 4.8m from soffit level to bed level. Preliminary calculations show that the road could be in the order of 40m above the river. In this situation the Callan Bridge Road would have to pass under the new road, this would best be achieved by extending the river bridge to cross both the Callan Bridge road and the Callan River. A multi span weathering steel bridge would be an economical solution for this situation. Plate 3.25 shows what a weathering steel bridge would like.

Plate 3.24 - Typical example of width of Callan River

Plate 3.25 - Weathering steel bridge on Newtownstewart Bypass

Plate 3.26 - Callan Bridge Road, at point of intersection with route corridor 2

3.4.5 Drainage Aspects

Proposed Drainage System

It is envisaged that for Route Corridor 2 a traditional closed linear storm drainage system, incorporating gulley pots, drainage pipes and manholes would be used (Figure 3.4) and that the existing drainage system on Station Road could be utilised within this Route Corridor. This type of drainage system is quite common particularly in urban areas and embankment conditions. In areas where there is little or no longitudinal gradient, such as roundabouts, combined kerb and drainage units would be installed (Figure 3.5).

Culverts

Within this Route Corridor there is one existing culvert at Lisanally Lane (See Ballynahone River Culvert on drawing No. 400370-SK-038, in Appendix B) and three proposed culverts. These are situated 480m west of the Drummanmore Road/Drummanhill junction, 180m southeast of the Killylea Road/Ballycrummy Road junction and 340m north of the Monaghan Road, near O'Neill's mound. The route of the existing watercourses (Plate 3.19) may be affected by the works, but would be maintained by way of suitably sized culverts under the proposed corridor.

The watercourses which require culverts are included in existing floodplains within the study area. The construction of embankments and culverts across floodplains may cause afflux which would change the shape of the existing floodplain and possibly affect adjacent properties. Detailed design at a future stage would examine these effects and accommodate watercourses and floodplains into the proposed option.

Embankments

As with Route Corridor 1, there are several major embankments in this Route Corridor. One is located between the Portadown Road and Drummanmore Road and two others are located between Drummanmore Road and Mullinure Lane. Careful consideration should be given to the type of drainage below the embankment footprint, as construction can prove problematic due to difficulties with the dissipation of porewater pressure below the embankments. Steps to mitigate against this could include staged construction of the embankment, surcharging and/or the installation of vertical band drains.

Also, between Convent Road and Callanbridge Road the proposed Route Corridor passes through an area of floodplain with 100 year flood levels of 36.36m AOD. It is anticipated that this section of road would run on an embankment. As has previously been mentioned, the Rivers Agency has advised that all development take place above 100 year flood levels and that mitigating steps should be taken to avoid changes to the floodplain or increase the risk of flooding.

Cuttings

There are several cuttings included in the preliminary alignments. There are two major cuttings, one immediately west of Drummanmore Road, and the other just east of Lisanally Lane; although the largest cutting, which is in the region of 20m deep, occurs through a large hill between Callanbridge Road and Ballycrummy Road (Plate 3.27). Details of ground conditions and possible drainage provision for high groundwater levels have been mentioned in section 3.4.3. Adequate slope face drainage provision would be required in the form of slip drains or relief drains.

Plate 3.27 - View of Ballycrummy Road area from adjacent hilltop

Sustainable Urban Drainage Systems (SUDS)

As with Route Corridor 1, it is anticipated that SUDS will be utilised within this Route Corridor, the type of which depends on space constraints. In the rural sections of the Route Corridor, i.e. between Portadown Road and Lisanally Lane and between Navanfort Road and Monaghan Road, it is more feasible to use SUDS such as retention ponds and infiltration basins (Figure 3.6). In urban areas, i.e. between Lisanally Lane and Navanfort Road, devices such as soakaways (Figure 3.7) would be more practicable. Within the linear closed drainage system sealed drains would convey the storm water run-off under the proposed roadside verges to a series of retention ponds. Within the rural areas, to the northeast and southwest of the study area, a number of suitably placed retentions ponds could be located to store, treat and attenuate the run-off before this is outfalled to receiving waters. Ideally, any retention ponds should be located outside existing floodplains. It is planned that these types of ponds, when matured, would contribute to the landscape and nature conservation of the surrounding area.

Existing Drainage

One section of Route Corridor 2 will replace an existing road, namely Station Road. At Station Road there is an existing 225mm gravity foul sewer. Depending upon the outcome of detailed drainage design, these existing sewer pipes may be utilised or may need to be replaced.

3.4.6 **Public Utilities**

By examining the services drawings (Drawing Nos. 400370-SK-109-01, 400370-SK-109-02, and 400370-SK-109-03), it has been noted that there are numerous occasions where the location of existing service utilities will affect the proposed route corridor.

There is an urban nature to this corridor suggesting that there will be a greater density of public utilities/services affected than for the other more rural corridors. Service diversions have the

potential to affect large numbers of people, not necessarily within close proximity to the site works.

Between Portadown Road and Station Road there are several incidences of 11kV overhead NIE cables crossing the route corridor and three occasions where BT lines pass through the route corridor. Moving of these may be needed depending on the final alignment, however it is not envisaged that these will cause any undue concern.

There are also three watermains located within this section of the route corridor. The small diameter mains that run along Drummanmore Road and Station Road can be accommodated by good construction management. There is a 9" main that runs along Mullinure Lane. This has the potential to affect a number of houses should it be damaged. Liaison with Water Service should ensure that adequate mitigation measures are put in place.

From Station Road to Killylea Road the route corridor passes through a relatively new housing development and recreational areas. Services associated with these areas will be affected, although these do not present any major concern.

As would be expected in urban areas there is an occurrence of streetlights in this area. These do not pose as significant a problem as similar densities of other services. Street Lighting will be provided along the new urban sections of link road. Liaison with Roads Service Divisional Street Lighting Department will ensure that adequate provisions are made to ensure that moving or decommissioning of street lighting plant is carried out with least disruption.

A High Risk 33kV overhead cable runs alongside the disused railway line between Portadown Road and Station Road. Upon reaching the Armagh North Substation the cable is ducted along Station Road and onwards to the City Centre.

There is an Eircom cable that runs out from the City centre along the Moy Road. These and British Telecom cables do not present any major concern as construction methods can easily accommodate these.

There are no significant services identified in the section between Moy Road and the Killylea Road other than an 11kV overhead line and a 4" waterman. These will not affect the alignment and can be dealt with by early service provider liaison and careful planning in the design stage.

The area between Callan Bridge Road and Killylea Road can be classed as a rural area. When compared to the previous areas there are relatively fewer utilities; although there are several incidences of possible conflicts between the route corridor and smaller magnitude services in the vicinity of Ballycrummy Road, such as 4" watermains and a 100mm pumped sewer.

Between Killylea Road and Monaghan Road there are no major causes for concern with regards to utilities.

3.4.7 **Traffic**

As with Route Corridor 1, the TRIPS output predicts that a reasonable proportion of city centre traffic will be attracted to the new link road. The outputs from the model indicate that Route Corridor 2 is predicted to encourage approximately 25 % of the total city centre trips away from the city centre and onto the new link road in the opening year 2009 – this is a slight decrease compared to Corridor 1. Unlike Route Corridor 1, this figure is slightly increased in the design year 2024 (to approximately 29%).

Examination of the key junctions summary statistics also indicate that all of the key junctions in the city will experience an increase in capacity, i.e. junction saturation is reduced, when compared with the Do Minimum scenario. This increase being as a direct result of less traffic within the city. Route Corridor 2 results in an average reduction in junction saturation of 14% in the city centre. In addition, each of the various links of the new link road are shown to be well within the 'Practical Link Capacity' in the future year 2024. Model output summary tables are included in Appendix D.

3.4.8 Summary

Route Corridor 2 does not perform particularly well against any of the engineering assessment criteria, with the exception of the traffic assessment. From Portadown Road to Moy Road, the corridor is common with Route Corridors 1 and 4. The section between Moy road and Killylea Road leads it through an area of recent housing development and associated services.

This route corridor is the shortest, at approximately 5.5km.

Geometric Summary

As Route Corridor 2 represents a reasonably smooth path through Armagh it performs well when assessed against the potential quantity of departures and relaxations required for horizontal alignment. A consequence of this is that it will directly impact up to 25 properties, in particular the recent development at Glen Mhacha on Cathedral Road. The corridor also has the potential to impact on 13 accesses.

There are a large number of constraints involving access/egress for both vehicles and pedestrians alike. Station Road is the main area to be affected due to space constraints in physically fitting a carriageway along it.

Furthermore, when assessed against topographical constraints, Route Corridor 2 performs quite badly. This is largely due to the hill through which it passes on the northern edge of Mullacreevie Park.

Geotechnical Summary

This corridor has the potential to come into contact with three contaminated sites. EHS have classified one of these as High Risk with the other two being classified as Medium Risk.

Based on preliminary examination this corridor potentially has the third best earthworks balance.

Structural Summary

This corridor, as with all four, will require two large structures. The first, common to all four corridors, is the underpass at Drummanmore Road. There may be the potential to raise the existing road slightly to reduce the cut required to allow the link road passage beneath it.

The second significant structure will be at the point where the link road intersects the Callanbridge Road, near its junction with the Mullacreevie Road. The route corridor crosses the Callan River at this location and a substantial structure may be necessary. In order to achieve

geometrical standards to the west of this structure, the vertical alignment would necessitate a large cutting in the magnitude of 20m in the vicinity of Mullacreevie Park.

Culverts are common across all four corridors. The largest one is currently at Ballynahone River (at the northern end of Station road). A structural assessment would be required to assess its suitability with regard to retaining it.

Drainage Summary

This corridor has the potential to utilise a large proportion of the existing infrastructure as it extends through a significant portion of urban area. The utilisation of existing infrastructure will have to be modelled to ensure there is sufficient capacity. There is the opportunity to aesthetically enhance urban areas by the construction of soakaways. The design of embankments and cuttings will be carried out in close liaison with drainage experts to ensure that appropriate measures are taken to engineer out potential problems.

Traffic Summary

This corridor provides an average improvement in performance at city centre junctions, delivering a significant reduction in congestion. Outputs from a preliminary traffic model predict that 25% of the total city centre trips will be encouraged to use this new route in 2009 with this increasing to 29% in 2024. The average change in average junction saturation, however, is 14%.

Summary of Effects of Public Utilities

A High Risk NIE cable exists from Portadown Road to Moy Road. This is overhead from Portadown Road to Station Road when it enters the Armagh North Substation. From this point onwards it is ducted underground.

There are no significant services identified in the section between Moy Road and the Monaghan Road. Any such services will not affect the alignment and can be dealt with by early service provider liaison and careful planning in the design stage.

The Engineering Assessment Tables (EAT) in Appendix A show the scoring of the above sub-objectives in tabular form. This is further summarised in Section 10.0.

3.5 Route Corridor 3

3.5.1 Description of Route

The alignment details of Route Corridor 3 are shown on drawing 400370-SK-030-03 in Appendix B.

Unlike the other Route Corridors, Route Corridor 3 passes through predominantly rural agricultural land along its entire length. It leaves the A3 Portadown Rd on the Northeast edge of Armagh City and continues west across or possibly under Drummanmore Road, passing the northern side of Drummanhill cul-de-sac before progressing towards Court Hill and across a small watercourse at the foot of Court Hill.

From Court Hill it crosses the disused Armagh-Portadown railway line, a small watercourse south of McGill's Bridge, and the B77 Loughgall Road while skirting along the Northern edge of Armagh City.

From here it traverses Lisdonwilly Road and Callan River before crossing Drumcairn Road and two adjacent small watercourses at a point approximately 150m south of Fairlawns before curving south in the direction of Liberty Hall.

After crossing another watercourse west of Moy Road and passing to the east of Liberty Hall it crosses the disused Armagh-Monaghan railway line and the B115 Cathedral Road.

From here it travels on the west side of Legar Hill adjacent to the Ballycrummy Road and crosses Navan Fort Road before crossing the A28 Killylea Road at a point approximately 180m east of the Ballycrummy Road/Killylea Road junction. From this point it travels south through agricultural land between the A28 Killylea Road and the A3 Monaghan Road. Along this stretch it crosses a small watercourse adjacent to Killylea Road and another at O'Neill's Mound before eventually tying in with the A3 Monaghan Road at a point approximately 150m east of Milford village.

The total length of Route Corridor 3 is approximately 6.6km.

3.5.2 Geometric Alignment

The Design Manual for Roads and Bridges (DMRB) Volume 6 – Section 1 – Highway Link Design (TD 9/93) outlines the basic principles to be used when determining the design speed and geometric alignment of single and dual carriageway roads in both urban and rural areas.

Unlike Route Corridors 1 and 2, Route Corridor 3 is located solely within a rural environ. Using the same principles to assess the surrounding topography and frequency of junctions and accesses it is envisaged that Route Corridor 3 will have a design speed of 60mph (100A) along its entire length.

Design Limitations

The table below details the relevant limitations of Stopping Sight Distance, Horizontal Curvature, Vertical Curvature, Overtaking Sight Distance, and Gradients for a design speed of 100A.

Design Speed	100A
Stopping Sight Distance (m)	
Desirable Minimum	215
One Step below Desirable Minimum	160
Horizontal Curvature (m)	
Minimum Radius without elimination of Adverse Camber and Transitions	2040
Minimum Radius with Superelevation of 2.5%	1440
Minimum Radius with Superelevation of 3.5%	1020
Desirable Minimum Radius with Superelevation of 5%	720
Vertical Curvature	
Desirable Minimum Crest K Value	100
One Step Below Desirable Minimum Crest K Value	55
Absolute Minimum Sag K Value	26
Overtaking Sight Distances	
Full Overtaking Sight Distance FOSD (m)	580
FOSD Overtaking K Value	400
Desirable Max Gradient	
All Purpose Single Carriageways	6%

Table 3.10 - Design Parameters

Topographical Constraints

The landform relief along Route Corridor 3 undulates significantly along its entire length. This indicates that in order to construct a carriageway that meets the desirable minimum standards of horizontal and vertical curvature as detailed in TD 9/93, cuttings and embankments may be required.

Plate 3.28 - View West from Lisdonwilly Road on Northern Section of Route Corridor 3

Particular areas where larger cuttings and embankments are envisaged include those adjacent to Drummanmore Road, Drumcairn Road, and Ballycrummy Road.

This route corridor passes through the outer fringes of a number of predicted flood areas. Full details of these can be found in section 3.5.5 of this report. Such areas are confined to the northern section of the corridor, namely to the east of Court Hill and the area between Drumcairn Road and Moy Road.

Plate - 3.29 View from Moy Road towards Drumcairn Road

Watercourses, including the Callan River and a number of smaller tributaries are traversed by this route corridor, as avoidance of these is virtually impossible. Legislation relating to construction works in the vicinity of watercourses could prove to be a further constraint. Section 3.5.5 of this report gives account of drainage factors influencing Route Corridor 2.

Physical Constraints

The geometric alignment of Route Corridor 3 is influenced by numerous physical constraints. Existing public utilities, as detailed on drawings 400370-SK-109-01, 400370-SK-109-02, and 400370-SK-109-03, are considered fully in section 3.5.6 of this report.

The requirement to link with the existing highway infrastructure has a strong influence on the geometric characteristics of Route Corridor 3. In particular, the entry gradients to the existing highway network should be a maximum of 6% as detailed in TD 9/93. This is of greater importance where Route Corridor 3 traverses Loughgall Road, Drumcairn Road, Moy Road, and Cathedral Road as the surrounding landform at these crossings lies either substantially above or below the existing carriageway levels. In addition, difficulties might arise where Route Corridor 3 crosses Drummanmore Road and Drumcairn Road. The preferred junction types at both these crossings, which have yet to be fully determined, may injuriously impact some surrounding properties. These include properties at Drumman Hill on the Drummanmore Road and those to the south of Fairlawns on the Drumcairn Road. A further constraint caused by the need to link with the existing highway network is the maintenance of traffic movements on all the above mentioned routes throughout the construction phase.

The proposed Junction Strategy for Route Corridor 3 can be found in section 3.1.4 of this report.

The condition of the existing road network must be considered when assessing the geometric characteristics of each route corridor. Road classification, structural integrity, surface condition, drainage, and maintenance of the existing carriageways are of key importance to the proposed corridors. As the above information is not readily available for all classifications of road, further investigation is required.

Proposed developments and local planning issues are further constraining factors which have a bearing on the geometric alignment and associated junctions. Details of these can be found in section 4.14 - Land Use.

The existing built environment consists primarily of rural dwellings positioned sporadically along the corridor. Additional larger developments which include Drumsill Park, Legar Hill, Callanbridge Park, and Mullacreevie Park lie in close proximity to Route Corridor 3 and have a bearing upon its alignment however minimal injurious impact to these is envisaged.
However, agricultural buildings, a builder's yard, a standing stone, and one residential property adjacent to Ballycrummy Road are likely to be impacted by this corridor.

Plate 3.30- Legar Hill viewed from Ballycrummy Road

Furthermore, three adjacent residential properties could potentially be injuriously affected where this corridor traverses Drumcairn Road.

This Route Corridor also traverses disused railway lines adjacent to McGill's Bridge and Calvert's Bridge in the Northern and Western sections respectively.

Departures and Relaxations

Due to the various constraints encountered by this Route Corridor, it is likely that relaxations and possible departures from standards will be required for the geometric alignment.

Particular areas where departures and relaxations might be applied to the alignment of Route Corridor 3 include the rural northern section of the corridor where the undulating landform poses

a potential problem to the vertical alignment, and the section adjacent to the townland of Drumcarn.

3.5.3 Geotechnical Elements

Topography

This Route Corridor will commence at a new junction on the existing A3 Portadown Road, and will extend offline in a north westerly direction towards Drummanmore Road predominantly on embankment at a height of around 10m bypassing the disused railway line located to the immediate south.

As the route continues in a north westerly direction through agricultural land extending beyond Drummanmore Road bypassing Drummanhill cul-de-sac it enters into a cut for approximately 0.5km, cutting through a large drumlin feature at a maximum depth of around 12m below existing ground level. A number of properties at Drummanhill may be affected by this cutting on its southern side. As the corridor moves west it is likely that an embankment with maximum heights of around 15m will be required for approximately 0.5km.

Plate 3.31 - View northwest of drumlin topography north of Drumman Heights

Plate 3.32 - View of drumlin topography looking west towards Drumcairn Road

Continuing in a northwesterly direction towards the disused Armagh to Portadown railway line it is carried as a cutting through a drumlin feature labelled as Court Hill. As the route begins to curve west skirting along the northern edge of Armagh City it is carried on a shallow embankment across the disused railway line, the B77 Loughgall Road and several minor watercourses.

After crossing the B77 Loughgall Road the corridor impacts upon a drumlin feature cutting into the land at approximately 5m below existing ground level for a distance of 150m before being carried on embankment across Lisdonwilly Road and the Callan River where a new structure will be required to carry the road over the river at this location.

Upon crossing the Callan River the route bypasses the northern boundary of a sewage treatment works gradually beginning to curve in a southerly direction and impacting upon a large drumlin feature cutting into the land at a depth of approximately 20m (see Plate 3.32 above). Several residential properties located on the upper part of the drumlin will be directly affected by the corridor.

On the western side of this drumlin at Drumcairn Road the route is carried on a 10m high embankment in a southwesterly direction across a minor watercourse skirting close to the Callan River before intersecting the A29 Moy Road.

Upon leaving the Moy Road the corridor immediately crosses a minor watercourse continuing in a southerly direction through agricultural land towards Liberty Hall running adjacent to the Callan River on its eastern side before crossing the disused Armagh to Monaghan railway line and the B115 Cathedral Road / Ballycrummy Road junction. A number of properties may be affected by the corridor in the vicinity of Cathedral Road.

As the route continues south from this junction it follows the existing alignment of the Ballycrummy Road for a short distance before entering low lying agricultural land cutting along the edge of a large drumlin feature to the east of Legar Hill and Callanbridge Park, before crossing Navan Fort Road. From this location the route is carried on shallow embankment intersecting the A28 Killylea Road at a point approximately 200m east of the Ballycrummy Road / Killylea Road junction.

Plate 3.33 - View looking north of low-lying land with drumlin feature in the background adjacent to the Killylea Road.

As the route continues south from the Killylea Road crossing agricultural land the corridor enters into cutting before being carried on shallow embankment across the floodplain of several small watercourses tying in with the existing A3 Monaghan Road.

Solid Geology

This corridor commences along the A3 Portadown Road and proceeds in a general north-westerly direction for an approximate distance of 2km across an area of bedrock known locally as the Armagh Group of which there are two types of sediments both carboniferous in age (Visean: Chadian – Brigantian). The first type of bedrock which the route crosses is known as the 'ARMA' Formation and is described as fossiliferous, pale to dark grey, bedded marine limestone's and thin shales, pale yellow to grey grainstones, with calcareous grits, sandstones and siltstones. Stratigraphically below and geographically to the west is the Drumman More Sandstone Formation which is described as virtually unfossiliferous, pale grey, non-calcareous, micaceous, fine to medium sandstone with carbonised plant fragments with thin black mudstones and thin coal beds which contain abundant miospores. These formations are bounded by a number of SE-NW trending faults.

A previous site investigation to the north of where the corridor crosses the B77 Loughgall Road revealed shallow bedrock at depths of between 0.4 and 3.4m below ground level consisting of

grey weathered sandstone. This is confirmed on the geological drift where a number of outcrops of shallow bedrock are highlighted in this general area. These sediments are assumed to be part of the Arma Formation.

In the general vicinity of where this corridor crosses Lisdonwilly Road it crosses the Derrycreevy Sandstone Formation, a member of the Sherwood Sandstone Group and Triassic in age. The geological maps describe this material as a red, fine to medium grained sandstone and red-brown micaceous siltstones and mudstones, with occasional ripple marks and worm trails. The alignment continues across this material in a westerly direction for approximately 250m, crossing the Callan River. These sediments are bounded by a number of north / south trending faults thrown down to the south and west respectively.

The route passes the northern boundary of a sewage treatment works, located at Drumcairn, the route re-enters the ARMA Formation. Continuing across it, initially in a westerly and then southerly direction for approximately 4.5km where it ties in with the existing A3 Monaghan Road, crossing a number of north / south trending faults on the way.

A plan showing the location of this proposed route corridor is shown on drawing 400370-SK-112 in Appendix B.

Geomorphology

This corridor commences along the A3 Portadown Road and proceeds offline in a north-westerly direction for an approximate distance of 1km through an area of glacial till.

At a point just east of the disused Armagh to Portadown railway line alluvial deposits are highlighted on the geological drift map around the base of a drumlin feature labelled as Court Hill and these deposits would be associated with the minor watercourses and field drains which traverse this general area.

In addition, an area of bedrock at or close to the ground surface is highlighted on the geological drift map located alongside the western face of this drumlin feature and the B77 Loughgall Road. The extent of this shallow rock was confirmed in a previous site investigation to the north where bedrock was encountered in a total of 13 trial pits at depths of between 0.4 – 3.4m below ground level.

Between Drumcairn Road and the Moy Road, in close proximity to the Callan River, the route enters a more extensive area of alluvium for approximately 1.2km where it progresses southwards generally passing the banks of the Callan River, a number of its tributaries and other more minor watercourses. One area of bedrock at or close to the ground surface is located in close proximity to where the route intersects the Moy Road.

The route then crosses an area of glacial till close to where it crosses the former Armagh to Monaghan railway line continuing southwards for an approximate distance of 1.2km.

From a point just east of the Ballycrummy Road / A28 Killylea Road junction the route crosses further alluvial deposits for an approximate distance of 1km continuing south towards the existing A3 Monaghan Road, generally crossing the alluvial deposits located alongside the course of the Callan River and other minor watercourses, etc.

A plan showing the location of this proposed route corridor is shown on drawing 400370-SK-110 in Appendix B.

Man-made Features

This corridor directly impacts upon one site as shown on drawing 400370-SK-111 in Appendix B, which EHS have highlighted as being potentially contaminated. This site relates to a former Kiln / Mineral Workings for which it was not possible to obtain further information. This site has been designated a high risk level by EHS and will need to be investigated during the ground investigation if found to directly impact upon the route.

Preliminary Engineering Assessment

Again, as previously discussed for Route Corridors 1 & 2, the available geological information indicates that a number of areas with differing geotechnical properties will be crossed by this route corridor.

Soft alluvial soils, typically normally consolidated or lightly consolidated clays with varying proportions of organic material, silts and sands, will be encountered in areas around the floodplain of the Callan and Ballynahone Rivers and other smaller watercourses possibly up to 5m in thickness. This material is relatively recent in origin and it can be marked by low shear strength and high compressibility. It can also consist of high organics content and can have poor drainage properties. This material can be sensitive to disturbance and prove difficult to build upon and consequently may prove to be unacceptable in places. This material is often found with or mixed with layers of peat. Careful consideration will need to be given in areas where large embankments are proposed in areas containing such material.

The reviewed exploratory hole records also revealed glacial till (boulder clay) generally consisting of gravely clayey silts, the consistencies of which ranged from soft to very stiff with the softer material generally being encountered at shallow depths. This material is the most prominent throughout the route corridor and will generally be found in all areas as indicated by the geological maps for the area.

Close to the surface these gravely clayey silts were found to be in a state of ongoing weathering and would generally be marked by high moisture contents, hence poor strength properties. As these layers increase with depth the undrained shear strength will improve thus indicating the increasing acceptability of the soil as an engineering material. Construction works in the upper regions of this material designated soft could result in settlement problems and therefore should be avoided unless the movement can be built into any design. Typically these materials would benefit from good undrained shear strengths, low compressibility and good bearing pressures.

Bedrock was confirmed in one previous site investigation just north of this route corridor along the B77 Loughgall Road and was encountered in a total of 13 trial pits, at depths of between, 0.4 to 3.4m below ground level. The geological maps for the area confirm an outcrop of bedrock within this general area.

As previously discussed for the other route corridors, groundwater is expected to be high in areas of the floodplains of the two main rivers. Careful consideration will need to be given during the design process to the overall drainage and the groundwater impacts particularly within

granular deposits. Short-term CBR values for construction purposes will also be poor and manoeuvrability will be problematic for wheeled plant. Access will need to be restricted to tracked plant only until adequate granular starter layers are in place to permit general trafficking.

Cuttings

The largest cut along this corridor is approximately 22m to the east of Drumcairn Road and at the very north of this corridor. To date there is no available site investigation information as to the exact nature of this material at these locations but it is expected that it will consist of glacial till and most likely bedrock.

Adequate drainage provision will be required to improve conditions and to draw down water levels were the water table is found to be high. Hydrological and hydrogeological studies may need to be undertaken in areas of proposed cuttings to assess the requirements for natural drainage.

Detailed slope stability analysis will need to be carried out in areas of cutting to assess potential stability of side slopes. Excavated material will need to be assessed for reusability during the main ground investigation.

Embankments

Sections of this corridor could potentially be constructed on embankments with an approximate height of 15 metres (east of Loughgall Road), primarily to provide a satisfactory vertical alignment and to raise the carriageway above low points such as rivers and areas of river floodplain, and it is these areas that will consist of soft alluvial deposits, which will prove difficult to construct upon.

With such high embankments proposed over these types of ground conditions, geotechnical, economic and programme constraints may not permit straightforward construction techniques to be employed. Measures may be required to modify the construction sequence, the form of embankment and the properties of the underlying ground, individually or in a combination. Techniques such as advance earthworks, special fills, staged construction, reinforcement, ground improvement and or reduced side slopes should be considered when evaluating methods of embankment construction.

The soil conditions at the proposed embankment locations over alluvial deposits will need to be assessed in detail during the ground investigation and detailed design process.

3.5.4 **Structural Elements**

Route Corridor 3 involves the construction of two significant bridge structures (one over the Callan River and an underpass at Drummanmore Road), eight box culverts (conveying the road over small water courses) and up to four cattle creeps. The underpass at Drummanmore road, the box culverts and the cattle creeps have been discussed as part of Route Corridor 1 in section 3.3.4, and will not receive further consideration here.

Bridge over Callan River(Near sewage treatment works)

In Route Corridor 3, the new route crosses the Callan River (see plate 3.34) near the sewage treatment works at the North of the city. The size of opening that is required for river flow at this

point has been confirmed by Rivers Agency as 30m at right angles to the channel and 5.4m from soffit level to bed level. A single span weathering steel bridge would be an economical solution for this size of opening. Plate 3.25 shows what a weathering steel bridge would like. At the point where the route crosses the river there is unconfirmed evidence of Sandmartins nesting in the bank (see plate3.35).

Plate 3.34 - Callan River at location similar to where Route Corridor 3 may cross it.

Plate 3.35 - Sandbanks with evidence of Sandmartins habitat

3.5.5 **Drainage Aspects**

Proposed Drainage System

It is envisaged that for Route Corridor 3 a traditional closed linear storm drainage system, incorporating gulley pots, drainage pipes and manholes would be used (Figure 3.4), although due to the rural nature of this Route Corridor, alternative systems such a surface water channel (Figure 3.8) or linear drainage channels (Figure 3.9) could be used. In areas where there is little or no longitudinal gradient, such as roundabouts, combined kerb and drainage units would be installed (Figure 3.5).

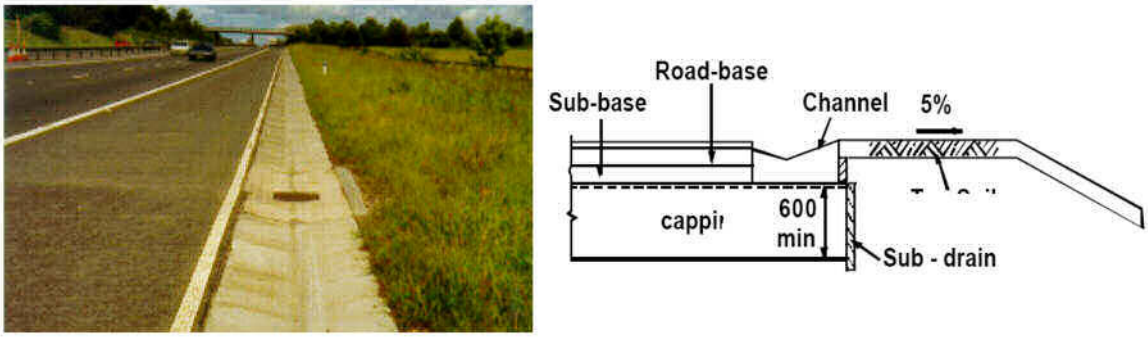

Fig 3.8 - Typical surface water channel layout

Fig 3.9 - Typical linear drainage channel layout.

Culverts

Within this Route Corridor there are 8 proposed new boxed culvert structures. The route of the existing watercourses may be affected by the works, but would be maintained by way of suitably sized culverts under the proposed road alignment. These proposed culverts would be located:

790m northwest of the Drummanmore Road/Drummanhill junction;
775m northeast of Longstone Hospital, near the disused railway line there would be two culverts here;
150m southeast of Fairlawns of the Drumcairn Road;
290m southwest of Fairlawns;
60m southwest of where the corridor crosses the Moy Road;
180m southeast of the Killylea/Ballycrummy Road junction; and
340m north of the Monaghan Road, near O'Neill's mound.

Again, several of the watercourses within the Route Corridor which require culverts are included in existing floodplains within the study area. The construction of embankments and culverts across floodplains may cause afflux which would change the shape of the existing floodplain and possibly affect adjacent properties. Detailed design at a future stage would examine these effects and accommodate watercourses and floodplains into the proposed option.

Embankments

Due to the nature of the topography to the north and west of Armagh City there are a large number of embankments and cuttings within this Route Corridor. Between the Portadown Road and the disused Armagh to Portadown railway line there are two large embankments in the order of 10m. One of these embankments passes through an area of floodplain with a Q100 of 31.03m AOD. Further embankments pass through floodplain areas close to the Lisdonwilly Road, Moy Road and Killylea Road. As has previously been mentioned, the Rivers Agency has advised that all development take place above Q100 levels and that mitigating steps should be taken to avoid changes to the floodplain or increase the risk of flooding. Careful consideration should be given to the type of drainage below the embankment footprint, as construction can prove problematic due to difficulties with the dissipation of porewater pressure below the embankments. Steps to mitigate against this could include staged construction of the embankment, surcharging and/or the installation of vertical band drains.

Cuttings

There are also several cuttings included in the preliminary alignments. There are five significant cuttings, one of which being in the region of 20m deep. There are two between Drummanmore

Road and the disused Armagh to Portadown railway line, one between Lisdonwilly Road and Drumcairn Road, one long cutting between Moy Road and Cathedral Road and one between Killylea Road and Monaghan Road. Details of ground conditions and the possibility of drainage provision for high groundwater levels have been mentioned in section 3.5.3. Adequate slope face drainage provision would be required in the form if slip drains or relief drains.

Sustainable Urban Drainage Systems (SUDS)

It is anticipated that SUDS will be utilised within this Route Corridor. The fact that this Route Corridor passes through mainly rural areas means that there is more scope for the kind of SUDS which can be implemented. It is feasible that SUDS such as retention ponds and infiltration basins (Figure 3.6) may be utilised. Within the linear closed drainage system sealed drains would convey the storm water run-off under the proposed roadside verges to a series of retention ponds. These retentions ponds could be placed in suitable locations to store, treat and attenuate the run-off before this is outfalled to receiving waters. Ideally, any retention ponds should be located outside existing floodplains. It is planned that these types of ponds, when matured, would contribute to the landscape and nature conservation of the surrounding area.

3.5.6 Public Utilities

This corridor passes through an exclusively rural area, and as such, there is a significantly lower density of utilities when compared to the other 3 proposed route corridors. In saying that, there are still conflicts between existing utility locations and the proposed route corridor which should be noted.

There is a High Risk 33kV overhead cable that runs north from the Armagh North Substation through the townland of Tullyard. Where the alignment crosses the line of this cable will require liaison with NIE at an early stage but should not pose any great concern.

There are a number of smaller services throughout the corridor but these do not pose any great concern and can be managed at a local level during the design and construction stages.

3.5.7 Traffic

Similar to Route Corridors 1 and 2, the TRIPS output for Route Corridor 3 predicts that a reasonable proportion of city centre traffic will be attracted to the new link road. The outputs from the model indicate that Route Corridor 3 is predicted to encourage approximately 20 % of the total city centre trips away from the city centre and onto the new link road in the opening year 2009. In contrast to corridor 1, however, the proportion of traffic attracted to the new link road in the design year 2024 increases to 30%.

The key junctions summary statistics also indicate that all of the key junctions in the city, with the exception of College Hill/Drumadd Road, will experience an increase in capacity (all remain within capacity in the design year 2024) when compared with the Do Minimum scenario. This increase being as a direct result of less traffic within the city. Average junction saturation in the city centre is reduced by 13% as a result of Route Corridor 3. In addition, each of the various links of the new link road are shown to be well within the 'Practical Link Capacity' in the future year 2024. Model output summary tables are included in Appendix D.

3.5.8 Summary

This route corridor is located in predominantly rural surroundings and so does not share some of the adverse conditions that other route corridors may experience. This corridor is the longest, at approximately 6.6km.

Geometric Summary

As Route Corridor 3 is located solely within a rural environ it is not subject to the same amount of physical constraints as the other route corridors and subsequently performs well in this category. A further benefit of this is that the alignment is largely uninterrupted and potentially requires less departures and relaxations from standards. This corridor had the potential to directly affect up to 4 properties, however only 2 accesses are likely to be affected.

The downside of the rural location of Route Corridor 3 is that the surrounding topography becomes more of a constraining factor. The frequency and quality of cuts and embankments is likely to be increased due to the undulating nature of the surrounding landform.

Geotechnical Summary

This corridor has the potential to come into contact with one contaminated site. EHS have classified this as High Risk.

Based on preliminary examination this corridor potentially has the worst earthworks balance.

Structural Summary

This corridor, as with all four, will require two large structures. The first, common to all four corridors, is the underpass at Drummanmore Road. There may be the potential to raise the existing road slightly to reduce the cut required to allow the link road passage beneath it.

The second significant structure will be at the point where the link road intersects the Callan River near Lisdonwilly Road.

Culverts are common across all four corridors. The largest one is currently at Ballynahone River (at the northern end of Station road). A structural assessment would be required to assess its suitability with regard to retaining it.

Drainage Summary

This corridor consists of five significant embankments and five significant cuttings. Some of these embankments pass through areas of floodplains. Careful consideration should be given to the design and construction of such embankments. The design of embankments and cuttings will be carried out in close liaison with drainage experts to ensure that appropriate measures are taken to engineer out potential problems.

This corridor has a greater number of culverts as a result of the number of embankments. There may be the need to direct some of the watercourses depending on their location in relation to the embankment. The length of this corridor will also necessitate more SUDS or soakaways which will increase costs, although it is not envisaged that this increase will have significant

bearing on the overall costs of the scheme. It should be noted however that the existing floodplains will have an effect on which systems to use.

Traffic Summary

This corridor provides the least improvement in performance at city centre junctions, delivering the least reduction in congestion. Outputs from a preliminary traffic model predict that 20% of the total city centre trips will be encouraged to use this new route in 2009. This reduction is the least of all corridors. This reduction improves significantly to 30% in 2024.

The traffic benefits are largely similar to Route Corridor 4 but the costs of accidents along this corridor act as a major factor in making this corridor least favourable. This is likely to be attributed to the increased length of the 60mph speed limit on this corridor.

Summary of Effects of Public Utilities

The High Risk 33kV NIE cable running north from the North Armagh Substation poses the most considerable risk when assessing route corridor 3's effect on public utilities. Early NIE involvement will ensure that any works can be successfully programmed into the construction phase.

The Engineering Assessment Tables (EAT) in Appendix A show the scoring of the above sub-objectives in tabular form. This is further summarised in Section 10.0.

3.6 Route Corridor 4

3.6.1 Description of Route

The alignment details of Route Corridor 4 are shown on drawing 400370-SK-030-04 in Appendix B.

Like the other Route Corridors, Route Corridor 4 leaves the A3 Portadown Rd on the Northeast edge of Armagh City and continues west across or possibly under Drummanmore Road, passing the northern side of Drummanhill cul-de-sac and crossing a small watercourse north of Drumman Heights before progressing towards Mullinure Lane. Along this stretch it passes through largely agricultural land.

At Mullinure Lane it converges with the disused Newry-Armagh railway line and follows this line to Station Road after crossing the Ballynahone River at Lisanally Lane. From here it continues along Station Road and adjacent to commercial/industrial properties before traversing both Railway Street and the A29 Moy Road.

From Moy Road it follows the disused Armagh-Monaghan railway line in a westerly direction. Here it skirts the cemetery and playing fields adjacent to Desart Lane Lower before continuing towards and across Callan River and then curves south towards the B115 Cathedral Road.

After crossing the B115 Cathedral Road it travels on the west side of the residential Legar Hill, adjacent to Ballycrummy Road before crossing Navan Fort Road and the A28 Killylea Road at a point 180m east of the Ballycrummy Road/Killylea Road junction. From here it travels south through agricultural land between the A28 Killylea Road and the A3 Monaghan Road. Along this stretch it crosses a small watercourse adjacent to Killylea Road and another at O'Neill's Mound before eventually tying in with the A3 Monaghan Road at a point approximately 150m east of Milford village.

The total length of Route Corridor 4 is approximately 5.7km.

3.6.2 Geometric Alignment

The Design Manual for Roads and Bridges (DMRB) Volume 6 – Section 1 – Highway Link Design (TD 9/93) outlines the basic principles to be used when determining the design speed and geometric alignment of single and dual carriageway roads in both urban and rural areas.

Like Route Corridors 1 and 2, Route Corridor 4 is located within both urban and rural environs and is therefore subject to varying degrees of alignment and layout constraints. Having assessed these constraints, which include the surrounding topography and frequency of proposed junctions and accesses, it is envisaged that Route Corridor 4 will have varying design speeds along its length. As with Route Corridors 1 and 2 these are likely to be 60mph (100A) along the rural sections and 40mph (70A) or 30mph (60B) along the urban sections of the corridor.

Design Limitations

The table below details the relevant limitations of Stopping Sight Distance, Horizontal Curvature, Vertical Curvature, Overtaking Sight Distance, and Gradients to design speeds for 100A, 70A, and 60B.

Design Speed	100A	70A	60B
Stopping Sight Distance (m)			
Desirable Minimum	215	120	90
One Step below Desirable Minimum	160	90	70
Horizontal Curvature (m)			
Minimum Radius without elimination of Adverse Camber and Transitions	2040	1020	720
Minimum Radius with Superelevation of 2.5%	1440	720	510
Minimum Radius with Superelevation of 3.5%	1020	510	360
Desirable Minimum Radius with Superelevation of 5%	720	360	255
Vertical Curvature			
Desirable Minimum Crest K Value	100	30	17
One Step Below Desirable Minimum Crest K Value	55	17	10
Absolute Minimum Sag K Value	26	20	13
Overtaking Sight Distances			
Full Overtaking Sight Distance FOSD (m)	580	410	345
FOSD Overtaking K Value	400	200	142
Desirable Max Gradient			
All Purpose Single Carriageways	6%	6%	6%

Table 3.11 - Design Parameters

Topographical Constraints

As with all the Route Corridors, sections of Route Corridor 4 lie along areas of undulating rural landform. Therefore, in order to construct a carriageway with acceptable standards of horizontal and vertical curvature, as described in the above table, cuttings and embankments will be required. These areas are largely confined to the northern section of the corridor between Lisanally Lane and Portadown Road, and the southwest section in the vicinity of O'Neill's Mound. The northern section of Route Corridor 4 follows a portion of the disused railway line from Station Road to Mullinure Lane, where the existing railway cuttings and ballast could potentially be utilised.

It is envisaged that a significant cutting will be required to the north of Drumman Heights in order to provide an acceptable vertical alignment and carriageway gradient on the approach to Portadown Road.

Like Route Corridors 1 and 2, a section of Route Corridor 4 follows Station Road. A relatively uniform terrain is encountered here, however construction of a carriageway with an acceptable horizontal alignment may dictate the need for structural support or slope stabilisation to the existing cuttings. The potential alignment will likely require the closure of a secondary access to Alexander Park.

Plate 3.36 - Existing cuttings on Station Road

The section of the corridor between Cathedral Road and Station Road lies to the north of the disused railway line on the northern edge of Desart Lane. As expected, this has relatively flat relief on a constant gradient. There are three properties that are built on the disused railway. These may be affected should the alignment follow the disused railway. The playing fields belonging to St. Patrick's Grammar School will be affected by this route corridor, however the extent shall not be realised until the detailed design stage. Localised embankments may be required to provide a carriageway alignment that meets the desirable minimum standards for horizontal and vertical curvature as detailed in TD 9/93.

Plate 3.37 - Line of trees to top right of photograph hides disused railway line on northern edge of Desart Lane

Also, a large hill on the north-west edge of Dukes Road is likely to influence both the horizontal and vertical alignment of this Route Corridor.

Plate 3.38 - Lower section of hill to north-west of Dukes Road

Watercourses, including the Ballynahone and Callan Rivers, and a number of smaller tributaries are traversed by this route corridor, as avoidance of these is virtually impossible. Legislation relating to construction works in the vicinity of watercourses could prove to be a further constraint. Section 3.6.5 of this report gives account of drainage factors influencing Route Corridor 2.

Physical Constraints

The geometric alignment of Route Corridor 4 is influenced by numerous physical constraints. Existing public utilities as detailed on drawings 400370-SK-109-01, 400370-SK-109-02, and 400370-SK-109-03 are considered fully in section 3.6.6 of this report.

Like all the Route Corridors, the requirement to link with the existing highway infrastructure has a strong influence on the geometric characteristics of Route Corridor 4. In particular, the entry gradients to the existing highway network should be a maximum of 6% as detailed in TD 9/93. This is of significant importance where Route Corridor 4 traverses Portadown Road, Moy Road, and Cathedral Road as the surrounding land form at these crossings lies substantially above or below the existing carriageway levels. In addition, difficulties might arise where Route Corridor 4 traverses Drummanmore Road and Desart Lane. The preferred junction types at both these crossings, which have yet to be fully determined, may injuriously impact the surrounding properties. In particular, the residential properties to the north of Glen Court on Desart Lane and those to the north of Drumman Hill on Drummanmore Road. A further constraint caused by the need to link with the existing highway network is the maintenance of traffic movements during the construction phase.

The proposed Junction Strategy for Route Corridor 4 can be found in section 3.1.5 of this report.

The condition of the existing road network must be considered when assessing the geometric characteristics of each route corridor. Road classification, structural integrity, surface condition, drainage, and maintenance of the existing carriageways are of key importance to the proposed corridors. As the above information is not readily available for all classifications of road and therefore not all roads within the study area, further investigation is required.

Proposed developments and local planning issues are further constraining factors which have a bearing on the geometric alignment and associated junctions. Details of these can be found in section 4.14 - Land Use.

The constraint of the existing built environment is largely concentrated on the western section of this route corridor. Station Road with its commercial and industrial properties incorporates a carriageway width ranging from 5.9m to 8.1m. Pedestrian footpaths are currently present on one verge for most of its length while a short stretch has these on both verges. Due to the high concentration of properties fronting on to Station Road, which includes a tile showroom, a tyre centre, an electrical supplies store, and a diner, the provision of access roads must be considered. These would accommodate continued service to the necessary properties while reducing the number of direct accesses onto the new link road. One possible location for a service road would be to the northwest of Station Road, adjacent to Gillis House. An approximate total of 12-16 properties in the Station Road, Alexander Park/Alexander Avenue areas could be affected.

To the south of Station Road, and spanning from Moy Road to Loughgall Road/Railway Street is a Timber Merchants (see plate 3.22). As Route Corridor 4 passes through this area it is likely that the Timber Merchants storage yard and shed will be injuriously affected. Furthermore, a section of the car park area at Spires Retail Park will potentially be affected to accommodate the proposed link road. In addition, the playing fields between Willowbank and Moy Road are directly traversed by this corridor.

Further constraints include the recently constructed residential development to the west of Glen Court on Desart Lane, and Legar Hill on the Western edge of Armagh City. Furthermore,

playing fields and a cemetery adjacent to Moy Road are in close proximity to Route Corridor 4. The playing fields are likely to be injuriously impacted if Route Corridor 4 were chosen.

In addition, agricultural buildings, a builder's yard, a standing stone, and one residential property adjacent to Ballycrummy Road are likely to be impacted by this corridor.

Plate 3.39 - View towards Killylea Road/Ballycrummy Road junction from Mullacreevie Park

A further constraint is the disused railway line, on which elements of the northern and western sections of this route corridor lie. The geometric attributes of this railway line constrain both the horizontal and vertical alignment of the proposed carriageway.

Departures and Relaxations

Due to the various constraints encountered by this Route Corridor it is likely that relaxations and possible departures from standards will be required for the geometric alignment.

Particular areas where departures and relaxations might be applied to the alignment of Route Corridor 4 include Station Road, where the existing horizontal alignment would be sub-standard if transferred to the new link road; the rural northern section of the corridor, where the undulating landform poses a potential problem to the vertical alignment, particularly to the north of Drumman Heights; and the area to the north west of Dukes Road.

3.6.3 Geotechnical Elements

Topography

This route corridor will commence at a new junction on the existing A3 Portadown Road and will extend offline in a westerly direction towards Drummanmore Road predominantly on embankment at a maximum height of around 10.0m bypassing the disused railway line located to the immediate south.

As the route continues west through agricultural land extending beyond Drummanmore Road bypassing Drummanhill cul-de-sac it will likely need to enter into a cut for approximately 350m, cutting through a large drumlin feature (low amplitude hills of glacial origin) at a maximum depth of approximately 10m.

Where the corridor converges with the disused railway line at Mullinure Lane the abutments of an old railway bridge are evident. At this location the old railway line is raised on embankment but as it extends to the west it enters into a cutting for approximately 250m. The indentations of the old railway sleepers, which have now been removed, can still be seen in the old ballast. It is thought that the line was decommissioned in 1958.

It is considered unlikely that any potential route would be constructed upon the existing railway line to the east of Mullinure Lane as it is constructed on quite high narrow embankments with steep side slopes.

For the next 1.5km the corridor will follow or lie relatively close to the disused railway line extending in a westerly and then south-westerly direction towards Station Road and traversing the Ballynahone River at Lisanally Lane.

At Station Road and for the next 2.0km the route generally passes through urban land, predominantly at grade level, which is a mixed use of residential and commercial properties.

As the route extends beyond Station Road it intersects Railway Street / B77 Loughgall Road and the A29 Moy Road.

From the A29 Moy Road the corridor travels in a westerly direction following the line of the disused Armagh to Monaghan railway line towards Desart Lane Lower where the corridor directly goes through a number of residential properties. As the corridor progresses along the disused railway line it passes between a set of playing fields to the immediate north and a cemetery to the immediate south (see Plate 3.40).

Plate 3.40 - View looking west along disused railway line and playing fields

The route then crosses the Callan River carried on embankment at height of around 7m above curving southwards cutting into a large drumlin at depth of around 15m.

After intersecting the B115 Cathedral Road to the east of its junction with Ballycrummy Road it bypasses Legar Hill to the immediate east continuing southwards across low lying agricultural land cutting along the western face of a drumlin before crossing Navan Fort Road.

From this location the route intersects the A28 Killylea Road at a point approximately 200m east of the Ballycrummy Road / Killylea Road junction and continues offline in a southerly direction linking the A28 Killylea Road and the A3 Monaghan Road. As the corridor progresses through agricultural land it cuts through the eastern flank of a drumlin feature, it then crosses a floodplain of several small watercourses, which are tributaries of the Callan River, before meeting the existing A3 Monaghan Road.

Solid Geology

This corridor commences along the A3 Portadown Road and proceeds in a westerly direction for an approximate distance of 1.9km across an area of bedrock known locally as the Armagh Group of which there are two types of sediments both carboniferous in age (Visean: Chadian – Brigantian). The first type is known as the 'ARMA' Formation and is described as fossiliferous, pale to dark grey, bedded marine limestone's and thin shales, pale yellow to grey grainstones, with calcareous grits, sandstones and siltstones. Stratigraphically below and geographically to the west is the Drumman More Sandstone Formation which is described as virtually unfossiliferous, pale grey, non-calcareous, micaceous, fine to medium sandstone with carbonised plant fragments with thin black mudstones, and thin coal beds which contain abundant miospores. These formations are bounded by a number of SE-NW trending faults.

Just east of where the disused Armagh to Portadown railway line crosses the Ballynahone River the route enters the Callan Group of rocks which includes three formations of Permian Age, namely the Dobbin Sandstone Formation, the Mall Member and the Drumarg Conglomerate Formation, continuing across it in westerly and then south-westerly direction for approximately 2km, crossing a number of SE-NW trending faults, two of which are lie in a southerly direction and one to the north and one to the west.

The Dobbin Formation is described as soft, red, fine grained, micaceous sandstone. The Mall member is described as soft, grey, sandy, limey rock, probably equivalent to magnesian limestone and the Drumarg Formation is described as purple-red, bedded, conglomerates and coarse-grained sandstones.

One borehole previously excavated close to where the corridor crosses the Ballynahone River encountered slightly weathered fragments of yellow sandstone at a depth of 10.2 below existing ground level. It is thought that this material is sediments from the ARMA Formation. Extracts from the ground investigations, and a map showing locations of boreholes (drawing 400370-SK-113) can be found in Appendix B.

One borehole and one trial pit excavated in close proximity to Station Road revealed bedrock at depths of between 6.1 and 6.8m below ground level. This material was described as weak red brown sandstone. It is assumed that this bedrock is part of the Dobbin Sandstone Formation.

In close proximity to where the route intersects Desart Lane Lower it re-enters the Arma Formation continuing south for approximately 2.5km where it ties in with the existing A3 Monaghan Road, crossing a number north / south trending faults on the way.

A plan showing the location of this proposed route corridor is shown on drawing 400370-SK-112 in Appendix B.

Geomorphology

This corridor commences along the A3 Portadown Road and proceeds offline in a westerly then southwesterly direction for an approximate distance of 3.3km through glacial till deposits. It crosses a narrow tract of alluvium just east of where the disused Armagh to Monaghan railway line crosses over the Callan River, before crossing glacial till deposits for a further distance of approximately 1.2km.

From a point just east of the Ballycrummy Road / A28 Killylea Road junction the route crosses further alluvial deposits for an approximate distance of 1km continuing south towards the existing A3 Monaghan Road, generally crossing the alluvial deposits located alongside the course of the Callan River, its tributaries and other minor watercourses.

A plan showing the location of this proposed route corridor is shown on drawing 400370-SK-110 in Appendix B.

Man-made Features

This corridor directly impacts upon four sites as shown on drawing 400370-SK-111 in Appendix B, which EHS have highlighted as being potentially contaminated. Three of these sites relate to the old disused railway lines, which have been designated a medium risk level, and one at the area on Station Road where the old railway depot was previous located. This site has been designated a high-risk level in terms of potential contamination.

Preliminary Engineering Assessment

The available geological and geotechnical information, which has been reviewed for this corridor, has revealed that the ground conditions along this route are of a highly variable nature with differing geotechnical properties.

Made ground was found to be present in depths up to 1.0m below existing ground level (at Navan Street) in various exploratory holes located within this route corridor. This material appears to be “inert” demolition rubble mixed with varying compositions of clay fill. The geotechnical properties of made ground are variable and unpredictable and this type of material is generally located within brownfield sites / urban areas.

At this stage the nature of this material is unknown both geotechnically and chemically but would generally be unsuitable for re-use. As the grading and density of the materials used for this backfilling is not known the potential for total excessive settlements, gas generation, or ground and groundwater contamination cannot be adequately assessed at this stage.

Soft alluvial soils, typically normally consolidated or lightly consolidated clays with varying proportions of organic material, silts and sands, will be encountered in areas around the floodplain of the Callan and Ballynahone Rivers and other smaller watercourses possibly up to

5m in thickness. This material is relatively recent in origin and it can be marked by low shear strength and high compressibility. It can also consist of high organics content and can have poor drainage properties. This material can be sensitive to disturbance and prove difficult to build upon and consequently may prove to be unacceptable in places. This material is often found with or mixed with layers of peat. Careful consideration will need to be given in areas where large embankments are proposed in areas containing such material.

The reviewed exploratory hole records also revealed glacial till (boulder clay) generally consisting of gravely clayey silts, the consistencies of which ranged from soft to very stiff with the softer material generally being encountered at shallow depths. This material is the most prominent throughout the route corridor and will generally be found in all areas as indicated by the geological maps for the area.

Close to the surface these gravely clayey silts were found to be in a state of ongoing weathering and would generally be marked by high moisture contents, hence poor strength properties. As these layers increase with depth the undrained shear strength will improve thus indicating the increasing acceptability of the soil as an engineering material. Construction works in the upper regions of this material designated soft could result in settlement problems and therefore should be avoided unless the movement can be built into any design. Typically these materials would benefit from good undrained shear strengths, low compressibility and good bearing pressures.

Bedrock was not encountered in any of the exploratory holes reviewed for this corridor and the geological drift map does not show any shallow bedrock outcrops within close proximity to the corridor.

In areas over the lower lying alluvial flood plains groundwater levels are expected to be high, although this should be controlled by any installed land drains, the surrounding drainage ditch collection system and the local watercourses.

Short-term CBR values for construction purposes in these areas will be poor and movement of construction plant should be restricted to tracked plant only until adequate granular starter layers are in place to permit general trafficking.

Cuttings

The largest cut along this corridor is approximately 15m to the immediate north of Cathedral Road. To date there is no available site investigation information as to the exact nature of this material at these locations but it is expected that it will consist of glacial till and most likely bedrock.

Adequate drainage provision will be required to improve conditions and to draw down water levels were the water table is found to be high. Hydrological and hydrogeological studies may need to be undertaken in areas of proposed cuttings to assess the requirements for natural drainage.

Detailed slope stability analysis will need to be carried out in areas of cutting to assess potential stability of side slopes. Excavated material will need to be assessed for reusability during the main ground investigation.

Embankments

Sections of this corridor could potentially be constructed on embankments with an approximate height of 16 metres (north of Drumman Heights), primarily to provide a satisfactory vertical alignment and to raise the carriageway above low points such as rivers and areas of river floodplain, and it is these areas that will consist of soft alluvial deposits, which will prove difficult to construct upon.

With such high embankments proposed over these types of ground conditions, geotechnical, economic and programme constraints may not permit straightforward construction techniques to be employed. Measures may be required to modify the construction sequence, the form of embankment and the properties of the underlying ground, individually or in a combination. Techniques such as advance earthworks, special fills, staged construction, reinforcement, ground improvement and or reduced side slopes should be considered when evaluating methods of embankment construction.

The soil conditions at the proposed embankment locations over alluvial deposits will need to be assessed in detail during the ground investigation and detailed design process.

3.6.4 Structural Elements

Route Corridor 4 involves the construction of two significant bridge structures (one over the Callan River and an underpass at Drummanmore Road), three box culverts (conveying the road over small water courses) and up to four cattle creeps. The underpass at Drummanmore road, the box culverts and the cattle creeps have been discussed as part of Route Corridor 1 in section 3.3.4, and will not receive further consideration here.

Bridge over Callan River

In Route Corridor 4, the new route crosses the Callan River near an existing railway bridge (Plate 3.41). The railway bridge will be maintained and at present it is envisaged that the new structure will be built upstream. The road level on the new bridge would be in the order of 10 metres above river bed level. A weathering steel bridge or a pre-stressed concrete bridge could be used here. The dimensions are to be confirmed by Rivers Agency.

Plate 3.41 - Existing railway bridge near where the corridor crosses the River Callan.

3.6.5 Drainage Aspects

Proposed Drainage System

It is envisaged that for Route Corridor 4 a traditional closed linear storm drainage system, incorporating gulley pots, drainage pipes and manholes would be used (Figure 3.4), and that the existing drainage system on Station Road could be utilised within this Route Corridor. This type of drainage system is quite common particularly in urban areas and embankment conditions. In areas where there is little or no longitudinal gradient, such as roundabouts, combined kerb and drainage units would be installed (Figure 3.5).

Culverts

Within this Route Corridor there is one existing culvert at Lisanally Lane (See Ballynahone River Culvert on drawing No. 400370-SK-038, in Appendix B) and three proposed culverts. These are situated 480m west of the Drummanmore Road/Drummanhill junction, 180m southeast of the Killylea Road/Ballycrummy Road junction and 340m north of the Monaghan Road, near O'Neill's mound. The route of the existing watercourses (Plate 3.19) may be affected by the works, but would be maintained by way of suitably sized culverts under the proposed corridor.

The watercourses which require culverts are included in existing floodplains within the study area. The construction of embankments and culverts across floodplains may cause afflux which would change the shape of the existing floodplain and possibly affect adjacent properties. Detailed design at a future stage would examine these effects and accommodate watercourses and floodplains into the proposed option.

Embankments

As with all the Route Corridors, there are several major embankments in this Route Corridor. One is located between the Portadown Road and Drummanmore Road and two others are located between Drummanmore Road and Mullinure Lane. Careful consideration should be given to the type of drainage below the embankment footprint, as construction can prove problematic due to difficulties with the dissipation of porewater pressure below the embankments. Steps to mitigate against this could include staged construction of the embankment, surcharging and/or the installation of vertical band drains.

Also, on the disused Armagh to Monaghan railway line (Plate 3.41) the proposed Route Corridor passes over the Callan River through an area of floodplain with 100 year flood levels of 35.29m AOD. It is anticipated that this section of road would run on an embankment. As has previously been mentioned, the Rivers Agency has advised that all development take place above 100 year flood levels and that mitigating steps should be taken to avoid changes to the floodplain or increase the risk of flooding.

Cuttings

There are also several cuttings included in the preliminary alignments. There are two major cuttings, one immediately west of Drummanmore Road, and the other just east of Lisanally Lane; although the largest cutting occurs through a large hill just north of Cathedral Road. Details of ground conditions and possible drainage provision for high groundwater levels have been mentioned in section 3.6.3. Adequate slope face drainage provision would be required in the form if slip drains or relief drains.

Sustainable Urban Drainage Systems (SUDS)

As with Route Corridor 1, it is anticipated that SUDS will be utilised within this Route Corridor, the type of which depends on space constraints. In the rural sections of the Route Corridor, i.e. between Portadown Road and Lisanally Lane and between Cathedral Road and Monaghan Road, it is more feasible to use SUDS such as retention ponds and infiltration basins (Figure 3.6). In urban areas, i.e. between Lisanally Lane and Cathedral Road, devices such as soakaways (Figure 3.7) would be more practicable. Within the linear closed drainage system sealed drains would convey the storm water run-off under the proposed roadside verges to a series of retention ponds. Within the rural areas, to the northeast and southwest of the study area, a number of suitably placed retentions ponds could be located to store, treat and attenuate the run-off before this is outfalled to receiving waters. Ideally, any retention ponds should be located outside existing floodplains. It is planned that these types of ponds, when matured, would contribute to the landscape and nature conservation of the surrounding area.

Existing Drainage

One section of Route Corridor 2 will replace/upgrade existing roads, namely Station Road. At Station Road there is an existing 225mm gravity foul sewer. Depending upon the outcome of detailed drainage design, these existing sewer pipes may be utilised or may need to be replaced.

3.6.6 **Public Utilities**

By examining the services drawings (Drawing Nos. 400370-SK-109-01, 400370-SK-109-02, and 400370-SK-109-03), it has been noted that there are numerous occasions where the location of existing service utilities will affect the proposed route corridor.

There is an urban nature to this corridor suggesting that there will be a greater density of public utilities/services affected than for the other more rural corridors. Service diversions have the potential to affect large numbers of people, not necessarily within close proximity to the site works.

Between Portadown Road and Station Road there are several incidences of 11kV overhead NIE cables crossing the route corridor and three occasions where BT lines pass through the route corridor. Moving of these may be needed depending on the final alignment, however it is not envisaged that these will cause any undue concern.

There are also three watermains located within this section of the route corridor. The small diameter mains that run along Drummanmore Road and Station Road can be accommodated by good construction management. There is a 9" main that runs along Mullinure Lane. This has the potential to affect a number of houses should it be damaged. Liaison with Water Service should ensure that adequate mitigation measures are put in place.

There are no significant services identified in the section between Moy Road and the Killylea Road other than two 11kV overhead lines, a 4" watermain, and a 100mm pumped sewer. These will not affect the alignment and can be dealt with by early service provider liaison and careful planning in the design stage.

3.6.7 Traffic

As with the previous three corridors, the TRIPS output for Route Corridor 4 predicts that a reasonable proportion of city centre traffic will be attracted to the new link road. The outputs from the model indicate that Route Corridor 4 is predicted to encourage approximately 26% of the total city centre trips away from the city centre and onto the new link road in the opening year 2009. In contrast to Route Corridors 1, but as with Route Corridor 2 and 3, this proportion increases in the design year to 30%.

The key junctions summary statistics also indicate that all of the key junctions in the city will experience an increase in capacity (all remain within capacity in the design year 2024) when compared with the Do Minimum scenario. In the city centre the average junction saturation is reduced by 14% as a result of Route Corridor 4. In addition, each of the various links of the new link road are shown to be well within the 'Practical Link Capacity' in the future year 2024. Model output summary tables are included in Appendix D.

3.6.8 Summary

This route corridor shares many of the same properties as route corridors 1, and 2. The benefit that it has over the other corridors comes from its unique section between Station Road and Killylea Road. The total length of Route Corridor 4 is approximately 5.7km.

Geometric Summary

As a large portion of Route Corridor 4 lies on the line of a disused railway track it avoids many of the Topographical and Physical Constraints that influence some of the other route corridors. Where it deviates from this line it skirts the outer fringes of Glen Court and Legar Hill however it

is unlikely to injuriously impact upon these. For these reasons, Route Corridor 4 performs quite well against the assessment criteria of Topographical Constraints and Physical Constraints.

There are a large number of constraints involving access/egress for both vehicles and pedestrians alike. Station Road is the main area to be affected due to space constraints in physically fitting a carriageway along it.

As a number of bends with sub-standard radii are envisaged adjacent to Dukes Road and Moy Road, Departures and Relaxations from the Design Standards are likely. Subsequently Route Corridor 4 does not perform well against this section of the assessment criteria.

Corridor 4 has the potential to directly affect up to 13 properties whilst having an effect on up to 18 accesses.

Geotechnical Summary

This corridor has the potential to come into contact with four contaminated sites. EHS have classified one of these as High Risk with the other three being classified as Medium Risk.

Based on preliminary examination this corridor potentially has the second best earthworks balance.

Structural Summary

This corridor, as with all four, will require two large structures. The first, common to all four corridors, is the underpass at Drummanmore Road. There may be the potential to raise the existing road slightly to reduce the cut required to allow the link road passage beneath it.

The second significant structure will be at the site of the existing Callan Bridge, to the west of Desart Lane.

Culverts are common across all four corridors. The largest one is currently at Ballynahone River (at the northern end of Station road). A structural assessment would be required to assess its suitability with regard to retaining it.

Drainage Summary

This corridor has the potential to utilise a large proportion of the existing infrastructure as it extends through a significant portion of urban area. The utilisation of existing infrastructure will have to be modelled to ensure there is sufficient capacity. There is the opportunity to aesthetically enhance urban areas by the construction of soakaways. The design of embankments and cuttings will be carried out in close liaison with drainage experts to ensure that appropriate measures are taken to engineer out potential problems.

Traffic Summary

This corridor provides the least improvement in performance at city centre junctions, hence delivering the least reduction in congestion. Outputs from a preliminary traffic model predict that 26% of the total city centre trips will be encouraged to use this new route in 2009, with 30% in 2024.

The reduction in average junction saturation is 14% but has a slightly higher accident cost than for route corridors 1 and 2.

Summary of Effects of Public Utilities

A High Risk 33kV NIE cable exists from Portadown Road to Moy Road. This is overhead from Portadown Road to Station Road when it enters the Armagh North Substation. From this point onwards it is ducted underground.

There are no significant services identified in the section between Moy Road and the Monaghan Road. Any such services will not affect the alignment and can be dealt with by early service provider liaison and careful planning in the design stage.

The Engineering Assessment Tables (EAT) in Appendix A show the scoring of the above sub-objectives in tabular form. This is also further summarised in Section 10.0.

4.0 Environment

4.1 Introduction

The Environment section of the report is divided into 13 sections detailing key subject areas to ensure a comprehensive assessment process. Section 4.15 is an additional chapter producing a scoring for each route corridor under the key subject areas. The 14 sections are as follows:

Section 4.2 – Noise
Section 4.3 – Local Air Quality
Section 4.4 – Greenhouse Gases
Section 4.5 – Landscape
Section 4.6 – Townscape
Section 4.7 – Heritage of Historic Resources
Section 4.8 – Biodiversity
Section 4.9 – Water Environment
Section 4.10 – Physical Fitness
Section 4.11 – Journey Ambience
Section 4.12 – Disruption Due to Construction
Section 4.13 – Policies & Plans
Section 4.14 – Land Use
Section 4.15 – Stage 1 Scheme Assessment Report Environmental Conclusions

Headings 4.2 – 4.11 above correspond with the headings outlined in the Transport Analysis Guidance (TAG). The headings 'Disruption Due to Construction', 'Land Use' and 'Policies and Plans' have been added to the environmental section topic criteria to increase the robustness of the assessment process. These headings are extracted from the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3. Each of the topic areas are discussed, with descriptions of the baseline conditions, potential impacts of the proposals and an outline of potential mitigation measures. Each environmental assessment has been completed to a level of detail equivalent to DMRB Stage 1.

Four route corridors will be subject to analysis and assessment in the sections detailed above. A list of appendices referred to are given below:

C1 – Environmental Figures
C2 – Consultee Replies
C3 – Sites and Monuments Records (SMR) Sites
C4 – Industrial Heritage Records (IHR) Sites
C5 – Listed Buildings & Structures
C6 – Optimum Periods for Ecological Survey
C7 – Agricultural Land Classifications
C8 – Armagh Area Plan Details
C9 – Planning Applications Housing

Numerous figures were produced to accompany text and assist in highlighting important aspects of each subject area. A list of figures (22 in total) is given below:

1. Figure 4.1.1 Route Corridors
2. Figure 4.2.1 Noise Sensitive Receptors
3. Figure 4.3.1 Air Sensitive Receptors
4. Figure 4.5.1 Landscape Character Areas

5. Figure 4.5.2 Landscape Constraints
6. Figure 4.6.1 Townscape Constraints
7. Figure 4.7.1 Recorded Archaeological Sites (SMR Sites)
8. Figure 4.7.2 Industrial Heritage Sites (IHR Sites)
9. Figure 4.7.3 Historic Buildings
10. Figure 4.8.1a Area of Ecological Constraint
11. Figure 4.8.1b Area of Ecological Constraint
12. Figure 4.8.2 Solid Geology
13. Figure 4.8.3 Drift Geology
14. Figure 4.8.4 Soils
15. Figure 4.8.5 Agricultural Land Classifications
16. Figure 4.9.1 Watercourses & Predictive Flooding Areas
17. Figure 4.9.2 Hydrogeological
18. Figure 4.9.3 Groundwater Vulnerability
19. Figure 4.10.1 Cycle Routes
20. Figure 4.12.1 Disruption due to Construction
21. Figure 4.13.1 Armagh Area Plan 2004
22. Figure 4.14.1 Land Use

For clarity purposes each route corridor was illustrated as a broad centreline to enable all four corridors to be displayed on each figure.

Each Route Corridor assessed is then summarised under each subject area in an Appraisal Summary Table (AST) found in Appendix A.

4.2 Noise

The generation of noise is a significant issue when assessing the likely impacts of any new road scheme. Noise generated from traffic has two common components; the noise generated from the engine of the car and noise generated from the interaction of the car's wheels with the road surface. The former is the most dominant noise source when the car is progressing at low speeds while the latter becomes more dominant under free flow traffic conditions at moderate to high speeds. The former is dominated by low frequency noise while the latter is dominated by high frequency noise. The road traffic noise level perceived at any particular point derives from the accumulation of a range of noise sources, all of which are dependent on a range of factors including vehicle speed, road surface, road gradient, road characteristics and composition of traffic.

The potential impact of noise generated from a new road scheme is commonly assessed based on the scheme's potential to generate noise nuisance or 'a feeling of displeasure evoked by noise' (World Health Organisation description). Displeasure from noise may be reflected in numerous ways but commonly felt mechanisms are interference with speech intelligibility and sleep disturbance. Surveys conducted on noise nuisance demonstrate a considerable variation in the sensitivity of the subjects partaking and therefore, any reference to noise nuisance is likely to be based on the average conditions experienced. Although it has long been accepted that a change of 3dB (A) is required in the noise level before such a change will be subjectively perceived by a person, more recent studies suggest that human hearing may be sensitive to changes in noise levels as small as 1dB(A). This is equivalent to a 25% increase or a 20% decrease in traffic flow.

As part of the initial phase of assessing any likely noise impacts from the Armagh North & West Link scheme, the study area was assessed in accordance with the Stage 1 methodology

outlined in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 7 – Traffic Noise and Vibration and the Department for Transport document 'Transport Analysis Guidance' (TAG). A Stage 1 DMRB Assessment involves characterising the noise environment in the study area and identifying likely noise sensitive receptors that should be avoided when the preferred alignment is being determined. As part of this assessment, four broad route corridors were presented as possible corridors to place the alignment for the proposed road. Each of the four broad route corridors (Route Corridors 1-4) was assessed from the viewpoint of determining the potential noise impact associated with each corridor.

Sensitive receptors that are taken account of at this stage for such a road project include schools, hospitals, homes for the blind or for aged persons, places of worship, special habitats, laboratories containing sensitive instruments, heritage buildings, amenity areas and outdoor areas commonly used by people and which have a low ambient noise level (i.e.<50dBA). Such sensitive receptors are identified in Table 4.2.1 and Figure 4.2.1.

The DMRB Stage 1 assessment methodology for noise sets out the requirement to identify existing roads where traffic changes of plus or minus 25% is expected in the year the scheme is opened. The assessment methodology also sets out the requirement to estimate the number of houses within 300 metres of existing roads subject to traffic changes of over 25%, using 100m bands from the centre line. The first 100m band is replaced by two 50m bands for urban schemes as in this case.

4.2.1 Baseline Conditions

The study area consists of the entire western and northern portions of Armagh City and the rural countryside that fringes the northern and western portions of the city. Due to the presence of major roads in the northern and western portions of Armagh City, it is anticipated that ambient noise levels will be relatively high due to traffic flow in these areas. Route corridors in more built up areas are likely to experience varying traffic speeds and more congested traffic flows which will contribute significantly to noise and vibration levels. In the rural countryside that fringes the city, it is likely that noise levels are much lower than that experienced in the more built up areas of the city.

Potential noise sensitive receptors in the vicinity of the study area are outlined in Table 4.2.1 below. This table includes sensitive receptors such as schools, hospitals and churches as well as recreational areas such as playing fields. This table should be read in conjunction with Figure 4.2.1.

Sensitive Receptor:		
Number	**Name**	**Location**
Hospitals / Nursing Homes		
01	Greenpark Private Nursing Home	Irish Street
20	Longstone Hospital (south of Mullinure Lane)	Mullinure Lane
21	Longstone Hospital (north of Mullinure Lane)	Mullinure Lane
22	St Luke's Hospital	Loughgall Road

30	Mullinure Hospital	Loughgall Road
40	Fairlawns Residential Home	Drumcairn Road
Schools / Colleges		
02	Christian Brothers Primary School	Irish Street
03	St. Malachy's Primary School	Chapel Lane
04	St. Brigid's High School	Chapel Lane
05	St. Catherine's College Convent of the Sacred Heart (Junior Dept)	Callan Bridge Road
06	Mount St Catherine's Primary School	Windmill Hill
07	St. Catherine's College Convent of the Sacred Heart (Senior Dept)	Covent Road
08	The Queen's University of Belfast at Armagh	Callan Street
09	Armagh Secondary School	College Hill
10	Armstrong Primary School	Robinson Drive
11	Armagh College of Further Education	Lonsdale Road
12	Desart Lodge Nursery	Cathedral Road
13	College Farm Nursery School	Desart Lane Lower
14	St. Patrick's Grammar School	Banbrook Hill
15	Railway Street Nursery School	Railway Street
16	Armagh College of Further Education	Lisanally Lane
17	City of Armagh High School	Lisanally Lane
18	St. Patrick's Primary School	Loughgall Road
19	Lisanally Special School	Lisanally Lane
31	The Royal School	College Hill
32	Armagh College of Further Education	Station Road
Places of Worship		
23	St. Malachy's RC Church	Irish Street
24	St. Patrick's Cathedral (C of I)	Vicar's Hill
25	Armagh First Presbyterian Church	The Mall West
26	The Mall Presbyterian Church	Gosford Place
27	Methodist Church	Abbey Street
28	Convent	Cathedral Road
29	St. Patrick's Cathedral (RC)	Cathedral Road
33	Armagh City Temple	Drummanmore Road
34	Armagh City Elim Temple	East of Loughgall Road
35	Gospel Hall	The Mall West
36	Baptist Tabernacle	The Mall West
Other		
37	Lisanally House (Armagh & Dungannon HSS Trust)	Lisanally Lane
38	Cemetery	Desart Lane Lower
39	Health Centre	Friary Road
41	Tullyelmer House	Drumcairn Road
42	Umgola House	Monaghan Road
Recreation and Amenity Sites		
43	Tennis Court	Umgola Road
44	Tennis Courts	Irish Street
45	Playground	Umgola Row
46	The Athletic Grounds	Drumarg Park
47	Playing Field	D'alton Park
48	Playing Field	Friary Road
49	Playground	Drumarg Park

50	Playing Fields	Callan Bridge
51	Playing Field & Tennis Courts	Nursery Road
52	Playground	Windmill Hill
53	Playing Field	Navan Fort Road
54	Tennis Court and Playing Field	Nursery Road
55	Tennis Court	Windmill Hill
56	Playing Fields	The Mall west
57	Cathedral Road Playing Field, Playground, Tennis Court & All Weather Pitch	Cathedral Road
58	Playing Fields	Ballycrummy Road
59	Tennis Courts	Cathedral Road
60	Playing Fields	Moy Road
61	All Weather Pitch	Moy Road
62	All Weather Pitch, Playing Field and Tennis Courts	Alexander Road
63	Playing Fields and Abbey Park	Drumbreda Walk
64	Playing Field	Loughgall Road
65	Playground and All Weather Playing Field	Drumcairn Road
66	Armagh Youth Resource Centre	Lisanally Lane
67	All Weather Pitches and Playing Fields	Lisanally Lane
68	Tennis Court	Loughgall Road
69	Tennis Courts	Mullinure Park
70	Disabled Riding School	Mullinure Park
71	Armagh Planetarium	College Hill
72	Youth Centre	Lisanally Lane

Table 4.2.1: Potential Noise Sensitive Receptors within the Study Area

In addition to identifying the noise sensitive locations in close proximity to the broad route corridors, residential property counts were conducted for various distance bands from the centre line of each of the corridors. The results of these counts are illustrated below in Table 4.2.2.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Route Corridor 4
0 – 50m	201	48	4	20
50 – 100m	329	157	47	135
100 – 200m	501	465	244	403
200 – 300m	700	477	301	514
Total within 300m	1,731	1,147	596	1,072

Table 4.2.2: Residential Properties within 300m of Proposed Broad Route Corridors

Generally in rural areas noise levels typically are in the region of 30 – 40 dB(A) Leq, which is very low in comparison to noise levels typically experienced in the vicinity of busy roads, residential areas or industrialised areas. Much of the study area is in close proximity to busy roads such as the existing A3, A28, A29, B77 and B115 and also some industrial complexes and dense residential development. Detailed baseline surveys and assessment will be required at the later stages of the assessment process to determine the noise levels in the vicinity of noise sensitive receptors and houses in the area.

4.2.2 Impacts

Four broad route corridors have been presented at this stage in order to refine possible corridors for the Stage 2 assessment. These corridors are discussed under the following headings (which are illustrated in Figure 4.2.1):

Route Corridor 1
Route Corridor 2
Route Corridor 3
Route Corridor 4

All four Route Corridors connect the A3 Monaghan Road in the south west of Armagh City to the A3 Portadown Road in the north east of the city. All of the Route Corridors pass close to noise sensitive receptors (See Figure 4.2.1). A description of the potential impacts associated with each of the broad route corridors is presented below.

Route Corridor 1

Route Corridor 1 departs the A3 Monaghan Road just east of Milford and travels in a northern direction until it encounters the Killylea Road. From its junction with the Killylea Road, the route corridor continues east along the Killylea Road onto the Friary Road. The route corridor stays on-line with the Friary Road for a short section of road before being directed north, parallel and west of Drelincourt Close before the slip lane that connects Friary Road to Irish Street. The route corridor continues in a northerly trajectory crossing Navan Street, Windmill Hill and Cathedral Road until it reaches the Moy Road. At this point the corridor veers in a north east direction continuing along the existing Station Road. The route corridor then travels in an eastern pathway through rural countryside just north of the old railway line and residential properties at Drumman Hill before connecting up with the existing A3 Portadown Road at Drummanmore Grange.

Table 4.2.2 illustrates that this route corridor has 1,731 residential properties within 300m of the centreline of the corridor and 201 properties within 50m. While many of these properties will have already experienced high noise levels on account of roads already in existence, there are a significant number of properties that would experience an elevated noise level on account of this route corridor. This is especially the case as the route corridor travels between the Moy Road and Friary Road.

This Route Corridor passes close to a large number of the sensitive receptors indicated in Figure 4.2.1, including Longstone Hospital, St Luke's Hospital, Armagh College of Further Education, St. Patrick's Cathedral, the Queens University of Belfast at Armagh, St. Brigid's High School, Mount St. Catherine's Primary School and St. Catherine's College Convent of the Sacred Heart.

Overall, this route corridor would pass close to the largest number of residential properties and sensitive receptors. Between the Moy Road and Friary Road, this route corridor would pass in close proximity to a large number of residential properties that are not at present adjacent to a busy noisy road. For this reason, this route corridor has been categorised as having a Major Adverse impact.

Route Corridor 2

Route Corridor 2 takes a similar initial path to Route Corridor 1 but travels further north and just east of the junction of the Navan Fort Road and Ballycrummy Road. From here it veers north

east over the Callan Bridge Road and then in between The Hermitage and Daire's Willows before crossing the Moy Road. From the Moy Road, the route corridor takes the same trajectory as Route Corridor 1.

Table 4.2.2 illustrates that this route corridor has 1,147 residential properties within 300m of the centreline of the corridor and 48 properties within 50m. A significant portion of these properties will already be experiencing high noise levels on account of their urban setting. However, some of these properties may experience elevated noise levels as a result of the construction of a new road along this Route Corridor. This is especially the case for properties in the vicinity of The Hermitage, Daire's Willows, Oldpark, Cathedral Mews and the Callan Bridge Road.

This route corridor passes close to a significant number of the sensitive receptors indicated in Figure 4.2.1, including Longstone Hospital, St. Luke's Hospital, Armagh College of Further Education, Desart Lodge Nursery and College Farm Nursery School.

Overall, this route corridor passes within close proximity to a significant number of residential properties and sensitive receptors and therefore, it is deemed to have a Moderate Adverse impact.

Route Corridor 3

Route Corridor 3 takes the same initial path as corridors 1 and 2 but continues in a northerly pathway along the western fringe of Armagh City until it reaches Moy Road. From here the route corridor arches in an eastern direction just north of Tullyelmer House but south of Fairlawns Residential Home. Travelling further eastwards, the route corridor passes north of the residential properties at Drumsill Park and Drumman Park before taking a south eastern trajectory towards its meeting point with the existing A3 Portadown Road at Drummanmore Grange.

Table 4.2.2 illustrates that this route corridor has 596 residential properties within 300m of the centreline of the corridor and 4 properties within 50m. This is significantly less than all of the other route corridors. While the number of properties likely to be impacted is significantly less, the impact on some of these receptors may be significantly greater due to the rural nature of their setting.

This route corridor passes close to several sensitive receptors indicated in Figure 4.2.1, including Fairlawns Residential Home and Tullyelmer House.

Overall, there are only 4 residential properties within 50m of this route corridor and aligned with the fact that there are few sensitive receptors within close proximity to it, this route corridor has been rated as having a Slight Adverse impact with regard to noise impacts.

Route Corridor 4

Route Corridor 4 takes the same pathway north from the existing A3 Monaghan Road as Route Corridor 3 but turns immediately eastwards along the path of an old disused railway line before reaching the Moy Road. This pathway takes the route corridor to a more urban connection with the Moy Road, after which the route corridor takes the same pathway as Route Corridors 1 and 2.

Table 4.2.2 illustrates that this route corridor has 1,072 residential properties within 300m of the centreline of the corridor and 20 properties within 50m. This route corridor passes close to a significant number of the sensitive receptors indicated in Figure 4.2.1, including Longstone Hospital, St. Luke's Hospital, Armagh College of Further Education and a cemetery.

Overall, due to the relatively high number of residential properties in close proximity to this route corridor, it has been labelled as having a Moderate Adverse impact.

Impact Conclusion

There are a large number of residential properties and sensitive receptors in close proximity to Route Corridor 1, especially within 50m of the centreline of the route corridor. Therefore, this Route Corridor is likely to have a Major Adverse impact in noise terms if chosen. Both Route Corridor 2 and Route Corridor 4 will impact upon a significant number of residential properties and have been deemed to have a Moderate Adverse impact. Route Corridor 3 takes a pathway outside the urban areas of Armagh City and with only 4 residential properties and no sensitive receptors within 50m of the route corridor, is deemed to have a Slight Adverse impact.

4.2.3 Mitigation

If noise levels for affected properties are found to be in breach of the Noise Insulation (Northern Ireland) Regulations (1995) mitigation measures would be required. Possible mitigation measures include earth mounding or boundary fencing, the use of quieter road surfaces and if necessary, compensatory measures (e.g. secondary glazing). Carefully recommended and designed boundary fencing can achieve up to 10 dB(A) reduction in noise levels at noise sensitive locations that are predicted to suffer significant noise impacts as a result of the construction of such a proposed route. Low noise surfaces are also proven to result in noise reductions of typically 3 – 4 dB(A). Some of the proposed corridors pass close to densely populated residential areas and if these are selected, it is likely that there would be a significant noise impact at these locations. Where any impacts are predicted to be significant in terms of the relevant legislative limit values appropriate mitigation measures will be recommended.

4.3 Local Air Quality

A desktop survey of local air quality within the vicinity of the proposed development scheme was carried out in order to determine existing baseline conditions and potential impacts from the proposed route corridors. Preparation of this section has involved a review of the following information:

Ordnance Survey of Northern Ireland (1990) Discovery Series 1:50,000 map Sheet 19 – Armagh;
Ordnance Survey of Northern Ireland 1:10,000 scale plan; and
Air quality monitoring documentation.

Property counts have been carried out in the vicinity of the proposed route corridors which have been split into the following distance bands: 0 – 50m, 50 – 100m, 100 – 150m and 150 – 200m from the centre of the proposed route corridors.

4.3.1 Baseline Conditions

Over the preceding ten years a legal framework has been developed in the European Union which aims to protect and improve air quality. EC Directive 96/62/EC on ambient air quality assessment and management established a framework through which the European Union will agree limit or target values for air pollutants. The limits within the EC Directive were implemented in the UK by the Air Quality Limit Value Regulations.

The Limit Value Regulations set air quality standards for a range of air pollutants including NO_2. The UK Government has published an Air Quality Strategy which sets out how the Government proposes to fulfil the UK's obligations under the Air Quality Directive.

The Air Quality Strategy includes more exacting objectives for some pollutants. The Air Quality Strategy (AQS) for England Scotland, Wales and Northern Ireland sets out the policy, targets and objectives for air pollutants up to 2010.

Part IV of the Environment Act 1995 requires local authorities to review and assess local air quality. The local authority is obliged to take any potential exceedance of air quality objectives into account.

Where the air quality objectives are likely to be exceeded then the relevant local authority must declare an air quality management area. Under the guidance to local authorities published by Department for Environment Food and Rural Affairs (DEFRA), local authorities are required to carry out a staged assessment of local air quality.

The Technical Guidance to local authorities for the review and assessment of air quality was updated in February 2003. This Guidance sets out the methods to be used to determine if the air quality objectives up to the year 2010 are likely to be achieved. Policy Guidance Northern Ireland LAQM PGNI(03) issued under Part III of the Environment (Northern Ireland) Order 2002, Local Air Quality Management, is designed to assist relevant authorities, district councils and public bodies with their local air quality management duties. The guidance requires that local authorities integrate air quality considerations into the planning process at the earliest possible stage. As a result, the land use planning system is integral to improving air quality.

PGNI(03) sets out those circumstances where air quality may be a material issue for planning applications and provides guidance to planning authorities on making these decisions. It states that air quality is likely to be particularly important:

where the development is proposed inside, or adjacent to, an AQMA;
where the development could in itself result in the designation of an AQMA;
where the development, including associated traffic, is likely to result in the deterioration of local air quality; or
where to grant planning permission would conflict with, or render unworkable, elements of a local authority's air quality action plan.

Air pollutants have the potential to impact upon the study area as there are many sensitive receptors, including residential properties, hospitals, schools and colleges. Table 4.3.1 summarises receptors in the study area which may be particularly sensitive to air pollution, due to extensive residential development this table excludes residential units. Residential areas have been identified in Figure 4.14.1.

Potential air quality sensitive receptors (excluding residential properties) in the vicinity of the study area are outlined in Table 4.3.1 below. This table should be read in conjunction with Figure 4.3.1.

Sensitive Air Receptor:		
Number	**Name**	**Location**
Hospitals / Nursing Homes		
01	Greenpark Private Nursing Home	Irish Street
20	Longstone Hospital (south of Mullinure Lane)	Mullinure Lane
21	Longstone Hospital (north of Mullinure Lane)	Mullinure Lane
22	St. Luke's Hospital	Loughgall Road
30	Mullinure Hospital	Loughgall Road
Schools / Colleges		
02	Christian Brothers Primary School	Irish Street
03	St. Malachy's Primary School	Chapel Lane
04	St. Brigid's High School	Chapel Lane
05	St. Catherine's College Convent of the Sacred Heart (Junior Dept)	Callan Bridge Road
06	Mount St. Catherine's Primary School	Windmill Hill
07	St. Catherine's College Convent of the Sacred Heart (Senior Dept)	Covent Road
08	The Queen's University of Belfast at Armagh	Callan Street
09	Armagh Secondary School	College Hill
10	Armstrong Primary School	Robinson Drive
11	Armagh College of Further Education	Lonsdale Road
12	Desart Lodge Nursery	Cathedral Road
13	College Farm Nursery School	Desart Lane Lower
14	St. Patrick's Grammar School	Banbrook Hill
15	Railway Street Nursery School	Railway Street
16	Armagh College of Further Education	Lisanally Lane
17	City of Armagh High School	Lisanally Lane
18	St. Patrick's Primary School	Loughgall Road
19	Lisanally Special School	Lisanally Lane
31	The Royal School	College Hill
32	Armagh College of Further Education	Station Road

Table 4.3.1: Air Quality Sensitive Receptors within the Study Area

Residential property counts have been carried out for the four proposed route corridors, the results of which have been tabulated below.

	Route Corridor 1	**Route Corridor 2**	**Route Corridor 3**	**Route Corridor 4**
0 – 50m	201	48	4	20
50 – 100m	329	157	47	135
100 – 150m	246	209	104	173
150 – 200m	255	256	140	230
0 – 200m	*1031*	*670*	*295*	*558*

Table 4.3.2: Residential Properties Counts within the Vicinity of the Proposed Route Corridors

4.3.2 Review and Assessment of Air Quality

Air quality in Armagh district has been monitored and reported as part of the Review and Assessment process since 2000, which has included monitoring of NO_2, SO_2 and PM10. Armagh City and District Council issued a Stage 2 update and Stage 3 Review and Assessment report in 2003. The most recent air quality monitoring report published by the Environment and Heritage Service (EHS) was released in December 2005 and details the findings from

monitoring across Northern Ireland during 2004. The EHS report concluded that, air quality during 2004 in Armagh was generally considered good. The annual average NO2 concentration measured at a continuous monitoring roadside location on Lonsdale Road, achieved the AQS objective of 40µg.m-3 during this period. NO_2 concentrations were also measured using diffusion tubes at a number of sites, including one within the study area, and four in the vicinity of its western boundary, the results of which are presented in Table 4.3.3.

Description	x	y	NO_2
17 Folly Lane	288200	344800	15.0
Bridge House, Barrack Street	287900	345000	28.0
Lower Irish Street	287400	344800	24.0
Mallview Terrace	287900	345200	41.0
Portadown Road	288700	345900	24.0

Table 4.3.3 - Annual Mean NO_2 Diffusion Tube Roadside Results for 2004 from Armagh City and District Council (µg.m-3)
x & y: grid square locations

The AQS annual NO_2 objective was achieved at four of the sites during 2004, whilst the concentration was slightly in breach of it at the Mallview Terrace site. For the pollutants SO_2 and PM10, annual mean measured concentrations were within the relevant AQS objectives. Moreover there was no requirement to designate an Air Quality Management Area (AQMA) within the jurisdiction.

The findings of the EHS report suggest that air quality is relatively good in the wider study area; however it is likely that pollutant concentrations will be increased in the vicinity of major roads and congested routes.

Table 4.3.4 summarises the range of background pollutant concentrations across the study area, which have been collated from the UK National Air Quality Information Archive. The archive provides estimates of pollution concentrations across the UK at a resolution of 1 km^2 for the Air Quality Strategy objective year of the specified pollutant. Data from this source have been collected for the grid squares representative of the study area. As anticipated the highest concentrations have been predicted for those grid squares which represent Armagh City urban area.

Pollutant	Estimated Concentration ($\mu g.m^{-3}$)	Annual Mean Objective (Year)
Oxides of Nitrogen (NO_x)	11.6 – 12.9	- (2005)
	9.4 – 10.2	- (2010)
Nitrogen Dioxide (NO_2)	9.1 – 10.2	40 $\mu g.m^{-3}$ (2005)
	7.4 – 8.0	40 $\mu g.m^{-3}$ (2010)
Particulate Matter (PM_{10})	15.0 – 15.3	40 $\mu g.m^{-3}$ (2004)
	14.2 – 14.5	*20 $\mu g.m^{-3}$ (2010)
Sulphur Dioxide (SO_2)	1.1 – 4.6	- (2001)
Benzene (C_6H_6)	0.23 – 0.30	16.25 $\mu g.m^{-3}$ (2003)
	0.21 – 0.27	3.25 $\mu g.m^{-3}$ (2010)
Carbon Monoxide (CO)	0.18 – 0.19	- (2001)
1,3-butadiene	0.06 – 0.06	2.25 $\mu g.m^{-3}$ (2003)

Table 4.3.4 Annual Mean Background Air Pollutant Concentrations in the Study Area
- No annual mean objective for this pollutant
* Provisional objective

4.3.3 Impacts

Route Corridor 1

As Route Corridor 1 traverses the urban and suburban areas of Armagh City it has the potential to influence air quality at numerous sensitive receptors. Property counts carried out for this corridor indicate that there are 1031 residential properties within 200m of the centre. The greatest concentrations of residential properties are situated within the 50 – 100m band, whilst the fewest are located within the 0 – 50m band. Other sensitive receptors within its vicinity include a church, two hospitals, two playschools, two colleges and four schools.

It is anticipated that where the route is on-line changes in local air quality will not be significant, however where a section of the link represents a new route in an area changes in traffic related pollutant concentrations may be significant. For example in the western section of the corridor, where the route veers from Friary Road heading north to Navan Street the route is positioned within 7m of properties at Drelincourt Close.

Due to the proximity of route Corridor 1 to sensitive receptors it has the potential to have a moderate adverse impact on local air quality.

Route Corridor 2

There are many sensitive receptors within the vicinity of Corridor 2 as it is proposed to cross through the suburban and urban landscape of Armagh City. Property counts indicate that the greatest concentration falls within the 150 – 200m band, whilst there are 48 properties within the 0 – 50m band.

The route corridor may have a significant impact on local air quality at sensitive receptors to the west of Convent Road, which are situated within 10m of the proposals. Also located within 200m of the proposed route corridor are a church, two colleges, two hospitals, a playschool, and four schools, which may also be sensitive to changes in local air quality.

Route Corridor 2 has the potential to have a moderate adverse impact on local air quality.

Route Corridor 3

The rural location of this corridor reduces the number of sensitive receptors within its vicinity, however local air quality may be significantly impacted at those existing receptors due to the potential increase in traffic flows and associated pollutants.

Residential property counts indicate that from the centre of the corridor out to 200m there are a total of 295 properties. The least number of properties are situated in the 0 – 50m and total 4, whilst the greatest concentration is in the 150 – 200m at 140. No other sensitive receptors have been identified within 200m of the route corridor 3.

Route Corridor 3 has the potential to have a slight adverse impact on local air quality.

Route Corridor 4

Corridor 4 is anticipated to have the greatest influence on local air quality to the west and east of Moy Road, and west of Drummanmore Road where the largest concentration of sensitive receptors are located. Along the entire length of the corridor there are 558 residential properties located between the centre of the proposed route and out to 200m. The least number of

properties falls within the 0 – 50m band. Other sensitive receptors within 200m of the route include two hospitals, a college, playschool and a high school.

Route Corridor 4 has the potential to have a slight adverse impact on local air quality.

4.3.4 Impact Conclusion

It is anticipated that the greatest impact on local air quality will arise from Route Corridors 1 and 2, due to the proximity of these routes to sensitive receptors within Armagh urban area. Route corridors 3 and 4 will also change traffic related pollutant concentrations in the area, however the relatively more rural location of these routes reduces the number of sensitive receptors within the vicinity.

4.3.5 Mitigation

The scope for mitigation of any adverse effect on greenhouse gases through route choice or design is limited in comparison with reductions in emission rates achievable through improved vehicle technology. EU Directives have outlined improved emission criteria, which manufacturers are required to achieve from vehicles produced in the past and even more stringent requirements which they must achieve in future years. This is a trend that has been in operation for many years and is destined to continue in future years for both cars and heavy goods vehicles. The UK MOT test has helped to reduce transport emissions by ensuring that all vehicles over 3 years old undergo an emissions test. In Northern Ireland the MOT test differs slightly from the UK test. Under the Northern Ireland testing system, cars and motorcycles over 4 years old, LGV's over 3 years old and HGV's over 1 year old are tested. The two exhaust gases that are checked are carbon monoxide and hydrocarbons.

Route specific mitigation measures can include either controlling the number of road users or by controlling the flow of traffic. Emissions tend to be higher under stop-start conditions when compared with steady speed driving. The free flow of traffic on routes allows for the generation of lower concentrations of traffic related pollutants due to more steady speed driving.

References

DEFRA 2003. Review and Assessment Technical Guidance TG(03).

Local Air Quality Management – Policy Guidance Northern Ireland (PGNI(03)).

Netcen 2003. Armagh City and District Council Stage 2 Update and Stage 3 Review and Assessment. Report to Armagh City and District Council.

Department of the Environment Air Quality \ Monitoring in Northern Ireland 2004. December 2005. Environment and Heritage Services.

The UK National Atmospheric Information Archive http://www.airquality.co.uk/archive/index.php

4.4 Greenhouse Gases

A desktop survey of regional air quality was carried out in order to determine existing baseline conditions and potential impacts from the proposed route corridors. Preparation of this section has involved a review of the following information:

Ordnance Survey of Northern Ireland (1990) Discovery Series 1:50,000 map Sheet 19 – Armagh;
Ordnance Survey of Northern Ireland 1:10,000 scale plan; and
Air quality documentation.

4.4.1 Baseline Conditions

Road schemes have the potential to change air quality at a local level, however there may also be changes in the overall quantity of emissions from the traffic on the road network following implementation of the scheme. Pollutants can contribute to more widespread deterioration of regional air quality and impacts such as the formation of photochemical oxidants, acid deposition and the greenhouse effect.

There have been a number of international protocols developed globally to determine agreed targets for reductions in global air emissions. Most recently the Kyoto Protocol was adopted by parties to the United Nations Framework Convention on Climate Change. Under this agreement the United Kingdom has set a legally-binding target to cut emissions of six greenhouse gases by 12.5% by 2008 to 2010, and a domestic goal of a 20% cut in emissions of carbon dioxide (CO_2) below 1990 levels by 2010.

The Greenhouse Gas Inventory Report for England, Scotland, Wales and Northern Ireland 1990 – 2003 was submitted to DEFRA in 2005. The findings of this report indicate that total emissions of CO_2 in NI accounted for 2.8% of the UK total in 2003 and have declined since 1990 by 3.4%. The energy industry is the largest source if CO_2 in NI, whilst road transport is the next largest source. It was estimated that 27.1% of CO_2 emissions in 2003 arose from road transport. Overall in the UK the contribution from NI roads accounted for 2.6% CO_2. These emissions have risen by 34.7% from 1990 to 2003 in NI compared with an 8.2% rise for the UK as a whole. Another important pollutant associated with road transport is nitrous oxide (N_2O). It was determined that road transport contributed 6.6% of the total 2003 NI N_2O.

CO_2 is considered to be the most important greenhouse gas and therefore it is used as a key indicator for the purposes of assessing the impacts of transport on climate change. When assessing a proposed road scheme the total amount of emissions associated with a particular route is determined rather than air quality at a specific location.

4.4.2 Impacts

No traffic data was available for this stage of the assessment and therefore greenhouse gases have not been quantified. However regional emissions of CO_2 arsing from proposed route corridors will be calculated at later stages of the assessment process. These emissions are calculated as the product of the route corridors length, its effective traffic flow and the emission rate per vehicle-kilometre provided by outputs from the Design Manual for Roads and Bridges Screening Model. For the purposes of this type of assessment the route corridor under consideration is broken down into sections (road links) according to traffic fleet characteristics,

based on 24-hour two-way flows provided as Annual Average Daily Traffic (AADT) containing the percentage of Heavy Duty Vehicles and average traffic speeds. The total emissions from the route being assessed are derived from the sum outputs of each of its constituent road links.

Impact Conclusion

It is anticipated that the greatest quantity of CO_2 will be emitted from the longest route corridor due to most vehicle miles travelled. Route corridors 1 – 4 measure 5.9, 5.4, 6.6 and 5.8 km respectively. Therefore route corridor 3 is predicted to emit the greatest total amount of CO_2.

4.4.3 Mitigation

The scope for mitigation of any adverse effect on air quality through route choice or design is limited in comparison with reductions in emission rates achievable through improved vehicle technology. EU Directives have outlined improved emission criteria, which manufacturers are required to achieve from vehicles produced in the past and even more stringent requirements which they must achieve in future years. This is a trend that has been in operation for many years and is destined to continue in future years for both cars and heavy goods vehicles. The UK MOT test has helped to reduce transport emissions by ensuring that all vehicles over 3 years old undergo an emissions test. In Northern Ireland the MOT test differs slightly from the UK test. Under the Northern Ireland testing system, cars and motorcycles over 4 years old, LGV's over 3 years old and HGV's over 1 year old are tested. The two exhaust gases that are checked are carbon monoxide and hydrocarbons.

References

Design Manual for Roads and Bridges. Volume 11. Environmental Assessment. DETR. 2000.

Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2003. Department for Environment, Food and Rural Affairs. 2005.

4.5 Landscape

This section of the environmental appraisal considers the landscape and visual impacts of the proposals.

This chapter should be read in conjunction with Figure 4.5.1 and Figure 4.5.2 which show Landscape Character Area and Landscape Constraints respectively.

The following text describes the key terminology used in the landscape assessment of baseline conditions in the vicinity of the proposed scheme.

Landscape Resource

The combination of elements that contribute to landscape context, character and value.

Landscape Value

The relative value or importance attached to a landscape that expresses national, regional or local consensus because of intrinsic characteristics.

Landscape Character

The distinct and homogenous pattern that occurs in the landscape. This is a composite of physical, social and cultural elements reflecting geological, landform, soil, vegetation and human influences.

Landscape Quality

The assessment of the landscape quality assesses the value of the landscape in relation to its rarity, location and landscape character attributes. In general, the higher the quality of landscape the more sensitive it will be to change.

Based on information gathered as part of the classification of the landscape, it is possible to assess the landscape quality of the study area using the methodology described in the DMRB. This has been completed using a 5-point scale as follows:

a) Highest quality - the landscapes of highest quality are, by definition, landscapes of an ‘awe inspiring’ or ‘sublime’ nature and are important on an international and national level.
b) Very attractive - this definition relates to landscapes which are still of high value nationally and can be defined as highly scenic.
c) Good landscape - this category contains areas that, although still attractive, have less significant and more common landscape features.
d) Ordinary landscape - this category contains areas that have only common landscape features and some intrusive elements such as conspicuous infrastructure with scope for improvement in management.

Poor landscape – this category includes areas that contain frequent detracting aspects and/or lack of management results in a degraded landscape with very few valued features.

Landscape sensitivity is used to establish the capacity of the landscape to accommodate the type of development proposed and is defined as follows:

High Highest/Very Attractive landscape quality with highly valued or unique characteristics susceptible to relatively small changes;
Medium Good landscape quality with moderately valued characteristics reasonably tolerant of changes;
Low Ordinary/Poor landscape quality with common characteristics capable of absorbing substantial change.

Magnitude of Landscape Resource Change

Direct resource changes on the landscape character of the study area are brought about by the introduction of the proposal and its effects on the key landscape characteristics.

The following categories and criteria have been used:

Category	Criteria
High	Total loss or alteration to key elements of the landscape character, which result in fundamental and / or permanent long-term change.
Medium	Partial or noticeable loss of elements of the landscape character and / or medium-term change.
Low	Minor alteration to elements of the landscape character and / or short-term/ temporary change.

Significance of Landscape Impact

The level of significance of impact on landscape character is a product of landscape sensitivity and the magnitude of change in landscape resource as indicated in the Table 4.5.1.

Magnitude of landscape resource change	Landscape Sensitivity		
	Low	Medium	High
No change	No change	No change	No change
Low	Slight	Slight / moderate	Moderate
Medium	Slight / moderate	Moderate	Moderate / major
High	Moderate	Moderate / major	Major

Table 4.5.1: Significance of Landscape Impact

Visual assessment has also been carried out for the baseline situation within the study area and below is the text that is used to describe the key criteria and terminology used in the visual assessment.

Visual Amenity

Visual amenity is the value of a particular area or view in terms of what is seen by the viewer. This value may be influenced by the physical condition of the landscape viewed and the contribution the characteristics of the view make to the local environment.

Visual Resources

Visual resources are the overall key elements/features/characteristics that combine to make a view.

Viewer Sensitivity

Viewer sensitivity is a combination of the sensitivity of the human receptor (i.e. resident; commuter; tourist; walker; recreationist; or worker) and the quality of view experienced by the viewer.

Category	Typical criteria
High sensitivity	e.g. users of an outdoor recreation feature which focuses on the landscape; valued views enjoyed by the community; tourist visitors to scenic viewpoint; occupiers of residential properties with a high level of visual amenity.
Medium sensitivity	e.g. users of outdoor sport or recreation which does not offer or focus attention on landscape; occupiers of residential properties with a medium level of visual amenity.
Low sensitivity	e.g. regular commuters, people at place of work; occupiers of residential properties with a low level of visual amenity.

Magnitude of Visual Resource Change

The magnitude of change in visual resource or amenity results from the scale of change in the view with respect to the loss or addition of features in the view and changes in the view composition, including proportion of the view occupied by the proposed development. Distance and duration of view must be considered. Other infrastructure features in the landscape and the backdrop to the development will all influence resource change.

Category	Criteria
High	Total loss or alteration to key elements/ features/ characteristics of the existing landscape or view and/or introduction of elements considered totally uncharacteristic when set within the attributes of the receiving landscape or view.
Medium	Partial loss or alteration to key elements/ features/ characteristics of the existing landscape or view and/or introduction of elements that may be prominent but not necessarily substantially uncharacteristic when set within the attributes of the receiving landscape/view.
Low	Minor loss or alteration to key elements/ features/ characteristics of the existing landscape or view and/or introduction of elements that may not be uncharacteristic when set within the attributes of the receiving landscape/view.

No change	Very minor loss or alteration to key elements, features, or characteristics of the existing landscape or view and/or introduction of elements that are not uncharacteristic when set within the attributes of the receiving landscape/view.

Significance of Visual Impact

Significance of visual impact can only be defined on a project by project basis responding to the type of development proposed and its location. The principal criteria for determining significance are magnitude of visual resource change and viewer sensitivity.

Table 4.5.2 illustrates significance of visual impact as a correlation between viewer sensitivity and magnitude of visual resource change.

Magnitude of visual resource change	**Visual Sensitivity**		
	Low	**Medium**	**High**
No change	No change	No change	No change
Low	Slight	Slight / moderate	Moderate
Medium	Slight / moderate	Moderate	Moderate / major
High	Moderate	Moderate / major	Major

Table 4.5.2: Significance of Visual Impact

The degree of impact will be a factor of the dominance of the road, the distance away from the viewer, the perceptions of the landscape and finally the opportunities for mitigation.

In terms of landscape, a qualitative assessment was made, using a seven-point scale to score the assessment. The terminology used in this scale is based on the Department of Transport 'Transport Analysis Guidance' document Sub-Objective 3.3.7. The assessment considered key features and elements present and typical in the local landscape. Indicators such as Scale it Matters, Rarity, Importance and Substitutability are considered. Scale it matters refers to the geographical scale at which particular attribute or feature matters to policy makers or stakeholders. A quantitative assessment is not applicable to this section however a brief visual survey was undertaken and culminated in the award of the overall qualitative assessment description in the Appraisal Summary Table (AST).

4.5.1 Baseline Conditions

A broad description of the baseline landscape character is provided within the Environment & Heritage Service (EHS) Northern Ireland Landscape Character Assessment Series 1999 where the proposed site falls within the Armagh 95/15 Series. The area of the proposed route corridors has been characterised as the "Armagh Drumlins" Landscape Character Area No. 66. This landscape character area is characterised by the following:

> Rolling drumlin landscape covering a large area and crossed by a large number of small river valleys.

Hedgerow and tree belts separate field systems which consist of improved pasture and orchards.
Scattered rural housing and farms.
Wooded historic estates and parkland landscapes.
Open views across the landscape from elevated locations while enclosed landscapes are found between drumlins.
Significant archaeological sites.

The surrounding landscape setting for Armagh is dominated by drumlins that are a key characteristics of the study area. Drumlins are generally orientated north-south and cover an extensive area. The hollows between the drumlins provide a sense of enclosure for the landscape and prevent long distance views from within this landscape. The Carrigatuke Hills are located to the south and views across the Armagh Drumlin landscape are available from the hills. Numerous small rivers and streams cross the area, most draining into the River Callan. In wetter locations small lakes and bogs occupy the hollows between drumlins. Improved pastures that are subdivided by hedgerows and tree belts dominate the agriculture of the area. There are a number of historic estates and parks that are defined by stone walls and mature wooded areas. The nearest estate to the site is the Palace Demesne. This estate has been identified as "distinctive landscape" by the Environment & Heritage Service. A further distinctive landscape feature identified by EHS is the Callan River corridor that meanders along the western and northern side of Armagh City with tree lined banks. The estate landscape surrounding Manor House at Milford has also been identified as a distinctive landscape by EHS. EHS have identified the landscape north east of the village of Milford as a buffer area to prevent the coalescing of Milford and Armagh City. A number of key views are identified by EHS on the west and north side of Armagh. All key views are back towards Armagh from; A29 Keady Road; B115; from Aghanore west of the A29 Moy Road; from the Grange off the B77.

Armagh is a cathedral city with a distinctive landscape setting and striking landmarks. Of particular note are the hill top Cathedrals that are visible from a wide area within and around the city. The city centre has a strong historic core laid out in narrow concentric streets with radial streets providing linkages and vistas to the surrounding lower lying landscapes. The Mall is located adjacent to the city centre within the historic core and is one of the most important urban open spaces in Ireland. Georgian buildings surround the Mall while the surrounding landscape is rich in significant archaeological sites. The city has a drumlin setting and the cathedral, churches, observatory, monuments and Palace Demesne are all striking local hilltop landmarks, visible from the main approach routes from Newry, Portadown, Moy/Dungannon, Killylea, Keady and Monaghan. To the south of Armagh City the landscape is more elevated with long views to the city available. The wooded grounds of the Palace Demesne now incorporating a golf course and recreational grounds form a green wedge that extends north to the heart of the city. To the north east of the city the wooded grounds and lakes of Mullaghbane Park (surrounding Castle Dillon House) form a particularly attractive entrance to the city.

The EHS NI Landscape Character Assessment states the principles for accommodating new development as follows.

New development should be located on the mid slopes of drumlins and blend with existing landform.
As far as possible, existing hedgerows should be retained and reinforced.
Armagh City is identified as extremely accessible and has a strong visual link with its hinterland. Each main approach road has important views of the city that require particular attention. New development at these gateways should be avoided to maintain the character of the existing approaches.

There is scope for development in the low lying areas of drumlins where impact on the approaches is avoided. Preference is stated for low lying areas between drumlins to be used for open space, liner footpaths and cycleway routes into the city.
Particular care is needed with regards to development that crosses drumlin tops.
The distinctive gateways into the city would benefit from additional planting and new development should reflect the use of local materials and native plant species.
EHS state that there is no scope for further development on the west and south side of Armagh.
Key junctions of radial roads on the edge of the city centre would benefit from quality buildings and open spaces.
The immediate setting of each of the city's key landmarks are identified as important.

4.5.2 Impacts

Route Corridor 1

This corridor crosses an area identified as "distinctive landscape" by EHS along the Callan River between the Monaghan Road and the Killylea Road. From the Killylea Road this corridor crosses an urban landscape on the edge of the historic city centre core. At Station Road the commercial/light industrial units may be injuriously affected and this is factored into the townscape impact scores. From Loughgall Road to Portadown Road this corridor crosses urban fringe agricultural lands. Significant embankments and cuttings are required across this agricultural landscape that are common to all the proposed corridors. There is potential for high levels of visual intrusion at Killylea Road, Windmill Hill to Moy Road and at Loughgall Road. Overall a qualitative assessment of moderate adverse was awarded.

Route Corridor 2

This route corridor is the same as corridor 1 apart for the mid section between Navan Fort Road and Moy Road where it follows a more direct route across part agricultural lands and part urban residential development where potential for significant visual intrusion exists. Along this mid section there is a potential requirement for a deep cutting that would be a significant scar in the immediate landscape. This route crosses the Callan Rivercorridor several times as with route corridor 1. From Moy Road to Portadown the impacts are as route corridor 1. Overall a qualitative assessment of moderate adverse was awarded.

Route Corridor 3

This corridor follows the longest corridor around the outskirts of the city. Throughout its length this corridor crosses an agricultural landscape. This corridor has potential to impact on three key views identified by EHS. A series of high embankments and deep cuttings are potentially required to cross the undulating drumlin landscape around Armagh City. This corridor has the lowest potential for visual impacts on residential properties. Overall due to the impact on landscape a qualitative assessment of moderate adverse was awarded.

Route Corridor 4

This route corridor is again similar to corridor 1 with the exception of its mid section between Killylea Road and Moy Road where the corridor follows a more westerly alignment through agricultural landscape and along an old railway embankment. There is scope for lower levels of visual intrusion on residential properties with this corridor than either 1 or 2. From Moy Road to Portadown the impacts are as route corridor 1. Overall a qualitative assessment of slight adverse was awarded.

Impact Conclusion

Overall route corridor 4 is marginally preferred to the other 3 corridors.

4.5.3 Mitigation

The choice of corridors should avoid potential adverse landscape impacts on areas identified as having high sensitivity. Route Corridors should have a good fit and avoid crossing ridgelines and drumlin summits. Existing vegetation should be retained where possible. Damage or loss of landscape features such as woodland, hedges, water features, rivers or field systems should be avoided or minimised. Route Corridors that aim to avoid sensitive landscapes are considered preferable.

The Route Corridors cross areas of residential landscape and as such there is potential for high levels of visual intrusion. Selection of corridors should avoid impacts on residential properties as much as possible by choosing the most sensitive route corridor. Route Corridors that would result in reduced visual impact are considered preferable.

There are many varied mitigation techniques available, the use of which will depend on the specific design characteristics of the route corridors. Typical techniques include: on and off-site planting; mounding; earth shaping; new water features and sensitive design of structures, alignment, roadside ditches and fences. New structures such as wall and bridges should use local construction materials where possible.

4.6 Townscape

With regard to aspects of townscape it was possible to give an initial indication of corridor sensitivity according to the Department of Transport 'TAG' document sub-objective 3.3.8. The assessment examines features and characteristics that reflect the urban environment and significant areas of aesthetic value with regards to Townscape.

4.6.1 Baseline

A visual survey and information gathering exercise was undertaken to assist in this exercise, culminating in the award of an overall qualitative statement within the Appraisal Summary Tables (AST).

The study area lies to the north and western side of Armagh City. Armagh is a cathedral city with a distinctive landscape setting and prominent landmarks. The city is unique in having a history of continuous habitation for over 1500 years and for being of Irish foundation. It is historically the seat for heads of both main religions in Ireland and the two distinctive hill top cathedrals dominate the skyline. The city centre has a strong historic core added to by impressive Georgian buildings that surround the Mall and scatter throughout the city. Due to the long history of human development the area is rich in archaeological remains exhibited best by the Neolithic tomb at Navan Fort to the west of the City Centre. The city has a drumlin setting with key landmark buildings perched on hilltops visible from the many radial approach routes to the city. To the south of the city, drumlins rise to form relatively pronounced hills. Wooded historic estates are found on the fringes of the City while the tree lined Mall with its open lawns is one of the most significant urban open spaces in Ireland.

The character and layout of townscape in Armagh City changes with distance from the City Centre. In the older parts of the city streets extend concentrically around the Cathedral hills with radial streets (providing vistas) extending outwards to what was historically a rural hinterland. This fine grain is dominated by stone buildings (Armagh limestone) in narrow streets. Currently vehicles dominate this townscape detracting from its appearance. The density of development is high with most buildings two and occasionally three storeys in height. Important vistas exist along the narrow streets to the surrounding city areas especially the Mall. To the east of the city centre the fine grain gives way to an interspersed coarse grain with open space surrounded by many listed Georgian buildings around the Mall. Buildings are predominantly three storeys in height on this side of the Mall. To the south of the city centre the Palace Demesne provides extensive open space areas mostly used for leisure and recreational purposes with the former Bishops House and Stables at its heart. The trees and open space within the townscape area play a vital role in the setting for Armagh City. To the west of the city centre the fine grain of the historic core also gives way to a coarser grain with modern housing estates set within areas of open space such as off Killylea Road and Umgola Road. Recreational grounds are interspersed with residential development throughout this western townscape. The residential developments are mostly high to medium density and a mixture of single and two storeys in height. Properties are a mixture of brick and rendered finishes. A similar townscape is found to the north of the city centre adjacent to Loughgall Road and Moy Road with high to medium density modern housing estates and adjacent opens spaces. The northern townscape does have a higher level of commercial and light industrial activity particularly in the Loughgall Road and Station Road areas. To the east of the Mall historic buildings can be found. These are in contrast to the city centre buildings as they are set in the adjacent attractive open space and tree-lined townscape areas. The older buildings gradually give way with distance east to high to medium density modern residential development with adjacent open space and greenbelt agricultural influences.

Relevant Townscape Designations

A review has taken place of the Armagh Area Plan 2004 to establish if there are any relevant landscape designations or protected views. It has been established that there are no landscape policy designations or protected views within the study area.

The historic core of Armagh City is designated as a Conservation Area (refer to Figure 4.6.1)

Within the Constraints Study Area, the Armagh Area Plan 2004 has not designated any Local Landscape Policy Areas (LLPA) which would influence development in the study area.

A significant portion of the study area is coincident with a Green Belt designation surrounding Armagh City and this designation is discussed further in Section 4.13 Policies & Plans.

4.6.2 Impacts

Route Corridor 1

This Route Corridor is the corridor that lies closest to the city centre crossing Moy Road, Cathedral Road and Killylea Road. Between Cathedral Road and Moy Road the proposed corridor skirts the grounds of St. Patrick's RC Cathedral and partially crosses the City Conservation Area. This area has a high historic and cultural importance at a national level. In common with most corridors there is potential for a beneficial relief of traffic movements within the historic townscape core. Overall this Corridor has been identified as having a Slight/Moderate Adverse impact due to its proximity to the Cathedral/Conservation Area and potential impact on buildings in the Loughgall Road/Station Road area.

Route Corridor 2

This Route Corridor follows the same line as Route Corridors 3 and 4 from Monaghan Road to Navan Fort Road where it changes eastwards crossing agricultural fields and open space. This Route Corridor also follows a similar route east of Moy Road to Route Corridor 1 as far as the Portadown Road. This corridor is located slightly more remote from St. Patrick's RC Cathedral and City Conservation than corridor 1. Buildings in the Loughgall Road/Station Road area may be injuriously affected. Overall this Corridor has been identified as having a Slight/Moderate Adverse impact due to its proximity to the Cathedral/Conservation Area and potential impact on buildings in the Loughgall Road/Station Road area.

Route Corridor 3

This Route Corridor is the most remote from the city centre and follows an alignment through a rural landscape. There will be no adverse impacts on townscape features are settings of key townscape landmarks. There is potential for beneficial impacts from relief from traffic congestion in the city centre. Overall this Corridor has been identified as having a Slight Beneficial impact.

Route Corridor 4

This Route Corridor is consistent with corridor 3 from Monaghan Road to Cathedral Road where the corridor moves eastwards along a redundant railway line towards Moy Road. From Moy Road this corridor is consistent with corridors 1 and 2. This corridor is slightly more remote from the City Conservation Area and St Patrick's Cathedral than corridors 1 and 2 but it may still injuriously affect some buildings in the Loughgall Road/Station Road area. Overall this Corridor

has been identified as having a Slight Adverse impact due to its potential impact on buildings in the Loughgall Road/Station Road area.

Impact Conclusion

Overall when townscape impacts are considered the preferred Route Corridor is 3. The least preferred corridors are 1 and 2.

4.6.3 Mitigation

At this stage of the assessment process it is not possible to provide detailed mitigation measures for townscape impacts and mitigation is discussed only generally in this text. The choice of route corridors should avoid potential adverse townscape impacts on areas or features identified as having a high sensitivity. Route Corridors that aim to avoid valued and sensitive townscapes are considered preferable.

Route Corridors cross areas containing residential development and as such there is potential for high levels of visual intrusion. Selection of Route Corridors should seek to avoid those likely to generate the most significant adverse impact on residential properties and settings of important landmark buildings and vistas.

There are many varied mitigation techniques available, the use of which will depend on the specific design characteristics of the route corridors. Typical techniques include: on and off-site planting; mounding; earth shaping; new water features; sensitive design of structures, use of local building materials for structures, alignment and presentation of roadside walls, ditches and fences.

4.7 Heritage of Historic Resources

This section provides an assessment of the potential impact of each proposed route corridor for the Armagh North & West Link on features of cultural heritage significance. There are four route corridors for the proposed link road which extend through the north and western sides of Armagh city and link the A3 Portadown Road (at the northeast) to the A3 Monaghan Road (at the southwest of the city). This assessment should be read in conjunction with Figures 4.7.1, 4.7.2, and 4.7.3 and Appendices C3, C4, and C5.

A desktop survey of archaeological and cultural heritage sites within the area of the proposed routes was carried out in order to assess heritage constraints. The Monuments and Buildings Record (MBR) for the area was the principal source for identifying archaeological constraints and built heritage constraints. In addition the following sources were consulted:

Northern Ireland Sites and Monuments Record, (the Sites and Monuments Record is a map-based record with data on approximately 14,500 archaeological sites and historic monuments in Northern Ireland),
Industrial Archaeological Record,
Historic Buildings Register,
Register of Historic Parks, Gardens and Demesnes,
Northern Ireland Heritage Gardens Inventory,
Northern Ireland Buildings at Risk Register,
Northern Ireland Buildings Database,
Aerial photographic coverage of the study area – no potential heritage features were noted.

4.7.1 Baseline Conditions

The city of Armagh is steeped in archaeological and historical sites and monuments dating to prehistoric times. Lewis (1837) notes that the area was originally named Druim Saileach, meaning ‘the hill of the sallows’ which was afterwards changed to Ard Saileach ‘the height of sallows’ and still later to Ard Macha, whether derived from Eamhuin Macha, the regal residence of the kings of Ulster, which stood a short distance to the west of the city, or as is most probable, from its characteristic situation Ard Macha signifying the ‘high place or field’.

The Prehistoric Period

The Early Mesolithic Period in Ireland is dated to 7000-6000 BC, followed by the Late Mesolithic Period, which is dated to 6000-4000 BC, the latter displaying a variation in the flint tool assemblage and production techniques. Mesolithic people were Stone Age hunters, fishers and gatherers, living on the coastline and along rivers, but with no knowledge of farming. They used flint and other stones to manufacture sharp tools (Anderson 1991, 35-8); their settlements can now be identified by locating scatters of discarded stone tools, and the debris from their manufacture, in ploughed fields. Traces of Mesolithic settlers within the county of Armagh are restricted to tools from Coney Island, on the southern shores of Lough Neagh, which are similar to examples recovered from the Early Mesolithic settlement at Mount Sandel, near Coleraine. Of later Mesolithic date are scatters of flints from the shores of Lough Neagh; a single Bann flake attributed to the Navan fort area; and several Bann flakes from the River Blackwater (Ramsey 2001). The nomadic lifestyle of Mesolithic communities and the temporary nature of their dwellings contribute to the difficulty in detecting the remains. There is no recorded evidence of Mesolithic activity located within the study area. However, despite the paucity of Mesolithic artefacts presently found, this does not preclude the possibility of such material from being encountered during the course of works for the proposed link road.

The Neolithic (or New Stone Age) period represents the arrival and establishment of agriculture as the principal form of economic subsistence. Over successive generations, farmers either moved slowly across Europe or had influenced local hunter-gathering populations to adopt the new economy (Mallory & McNeill 1991, 29). During the Neolithic and Early Bronze Age (c.3500-c.1500 BC) a characteristic feature of farming communities in Ireland, and over much of Western Europe, was the practice of collective burial in stone tombs, now known as 'megalithic tombs' (Twohig 1990). Megalithic tombs remain as enduring monuments of the Neolithic that are visible within the landscape, however the presence of Neolithic settlement sites are not so obvious. While the location of burials would suggest settlement in the near vicinity, as in the south of the county, the actual evidence for Neolithic habitation is limited. There are traces of structures at Coney Island, with signs of domestic activity occurring at Navan Fort (ARM012:015), Ballyrea (ARM012:088) and in parts of Armagh city (ARM012:093) (Ramsey 2001). None of these sites will be impacted by the proposed route corridors.

A characteristic of the earlier Bronze Age in Ireland, apart from the arrival of metalworking, is the emergence of a distinctive burial custom, often termed the 'single burial tradition' (Doody 1986; Waddell 1990; Waddell 1991), which was part of a wider European milieu. In the initial stages of this tradition both inhumation and cremation were practiced. Burial in cairns (stone mounds), barrows and tumuli (earthen mounds) or cists (box-like and slab-built burial compartments) was fairly common. There is a cairn or barrow located at Tullymore and named 'Niall's or O'Neill's Mound' (ARM012:027) that will be impacted by the proposed link road. This is an elongated mound measuring 20.5m E-W x 46m N-S and stands c. 1m above the adjacent ground level. A large part of the SE side has been removed by quarrying, revealing a largely stone construction. At the north end there is a circular ruined stone-walled enclosure 7.6m in external diameter, standing 1.45m high but is of no great antiquity. Traditionally the site is said to be the burial place of King Niall Mac Aedha or Niall Caille who died at the Callan River in 846AD.

The results from excavations suggest a long tradition for such monuments ranging in date from the Neolithic to Early Bronze Age times. As the Bronze Age progressed (c.3000-1500BC) other stone built monuments were constructed such as stone circles, stone rows and standing stones. A stone circle (no visible remains) is located off Navan Street (ARM012:051) and within the area of the proposed route corridors. It is said that the site was removed c. 1840. There are also two standing stones that are affected: ARM012:006 and ARM012:074. The standing stone at Legarhill (ARM012:074) is a limestone pillar 1.5m high x 0.3m wide x 0.25m thick. Local people have not regarded the stone as an antiquity however a case has recently been made for its identification with the stone known as Crewroe, cited as a boundary marker in several early seventeenth century grants of lands formerly belonging to the Abbey of St. Peter & Paul to the Caulfield family. The standing stone at Longstone (ARM012:006) is located just south of a local hilltop, close to a recent field boundary. On plan, the stone appears as a parallel sided slab, 0.4m thick x 1.5m wide, aligned NE-SE. Its stands 1.7m high and is of the so called 'Armagh Marble'. Longstone is a very small townland and it is possible that it derives its name from this site as well as the destroyed cairn that is also reported to have been located here. Single upright stones are a common feature of the Irish countryside and are known by various names (gállan, dállan, leacht, long stone) (O'Kelly 1989, 228-9). They are not all necessarily of one period or serving the same purpose. Some have been shown to mark prehistoric burials while others may have had a commemorative or ritual function, or served as boundary markers or position posts along ancient routeways (Buckley & Sweetman 1991, 73). The vast majority of standing stones have their long axis north-east/south-west, which suggests a close affinity with stone rows and pairs, which share the same orientation pattern. With the presence of Late Neolithic/Early Bronze Age monuments within the landscape of the study area it is possible that associated occupation/habitation sites could yet be encountered in the area.

As with the Neolithic period, there is comparatively little evidence for Bronze Age settlement in the county, however Haughey's Fort (located west of Armagh city) was constructed c. 1100BC but with no visible features remaining above ground it was originally located through aerial photographs. A range of artefacts dating from the Bronze Age have been discovered here, and the associated King's Stables (an artificial lake utilised as a place for votive deposits to the gods) has also yielded a significant amount of Bronze Age items. If Haughey's Fort and the King's Stables formed the focus of attention in this area during the Bronze Age, the succeeding Iron Age saw a shift in the balance of power towards the nearby sites of Navan Fort (ARM012:015) and Loughnashade (ARM012:034). Although there is evidence for Bronze Age activity at Navan, it is during the Iron Age that the site reveals its most impressive features. None of these nationally important sites will be impacted by the proposed road scheme.

In comparison with the Bronze Age, evidence for the Iron Age activity in Ireland as a whole is somewhat scant. Though there is a lack of archaeological evidence, the earliest Irish sagas such as the epic poetry of the Ulster Cycle, are thought to relate to events associated with Gaelic chiefs during the Iron Age (c. 250 BC to 400 AD). While these tales reveal little about the archaeology of the Iron Age, they do provide us with an insight into the political and religious life of early Gaelic society.

Apart from scatters of artefacts, evidence for other aspects of Iron Age life are limited, particularly regarding habitation and burial practices. The surviving evidence (e.g. highly decorated metal items; large-scale forts) is skewed towards providing a picture of a social elite, represented by high status artefacts and 'royal' sites. One of these royal sites is Navan Fort (ARM012:015), some two miles west of Armagh city. Navan fort (Emain Macha) is the site mentioned in the Old Irish manuscripts ultimately dating to the seventh and eighth centuries AD, the stories of the so-called Ulster Cycle. These early renditions recall pre-Christian times when Emain Macha, as the ancient capital of Ulster, was at the peak of its power and influence. Figures such as Cú Chulainn, the Red Branch knights, Concobhar (Conor) and Deirdre; are all part of Emain Macha and Ulster's mythology.

The Early Medieval Period (AD 400 – 1169)

The early medieval period (AD 400 – 1169) was a time of profound internal social and economic change in Ireland. The dominant site types associated with this period include ringforts (raths), souterrains and enclosures.

Ringforts are undoubtedly the most widespread and characteristic archaeological field monument in the Irish countryside. They are usually known by the names ráth or lios consist of a circular or roughly circular area enclosed by an earthen bank formed of material thrown up from a concentric fosse (or ditch) on its outside. Archaeological excavation has shown that the majority of ringforts were enclosed farmsteads which acted as a defence against natural predators like wolves, as well as against the cattle raids. Souterrains (underground chambers) are often found in association with ringforts. There is an enclosure (ARM012:065) and a rath (ARM012:005) located within the proposed corridors for the Armagh North & West Link. There is no description available for the enclosure (ARM012:065) at Armagh NE Ward whilst the rath (ARM012:005) is located in Lurgyvallen townland on a small eminence NE of the summit of a drumlin overlooking the Callan River. The site is in poor condition and consists of a low, irregular platform 31m N-S and 21.5m E-W. On the north and south it stands up to 1m above the surrounding ground. There is no visible bank or ditch. A disused track follows around the western side and may have cut away part of the monument. In the OS 6-inch map of 1835 the site appears rather angular.

The early medieval period in Ireland saw the introduction and establishment of Christianity. The process of conversion of the native population would not have been rapid but rather one of

steady infiltration. Over and above the change in religious outlook that conversion would have meant for the individual, the establishment of the Irish Church was to have profound implications for political, social and economic life, in no small part due to the introduction of writing into the country. In Ireland there was from now on 'in existence an organisation part of whose function was to maintain contacts, both in ideas and through individuals, between Ireland and the rest of Europe' (Mallory and McNeill 1991, 181). The introduction and establishment of Christianity is attested to in the archaeological record by the presence of church sites, associated places for Christian burial and holy wells. There is a range of Early Christian sites located within the study area that include multi-period churches (including the cathedral in Armagh city (ARM012:052), graveyards, ecclesiastical settlements, holy wells, early medieval trackways and settlements. A trackway (ARM012:080) will be affected by the proposed route corridors although this site has not been precisely located.

The development and spread of Christianity in Ireland, starting in fifth century AD, is associated in popular terms with the figure of St Patrick. The position of Armagh (Ard Macha) as the religious centre of Ireland is also inextricably linked about this saint, as is the modern image of Armagh as Cathedral city. The story of Armagh's foundation and rise to power during this period is mainly derived from written accounts. Sources of particular significance in raising the profile of Armagh in this Christian era are the Book of Armagh (807AD), now housed in Trinity College Dublin, and the various annals (Ramsey 2001). As such, Armagh's role in the development of Christianity during the early medieval period is unique and well documented. With such ecclesiastical wealth and learning Armagh was also a favourable target for Viking attacks and such incidents are recorded from 832 AD. Despite the frequency of these attacks however, there is remarkably little archaeological evidence for their presence in the city.

The Late Medieval Period (AD 1169 – 1600)

The feudalisation of Gaelic-Irish society c. 1000AD, demarcated by the apparent abandonment of ringforts in the period around the turn of the millennium and the very low numbers of newly-built ringforts in the early centuries of the second millennium AD, involved the new divisions of land of which the modern townland is the descendent. The actual boundaries of these land units, however, must have reflected very closely the rural geography of Ireland in the immediate pre-feudal period. By the same token, the land units of the Anglo-Normans – the cantreds and manors – were themselves copies of the territories of pre-colonial Ireland.

In the twelfth century the territory known as the Airthir, later Oirthir, meaning the 'eastern parts' (of the mid-Ulster kingdoms), was nearly co-terminus with the modern county of Armagh, but it was not united under one dynasty (Simms 2001). It had been ruled by a single king from the sixth to early ninth centuries, with the prestigious ecclesiastical settlement of Armagh as its political centre. After the battle of Leth Cam in 827AD, however, the whole area was brought under the overlordship of the Cenél nEógain branch of the Northern Uí Neill, and gradually more and more land in the northern and western parts was taken into the hands of Cenél nEógain families (ibid.). The people of Airthir split into segments ruled by a number of interrelated dynasties, each of whom continued to supply the ecclesiastical establishment at Armagh with hereditary clerics, under Cenél nEógain patronage.

However by the time of the Norman invasion 1169-71 and up until c. 1200 the city of Armagh and Airthir sustained a series of attacks. When the Anglo-Norman settlers succeeded in rolling back the boundaries of Ó Néill influence, one consequence was to release the native chiefs of the Oirthir from their subjection to a Cineál Eoghain overlord (ibid.). Consequently it is during the thirteenth century that we find chiefs such as the Ó hAnnluain enjoying a peak period of independence, even power. However, in the sixteenth century the Ó Néill dynasty recovered its grip on central Ulster, and the annals record their exploits against forces of the Crown for the

following century. Just outside the study area is the location of such a battle, popularly referred to as the Battle of Yellow Ford which took place in 1598 (ARM012:001).

Within this period, towns, markets and fairs were established and change and reform attempted in the Irish church. Within the Armagh city area there are at least eight recorded medieval settlement sites. The Irish church has a long tradition of monasticism dating back to the sixth century however; a new wave of monasticism was introduced in the twelfth century by the Cistercians, Augustinians, Benedictines and Cluniacs. The Cistercians brought with them the claustral plan (central cloister or courtyard) (Stalley 1987), which was to remain the basis of all monastic building until the sixteenth century. There is an Augustinian Abbey and associated ecclesiastical buildings located in Armagh city (ARM012:055). One of the major religious events in thirteenth century Ireland was the arrival of the Friars; these were mendicant orders, vowed to poverty and committed to preaching to the general population. There is a Franciscan Friary located within Armagh city (ARM012:016). A second medieval wave of monastic foundations is a feature of the fifteenth century, a period in which many existing monastic complexes were extensively refurbished and extended. None of these sites will be affected by the proposed scheme.

The post-medieval period (AD 1600 - Present)

The sixteenth century was a turbulent time in Irish political matters. A new order of Irish lordships emerged as previous English settlements were almost eliminated. During the later sixteenth century the Irish lords came into bitter conflict with England when the Tudor kings and queens, particularly Elizabeth I, were determined to assert (or re-assert) English control tightly over Ireland. The resulting wars dating from the 1560s to 1603 bring this unsettled period to an end.

In 1601 Lord Mountjoy made Armagh one of his principal positions in his Ulster expedition, and occupied it with a garrison of 900 men (Lewis 1837). In the early part of the seventeenth century, a colony of Scottish Presbyterians settled here. However, at the commencement of the war in 1641, Armagh fell into the hands of Phelim Ó Néill, who, on being soon after forced to evacuate it, set fire to the cathedral and many of the inhabitants were killed (ibid.). During the following century, Armagh was subject to attack during the Williamite wars while during the 1798 rebellion the town was temporarily guarded by a voluntary garrison formed by the inhabitants.

Armagh was a fair and market town, one of many hundreds throughout Ireland including many developed by landlords during the eighteenth century. The town had been granted a weekly market by royal charter as early as 1587. It obtained a new charter in 1613 following the plantation of Ulster and there is a recorded plantation settlement within Armagh city (ARM012:089). The town retained many of its older features at this time, including the ground plan with the streets circling the hill where the cathedral sat. The now familiar street names such as English, Scotch and Irish; date from the end of the seventeenth century.

An ambitious building programme was initiated by Archbishop Robinson in 1765, which was to transform the city. Richard Robinson was the first resident archbishop in Armagh during the eighteenth century. The building programme was undertaken by compelling his tenants to rebuild their houses in stone and slate as well as constructing many public buildings such as an infirmary, a bishop's palace, a library, market house, observatory, county gaol, and a classical school (Clarkson 2001). The surrounding countryside was thriving and the country itself was enriched by a prosperous linen industry. Rural prosperity generated wealth and the city thrived on its trade in provisions and linen and Armagh was one of the most vibrant towns in Ireland at the end of the eighteenth century.

The population of Armagh in 1813 was c. 7000. Since the town grew rapidly during the eighteenth century; it is estimated that the population was as low as c. 1000 in 1700. Ireland enjoyed an economic boom during the eighteenth century and especially from about 1730, based to a considerable extent on the export of linen yarn and cloth. Armagh was ideally situated in the linen triangle to reap the economic benefits and it was located in the fertile northern part of the county. As such, it was the linen industry that firmly bound eighteenth-century Armagh to the international world of commerce. Linens for local use had been woven in Ireland for centuries, but the industry assumed an international importance at the end of the seventeenth century (ibid.). The city was additionally, an ecclesiastical, educational and legal centre, with the sciences also well represented.

The eighteenth and nineteenth centuries were a time for an upturn in industrial growth in Ireland and this is demonstrated by the large number of industrial archaeological sites located within the study area. One of the most distinctive traits of Ulster is the range and variety of industrial activities that developed in the post-medieval period. The industrial site-types located within the area of the proposed corridors include nine bridges, one quarry & limekiln, one saw mill, a signal post and crossing and a level crossing, gasworks and a threshing machine.

Portions of the Great Northern Railway line are located within the study area for the proposed Armagh North & West Link route corridors. The Great Northern Railway of Ireland, originally known as the Irish North Western Railway, maintained an independent existence for 77 years, much of that time prosperously established as the second largest and certainly the most enterprising of the Irish railway systems. Springing basically from the need to link Dublin and Belfast by rail, the Great Northern was the result of amalgamation of numerous smaller companies.

The system began in the mid-1830s when the Ulster and the Dublin & Drogheda Railway Companies were formed. The Dublin-Belfast rail link was forged piecemeal. Construction of the Ulster Railway between Belfast and Armagh began in 1837 and was slow even by the standards of the time. It took two years to build 7.5 miles to Lisburn, but the line was solidly built and opened on 12 August 1839.

Throughout the eighteenth and nineteenth centuries, there was the development of high and low status housing and urban settlements throughout Ireland. In particular local landlords improved their estates and built residences for themselves. This is clearly discernible within Armagh city with houses and attendant grounds listed in the EHS Register of Historic Parks, Gardens & Demesnes (The Mall, The Palace, Dean's Hill, Abbey House and Umgola House) that are located within the City. There is also a series of other types of buildings and structures in Armagh City listed for protection, predominantly in urban areas, however, detailed examination of these is beyond the scope of this study.

Although there are several recorded archaeological monuments within the study area it should be noted that there is potential to reveal hitherto unknown archaeological sites/features along the proposed corridors that are not visible above the current ground surface.

The following outlines the background to statutory protection of archaeological and built heritage monuments and cognisance should be taken of some when assessing the proposed route corridors. In addition, the baseline conditions of the overall study area have been scoped and tabulated into the relevant site/building type.

Legal and Policy Framework

The principal basis for the protection of archaeological sites in Northern Ireland is the 1995 Historic Monuments and Archaeological Objects (Northern Ireland) Order. The law provides for

historic monuments and archaeological sites to be protected in a variety of ways, including taking into state care and scheduling. In the former case, monuments are owned, leased or are placed in the guardianship of the Environment and Heritage Service (EHS) of the Department of the Environment for Northern Ireland (DOENI). When sites and monuments are scheduled, they remain in private ownership but are protected from damage and unauthorised development. Sites are scheduled in accordance with quality and rarity criteria.

The EHS are also concerned with the survival of other sites not protected under the 1995 Order and it is automatically consulted by the Planning Service about every new development likely to affect a site or its setting (Source: EHS). Furthermore a licence is required to search for archaeological objects, or to carry out an excavation, and any archaeological object found must be reported. All archaeological excavations must be carried out under the direction of a qualified archaeologist, licensed by the EHS. A licence application must be submitted for every excavation, by the archaeologist who will direct the work, at least three weeks before the date on which work is due to begin. There are a total of seven recorded archaeological sites within the study area, although none have scheduled statutory protection status (see Table 4.7.1 below).

RPS Unique Ref. No.	SMR Number	Townland	Monument Type	National Grid Ref.	Statutory Protection
13	ARM012:005	Lurgyvallen	Rath	H86114671	Not defined
9	ARM012:006	Longstone	Standing Stone	H87864657	Scheduled
51	ARM012:027	Tullymore	Cairn or Barrow: Niall's or O'Neill's Mound	H86184414	Scheduled
35	ARM012:051	Corporation	Stone Circle	H872450	Not defined
10	ARM012:065	Armagh NE Ward	Enclosure	H875463	Not defined
40	ARM012:074	Corporation	Standing Stone	H86024504	Not defined
14	ARM012:080	Mullynure Longstone	Trackway	H8846	Not defined

Table 4.7.1 List of recorded archaeological sites located on or adjacent to proposed routes (see Figure 4.7.1)

4.7.2 Built Heritage Baseline

In addition to archaeological sites, the EHS also has the responsibility under the Planning (Northern Ireland) Order 1991 for the protection of post-medieval buildings and structures. The Department of Environment has a programme of area plans for Northern Ireland. Area plans provide the primary means of reconciling conflicts between the need for development and the need to protect the natural and man-made heritage. There are more than 8,500 listed buildings/structures in Northern Ireland (currently under review); varying from fine churches and country houses to thatched cottages and post boxes. To be selected for listing, a building must be assessed and evaluated against established criteria. Key elements include the age of a building, its condition, style, aesthetic quality, structure and any innovatory qualities (Source: EHS). Given the historical origins of Armagh City there is a significant volume of listed historic buildings within the study area. However, none are directly affected by the proposed road routes while a total of seven (see Table 4.7.2 below) may potentially be indirectly affected in terms of views and prospects, however this will need to be substantiated by a buildings survey. The Planning Order (NI) 1991 also provided for the designation of areas of special architectural or

historic interest called Conservation Areas, the character and appearance of which it is intended to preserve and enhance. The central core of Armagh City is designated as an Area of Conservation and is affected by three of the proposed routes at its most northerly portion.

HB Ref No	Address	Survey 1	Current Use
15/16/009	Main Building of St. Luke's Hospital	B1	Hospital Building
15/16/010	The Hill Block of St. Luke's Hospital	B1	Hospital Building
15/20/020	St Patrick's RC Cathedral	A	Church
15/20/021	Synod Hall & Sacristy of St Patrick's RC Church	B+	Hall
15/20/023	Sexton's Lodge of St Patrick's RC Cathedral	B2	Gates/Screens/Lodges
15/20/032	Callan Bridge	B1	Bridge
15/20/030	Convent of the Sacred Heart, Convent Rd	B	Religious House

Table 4.7.2 Listed Historic Buildings located adjacent to the proposed routes (see Figure 4.7.3)

The Buildings At Risk in Northern Ireland (BARNI) Register serves to highlight the vulnerability of our historic built environment and acts as a catalyst for its restoration and reuse. The BARNI Register contains a selection of listed buildings, scheduled monuments and other historic structures from throughout Northern Ireland – ranging from humble dwellings to large industrial complexes – which are currently at risk and require a sustainable future. Within the study area there is currently one structure, Armagh Gaol (BARNI No. 15/17/001) that is a listed historic building as well as being deemed as a Building at Risk. It is an important listed building that helps to frame the historic Mall however it will not be impacted by the proposed route corridors.
The Register of Historic Parks, Gardens and Demesnes contains 154 sites that have been selected as being worthy of protection though the planning process. There are six registered historic parks, gardens or demesnes within the study area (see Table 4.7.3 below).

Property	Description
-	The town house built *c.* 1760 is in a pleasant position on high ground near the COI Cathedral. The site is shown on Rocque's map of 1760. It has an enclosed walled garden, which is fully maintained. It is a rare example of a surviving town garden. It is intensively cultivated with ornamental areas and a productive garden. There is a utilized glasshouse. Fine views to the city below can be glimpsed from the eastern end. Private.
-	Formerly the Deanery. The elegant house of 1772-4 (HB 15/17/39) is on an elevated site. There are views for a great distance, as far as the Sperrins, from the north front entrance. This and the Observatory are both associated with the palace inception and as such are smaller examples of Georgian landscaping. The austere classical buildings are on high

Property	Description
	ground set in lawns, with sweeping approaches and well disposed trees that give shelter and allow for vistas. The Dean's Hill avenue is flanked by fine limes. A row of yew trees, a wisteria, glasshouse and a box edged border have been introduced near the house during the 19th century. The partially walled garden has an orchard, kitchen garden and vinery. There was a large elm that succumbed to disease but a notable laburnum is thought to be very old. The gate lodges is *c.* 1845 and the original 18th century gates have gone due to road re-alignment in recent years.
-	The grounds for the Observatory are set out as a landscape park. The building (HB 15/3/2) is on a hill top, sheltered by a belt of trees. Built for Archbishop Robinson in 1790, it reflects his taste for the then fashionable classical buildings set in austere parkland and has the attributes of the palace in miniature. The carriage drive sweeps steeply up hill from the road to the south to the entrance on the north side of the building. There is a walk through the shelter belt of mature trees. Much of the parkland is now let out as playing fields to the Royal School. Views of the city unfold over lawns on the south side of the building, now fringed by a 'Sunburst' garden of radiating blocks of flowering shrubs. This was created to commemorate the 200th anniversary of the foundation of the Observatory, as was also the Lindsay Sundial Garden on the north side of the house. There is a disused ice house and walled garden. The gate lodge is contemporary. Private. Public access to grounds during office hours.
-	The Archbishop's Palace (HB 15/18/16) of 1770 is now the council offices of Armagh District Council. The walled demesne referred to by Inglis in 1834 as '…in excellent order…laid out with much taste…' is largely parkland. The ground undulates and the house is on high ground, with fine views of the city and the COI Cathedral. The original planting set off the house and the vistas. To the north it is now a public area in grass, with mature parkland trees (chiefly sycamore) and to the south it is grazing, with a stand of 19th century exotic trees near the house. There is an eye-catcher obelisk, the Rokeby Obelisk (HB 15/18/21) erected in 1782, at the southern end of the park. A belt of woodland on high ground to the west of the northern section of the parkland affords necessary protection. A golf course now occupies the northeastern section. The walled garden is at the north end, with a garden house (HB 15/18/14). It is not cultivated but used by the rugby club. There are modern ornamental gardens on the south side of the house and a 1990s garden

Property	Description
	on the west side, near the chapel of 1770 (HB 15/18/17). A fine 19th century glasshouse (HB 15/18/20) and ice house also lie to the west of the house and there is another ice house near the main entrance (HB 15/18/15 & 19). The stables and coach yard (HB 15/18/18) have been converted for tourism. The entrance gates were moved when the road was altered and this unfortunate development effectively cut the demesne off from the city, though the grounds are open for public enjoyment. The 18th century gate lodge has been demolished and only one of three remains. SMR ARM012:016 Franciscan Friary ruins, ARM012:017 St. Bridget's Holy Well in the grounds. Public access to part of the grounds.
The Mall Registered Site - Area Plan Armagh 15	Long established as open ground, The Mall was known as 'The Common' on John Rocque's map of the city in 1760. It was then surrounded by a race track, known as 'The Horse Course'. The latter was removed on the orders of Primate Robinson. In 1773 he leased the open area to the Sovereign and Burgesses of the city as a public open space for citizens to enjoy for walking. A date stone on the gateway on the north side of 1798 and the perimeter walk is recorded as being 4 furlongs. By 1803 it was enclosed, had gravelled paths and a lawn. The well lit White Walk was privately funded in 1836. By 1888 mature trees were noted '…now of majestic proportions'. Cricket and football were played and cattle grazed within the area. Paths, lawns and pitches remain but not the cows. Iron lamp posts and railings are in evidence. There is a captured gun and carriage from the Crimean War and War Memorials from the Boer War and First World War. The bandstand and old cricket pavilion have gone. A pavilion replaced the latter in 1964. Trees surround the perimeter. Many elegant buildings enhance the area of this important urban open space and thoroughfare within the city. Public access.
-	A villa of *c.* 1870 Umgola (HB 15/19/14 – includes a conservatory and glasshouse, gates and railings) has a very well maintained garden and is surrounded by mature trees. One or two original features have not been kept up, such as the Japanese garden and pond but there is a formal sunken garden, with a rectangular pond in lawns and glasshouse. The latter has vines and peaches. The iron-framed conservatory was built in 1905 by Phillips & Sons of Belfast and the plans survive. It is in full use. There is a summer house and hut.

Table 4.7.3 Register of Historic Parks, Gardens and Demesnes, Northern Ireland

The Heritage Gardens Inventory contains a comprehensive archive for over 700 historic parks, gardens and demesnes in Northern Ireland although they are not afforded statutory protection. There are six heritage gardens that are located within the Armagh City area that include those registered and outlined in Table 4.7.3. Only one, the Royal School is in addition to those listed in the Register of Historic Parks, Gardens and Demesnes whilst The Mall gardens are not included in the Heritage Gardens Inventory. None of the registered historic parks, gardens and demesnes or the heritage gardens will be directly affected by the proposed route corridors.

The Industrial Heritage Record is a map-based archive of over 18,000 industrial sites. Within the study area several industrial heritage sites were noted. A total of fifteen sites were identified that are on or adjacent to the proposed route corridors and these are outlined in Table 4.7.4 below. It should be noted that industrial heritage sites do not currently have statutory protection however they form a significant part of local and national heritage.

RPS Unique Ref. No.	IAR Reference Number	Type/Description
1	00231:003:00	Bridge Under Rail Road GNR Branch Line
4	00231:062:00	Bridge
5	00231:063:00	Level Crossing
6	00231:064:00	Bridge
10	00132:045:00	Bridge
11	00199:000:00	Quarry with Limekiln
22	00132:060:00	Signal Post and Crossing
23	00729:000:00	Saw Mill
24	00232:006:00	Bridge
25	00132:061:00	Bridge
32	00232:007:00	Bridge
33	00717:000:00	Threshing Machine
37	00232:008:00	Bridge
40	00696:000:00	Gasworks
41	00232:009:00	Bridge

Table 4.7.4 Industrial Heritage sites on or adjacent to proposed routes (see Figure 4.7.2)

4.7.3 Impacts

Following a desktop survey of archaeological and built heritage sites, some twenty-nine recorded heritage constraints have been identified from the overall study area for the proposed Armagh North and West Link route corridors. These include seven recorded archaeological (SMR) sites; seven historic buildings and fifteen industrial heritage sites. In addition, a special area of conservation within Armagh City is affected whilst each route crosses a river network that may have underwater archaeological potential. Armagh City and environs are rich in heritage remains, particularly dating from medieval times. Given this and the fact that each route is traversing hitherto undisturbed ground, there is potential to discover sub-surface archaeological remains.

The following tables outline the predicted impacts relevant for each of the route corridors 1 – 4. The impacts have been divided into:

direct (directly located on the route),
indirect (located within 20m of the route),
potential direct (where there is potential for sub-surface and presently unrecorded, archaeological remains located directly on the route), and;
potential indirect (located beyond 20m from the route corridor but may be, for example, visually impacted upon or sensitive to movement of machinery during construction – this cannot be ascertained until field survey is undertaken).

RPS Unique Ref. No.	Heritage Reference Number	Type/Description	Distance from road-take	Direct	Indirect	Potential Direct	Potential Indirect
1	00231:003:00	Bridge Under Rail Road GNR Branch Line	25m				✓
4	00231:062:00	Bridge	0m	✓			
5	00231:063:00	Level Crossing	0m	✓			
6	00231:064:00	Bridge	0m	✓			
22	00132:060:00	Signal Post and Crossing	0m	✓			
23	00729:000:00	Saw Mill	15m		✓		
24	00232:006:00	Bridge	10m		✓		
32	00232:007:00	Bridge	0m	✓			
33	00717:000:00	Threshing Machine	0m	✓			
37	00232:008:00	Bridge	0m	✓			
40	00696:000:00	Gasworks	50m				✓
41	00232:009:00	Bridge	0m	✓			
9	ARM012:006	Standing Stone	0m	✓			
51	ARM012:027	Cairn or Barrow: Niall's or O'Neill's Mound	50m				✓
35	ARM012:051	Stone Circle	30m				✓
10	ARM012:065	Enclosure	10m		✓		
14	ARM012:080	Trackway	0m	✓			
-	HB15/16/009	Main building of St. Luke's Hospital	100m				✓
-	HB15/19/010	The Hill Block of St. Luke's Hospital	100m				✓
-	HB15/20/020	St. Patrick's RC Cathedral	50m				✓
-	HB15/50/021	Synod Hall & Sacristy of St. Patrick's RC Church	50m				✓
-	HB15/20/023	Sexton's Lodge of St. Patrick's RC Church	50m				✓
-	HB15/20/030	Convent of the Sacred Heart, Convent Rd.	70m				✓

RPS Unique Ref. No.	Heritage Reference Number	Type/Description	Distance from road-take	Direct	Indirect	Potential Direct	Potential Indirect
-	-	River Crossing at Tullymore - Area of Archaeological Potential.	0m			✓	
-	-	Special Area of Conservation	0m	✓			

Table 4.7.5 Impacts: Route Corridor 1

RPS Unique Ref. No.	Heritage Reference Number	Type/Description	Distance from road-take	Direct	Indirect	Potential Direct	Potential Indirect
1	00231:003:00	Bridge Under Rail Road GNR Branch Line	20m		✓		
4	00231:062:00	Bridge	0m	✓			
5	00231:063:00	Level Crossing	0m	✓			
6	00231:064:00	Bridge	0m	✓			
22	00132:060:00	Signal Post and Crossing	0m	✓			
23	00729:000:00	Saw Mill	10m		✓		
24	00232:006:00	Bridge	0m	✓			
9	ARM012:006	Standing Stone	0m	✓			
51	ARM012:027	Cairn or Barrow: Niall's or O'Neill's Mound	50m				✓
10	ARM012:065	Enclosure	15m		✓		
14	ARM012:080	Trackway	0m	✓			
-	HB15/16/009	Main building of St. Luke's Hospital	150m				✓
-	HB15/19/010	The Hill Block of St. Luke's Hospital	150m				✓
-	HB15/20/032	Callan Bridge	200m				✓
-	-	River Crossing north of Callan Bridge – Area of Archaeological Potential				✓	
-	-	Special Area of Conservation		✓			

Table 4.7.6 Impacts: Route Corridor 2

RPS Unique Ref. No.	Heritage Reference Number	Type/Description	Distance from road-take	Direct	Indirect	Potential Direct	Potential Indirect
1	00231:003:00	Bridge Under Rail Road GNR Branch Line	20m		✓		
10	00132:045:00	Bridge	50m				✓
11	00199:000:00	Quarry with Limekiln	0m	✓			
13	ARM012:005	Rath	25m				✓
40	ARM012:074	Standing Stone	25m				✓
51	ARM012:027	Cairn or Barrow: Niall's or O'Neill's Mound	45m				✓
-	-	River Crossing at Drumcarn - Area of Archaeological Potential	0m			✓	

Table 4.7.7 Impacts: Route Corridor 3

RPS Unique Ref. No.	Heritage Reference Number	Type/Description	Distance from road-take	Direct	Indirect	Potential Direct	Potential Indirect
1	00231:003:00	Bridge Under Rail Road GNR Branch Line	5m		✓		
4	00231:062:00	Bridge	0m	✓			
5	00231:063:00	Level Crossing	0m	✓			
6	00231:064:00	Bridge	0m	✓			
22	00132:060:00	Signal Post and Crossing	0m	✓			
23	00729:000:00	Saw Mill	0m	✓			
24	00232:006:00	Bridge	5m		✓		
25	00132:061:00	Bridge	0m	✓			
9	ARM012:006	Standing Stone	0m	✓			
51	ARM012:027	Cairn or Barrow: Niall's or O'Neill's Mound	50m				✓

RPS Unique Ref. No.	Heritage Reference Number	Type/Description	Distance from road-take	Direct	Indirect	Potential Direct	Potential Indirect
10	ARM012:065	Enclosure	10m		✓		
14	ARM012:080	Trackway	0m	✓			
-	HB15/16/009	Main building of St. Luke's Hospital	100m				✓
-	HB15/19/010	The Hill Block of St. Luke's Hospital	100m				✓
-	-	River Crossing at disused railway crossing over Callan River- Area of Archaeological Potential.	0m			✓	
-	-	Special Area of Conservation	0m	✓			

Table 4.7.8 Impacts: Route Corridor 4

Route Corridor 1

Route Corridor 1 has a total of twenty-five heritage constraints. Of these constraints, eleven will be directly affected, comprising eight industrial sites, two SMR sites (one of which is a scheduled monument) and a special area of conservation within Armagh City itself. In addition, two industrial sites and an SMR enclosure site may be indirectly affected due to the close proximity of the proposed route to these sites. The route crosses a tributary of the Callan River at Tullymore, immediately south of the Killylea Road, at the southwestern limits of Armagh City and there is potential for direct impact on underwater remains should they exist at this location. Finally there are ten sites that have potential to be indirectly affected by the proposed route. These include two industrial sites and two SMR sites that may be affected by movement of machinery during road construction. The remaining six sites are historic buildings that are located adjacent to the route and may be visually impacted. It should be noted that the current complex of buildings at St. Patrick's Cathedral, occupy the site of a multi-period ecclesiastical settlement that is also a recorded SMR (ARM012:052). Sub-surface archaeological remains may potentially be disturbed in this area during construction. Due to the proximity of the proposed route to the historic sites it has the potential to have a major adverse impact.

Route Corridor 2

Route Corridor 2 has a total of sixteen heritage constraints. Of these constraints, eight will be directly affected comprising five industrial sites, two SMR sites (one of which is a scheduled monument) and a special area of conservation within Armagh City itself. In addition, two industrial sites and an SMR enclosure site may be indirectly affected due to the close proximity of the proposed route to these sites. The route crosses a pronounced bend on the River Callan, immediately north of Callan Bridge at the western/southwestern side of Armagh City and there is potential for direct impact on underwater remains should they exist at this location. Finally there are four sites that have potential to be indirectly affected by the proposed route. These include a scheduled SMR site that may be affected by movement of machinery during road construction. The remaining three sites are historic buildings that are located adjacent to the route and may be visually impacted. This route corridor has the potential to have a major adverse impact on local historic sites.

Route Corridor 3

Route Corridor 3 has a total of seven heritage constraints. Of these constraints one industrial site (a quarry with a limekiln) will be directly impacted. Another industrial site may be indirectly affected due to its close proximity to the proposed route. The route crosses the Callan River at Drumcarn on the northern extent of Armagh City, immediately west of IHR 00199:000:00 (quarry with lime kiln) and there is potential for direct impact on underwater remains should they exist at this location. Finally there are four sites that have potential to be indirectly affected by the proposed route. These include three SMR sites, one of which is scheduled and an industrial site that may be affected by movement of machinery during road construction. Therefore route corridor 3 has the potential to have a slight adverse impact upon these sites.

Route Corridor 4

Route Corridor 4 has a total of sixteen heritage constraints. Of these constraints, nine will be directly affected comprising six industrial sites, two SMR sites (one of which is a scheduled monument) and a special area of conservation within Armagh City itself. In addition, two industrial sites and an SMR enclosure site may be indirectly affected due to the close proximity of the proposed route to these sites. The route crosses the Callan River where the disused railway line also crosses at the western side of Armagh City and there is potential for direct impact on underwater remains should they exist at this location. Finally there are three sites that

have potential to be indirectly affected by the proposed route. These include a scheduled SMR site that may be affected by movement of machinery during road construction. The remaining two sites are historic buildings that are located adjacent to the route and may be visually impacted. This route corridor has the potential to have a major adverse impact upon historic sites in its vicinity.

The tables above indicate the number of impacts that each of the route corridors encounter and have been divided into 'direct' and 'indirect' impacts. These impacts have been assessed in terms of significance, that is, primarily whether a protected site/feature is affected (see Table 4.7.9 below).

Importance	Definition
High	Sites of regional importance, including Grade A Listed Buildings, Scheduled Monuments and other important sites
Medium	Sites or buildings of local importance, including Grade B+ Listed Buildings.
Low	Sites which are not of regional or local importance and Grade B1 or B2 Listed Buildings.

Table 4.7.9 - Criteria for assessing the significance & sensitivity of cultural heritage constraints

Route Corridor	Impacts	Significance	Preference
1	25 impacts, 11 of which are direct	3 direct impacts – high 8 direct impacts – low	4th
2	16 impacts, 8 of which are direct	3 direct impacts – high 5 direct impacts – low	2nd
3	7 impacts, 1 of which is direct	1 direct impact - low	1st
4	16 impacts, 9 of which are direct	3 direct impacts – high 6 direct impacts – low	3rd

Table 4.7.10 - Comparison & Preference of Route Corridors

From the perspective of minimising potential impacts on heritage resources and the level of direct physical impact on these features, it is considered that Route Corridor 3 has the highest merit, followed by (in order of preference) Route Corridor 2 and Route Corridor 4. Route Corridor 1 is least preferred in terms of impact on the heritage resource.

4.7.4 Mitigation

Further environmental assessment of the heritage resource within the study area will be required for ES Stage 2 involving field survey in order to determine if previously unrecorded archaeological or architectural features exist within the route corridors. This will facilitate a more informed route corridor assessment.

All archaeological activities regarding the proposed Armagh North & West Link scheme will be subject to discussion with, and approval from, the relevant Planning Authorities and the EHS. The emerging preferred route should be systematically walked and inspected by an archaeologist in order to identify any previously unknown or unrecorded sites/buildings. Any new items discovered in this way should be reported to the EHS. If avoidance of directly

impacting such sites is not possible the EHS may recommend full archaeological excavation and/or building surveys of the sites.

The primary aim of the mitigation strategies is to ensure that, where the proposed route directly affects or encroaches on a heritage site, the correct procedures will be established to protect the site or to minimise the direct impact on that site.

Prior to the commencement of any development, a programme of phased cultural heritage investigations should be agreed between the client and the Environment and Heritage Service of the Department of Environment (Northern Ireland).

The archaeologist will be empowered to halt the proposed road scheme if buried archaeological features or finds are uncovered. Provisions should be made to resolve any newly exposed archaeological sites.

Any archaeological sites (including underwater) that are subject to unavoidable partial or total destruction should be fully archaeologically excavated, therefore preserving the sites by record. This should be carried out by a suitably qualified archaeologist under licence from the Environment and Heritage Service of the Department of Environment (Northern Ireland).

All industrial archaeological sites that are subject to unavoidable partial or total destruction should be fully archaeologically recorded (including cartographic research), therefore preserving the sites by record, subject to agreement from EHS.

All historic buildings that are subject to unavoidable partial or total destruction should be fully recorded (including cartographic research), (written/drawn/photographic) therefore preserving the buildings by record, subject to agreement from EHS. For those buildings that are indirectly affected in a visual manner (including SACs), appropriate screening should be put in place.

All potential archaeological sites that are subject to unavoidable partial or total destruction should be fully archaeologically recorded, therefore preserving the sites by record, subject to agreement from EHS.

References

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4.8 Biodiversity

This section of the report outlines the ecological, nature conservation and earth heritage interests within the study area, the environmental protection that exists in the area and the potential effect of the road scheme on such interests. This section should be read in conjunction with Section 4.9 Water Environment.

This assessment follows the methodology outlined in the Transport Analysis Guidance (TAG) Sub-objective 3.3.10 Biodiversity and Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 4 – Ecology & Nature Conservation, & Part 11 – Geology and Soils. The following text should be read in conjunction with Figures 4.8.1A and 4.8.1B showing designated areas and areas of ecological value within the study area.

Table 4.8.1 shows relevant consultation undertaken as part of the EIA process. Consultation serves to collect data held by statutory and non-statutory organisations of relevance to the environmental assessment process. The study area was subject to a desktop survey using a combination of recent aerial photography and GIS resources to identify statutory designated nature conservation sites, non-statutory sites, and undesignated potential areas of ecological value. The earth science desktop assessment involves the identification of three main components:

Solid geology maps
Drift geology maps
Agricultural land and soil cover maps

The following key publications, documents and websites were reviewed:

Ulster Museum website and databases;
Earth Science Conservation Review website;
EHS website and databases;
National Biodiversity Network website and databases;
Reference to the GSNI – Solid and Drift Geology (Sheet 47) for Armagh;
The Wildlife (Northern Ireland) Order 1985;
The Nature Conservation and Amenity Lands (Northern Ireland) Order 1985;
The Conservation (Natural Habitats etc.) Regulations (Northern Ireland) 1995;
Biodiversity Strategy for Northern Ireland (EHS, 2002);
The Environment (Northern Ireland) Order 2002;
The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003;
DoE (NI) Landscape Character Assessment to include biodiversity and geodiversity profiles;
Armagh Area Plan 2004 (and subsequent alterations); and
Armagh Area Plan 2018 – Issues Paper.

Consultees	Response
BSBI Vice-county Recorder - Armagh	Yes
Countryside Access & Activities Network	
DARD – Environmental Policy Division	Yes
DARD – Inland Fisheries and Waterways	
DARD - Rivers Agency	Yes
DARD - Forest Service	

Consultees	Response
EHS – Natural Heritage Directorate	
EHS – Built Heritage Directorate	Yes
EHS – Environmental Protection Directorate	Yes
EHS - Council for Nature Conservation & Countryside	Yes
DRD - Water Service	Yes
Fisheries Conservancy Board for Northern Ireland	Yes
Geological Survey of Northern Ireland	Yes
Northern Ireland Tourist Board	Yes
Royal Society for the Protection of Birds	Yes
Sustrans	Yes
The National Trust	
Ulster Wildlife Trust	Yes
Waterways Ireland	

Table 4.8.1 Information Sources Consulted

4.8.1 Baseline Conditions

Statutory Designated sites

Sites designated for nature conservation value in Northern Ireland are given statutory protection under legislation described in Table 4.8.2 below.

Type of Site	Legislation	Location
Nature Reserves	Nature Conservation and Amenity Lands (Northern Ireland) Order 1985	No nature reserves occur within the immediate vicinity of the study area
Special Areas of Conservation (SACs)	Conservation (Natural Habitats) Regulations (Northern Ireland) 1995	No SACs occur within the immediate vicinity of the study area
Special Protection Areas (SPAs)	Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995.	No SPAs occur within the immediate vicinity of the study area
Ramsar sites	(Ramsar Convention 1979)	No Ramsar sites occur within the immediate vicinity of the study area
Areas of Special Scientific Interest (ASSI)	Nature Conservation and Amenity Lands (Northern Ireland) Order 1985; Environment (Northern Ireland) Order	No ASSI's occur within the study area however Annaghcramph Meadows ASSI is situated 2.5 km to the north.

Table 4.8.2: Statutory Nature Conservation Sites in Northern Ireland

Non-statutory Designations

Sites of Local Nature Conservation Importance (SLNCI) are local designations within Northern Ireland, and derive from the Regional Development Strategy for Northern Ireland 2025 under SPG-Env 1.2. They are designated in council area plans and development plans with the aim to manage suitable sites, particularly in urban and urban fringe situations, as Local Nature Reserves where habitat creation and conservation is combined with public access and

environmental education. Consultation with the Biodiversity Unit of EHS has revealed that three sites are designated as SLNCIs within 1 km of the broad route corridors. These are Drumarg and Loughnashade SLNCIs in the south and southwest of the study area, and Castle Dillon Lake in the northeast of the study area. The Armagh Area plan 2018 is at the pre-draft plan stage, with the Issues Paper released for comment in March 2004. The draft Plan has not yet been released for consultation and more detail on the SLNCIs is currently unavailable. Table 4.8.3 lists areas of ecological value in the study area.

Feature
Callan River
Callan River tributary (Wooded stream valley)
Ballynahone River
Disused Railway (Habitat Corridors)
Woodland

Table 4.8.3 Summary of Areas of Ecological Value (See Figure 4.8.2)

Callan River

The Callan River is a tributary of the River Blackwater and is designated as a Salmonid River under the EC Freshwater Fish Directive (78/659/EEC). This area consists of a wooded corridor surrounding a small river and dominated by beech in the canopy. Other species present; hawthorn Crataegus monogyna, ash Fraxinus excelsior, ground elder Aegopodium podagraria, lords and ladies Arum maculatum, ivy Hedera helix, wych elm Ulmus glabra, sycamore Acer pseudoplanatus and cherry laurel Prunus laurocerasus. The river is highly suitable for otter Lutra lutra and could also possibly support kingfisher Alcedo atthis and dipper Cinclus cinclus. The woodland is of moderate value, locally important and the river tributary is of high value, locally important.

Ballynahone River

Three corridors cross the Ballynahone River at Lisanally Lane to the north of the city centre. The Ballynahone River is a tributary of the Callan River, which flows through Co. Armagh, and drains into the River Blackwater, and eventually Lough Neagh. The Ballynahone River is a slow flowing, low energy river within an urban catchment. Consultation with the Fisheries Conservancy Board for Northern Ireland has revealed that an important fish hatchery facility owned by the Armagh and District Angling Club is in the upper reaches of the Ballynahone River. This river is assessed as being of high value, locally important. Grassland covers the majority of the wider landscape to the north and west of the study area, approximately 70% of which is improved pasture of generally low biodiversity.

Other areas

The study area is situated at approximately the northern extent of the urban fabric of Armagh, as shown in Figures 4.8.1A and 4.8.1B. Land in the south west of the study area is mixed residential, commercial and amenity.

The northern and western portions of the study area are dominated by agricultural land that is either improved grassland or arable fields. This agricultural landscape is intensively managed or highly modified agricultural grasslands that has been seeded and/or regularly fertilised, and is now heavily grazed and/or used for silage making. Some fields may be regularly reseeded monoculture grasslands and rye grass mixes that are planted as part of an arable rotation. Improved agricultural grassland is typically species-poor. Sward quality varies depending on

soil type, fertility, drainage and management. Perennial rye grass Lolium perenne is the dominant species with a very limited range of species indicating recent reseeding if the fields. Species such as broad-leaved dock Rumex obtusifolius and common nettle Urtica dioica have a patchy distribution around the periphery of the improved grassland fields. Livestock grazes over much of the agricultural land. Occasional woodland and river corridor habitats occur that are important as habitat corridors.

A portion of the proposed corridors follow the path of a disused railway. Linear features in the landscape, such as disused railways, often act as wildlife corridors, particularly when located in proximity to urban centres. The associated network of hedgerows and tree lines also act as habitat corridors. Their potential value is enhanced with the presence of streams and drains flowing through the area. This would be referred to as an 'arterial corridor', and has potential to be used by birds, bats and small mammals.

Protected flora

The study area bisects 1 10km grid square, namely H84. The Protected and Priority Plant database of the Ulster Museum and the EHS natural heritage website were consulted to identify any plants which could possibly be present in the study area and are afforded protection under the Wildlife (NI) Order, 1985. Several were found and are presented in Table 4.8.4 below.

Latin binomial	Common name	Occurrence	Habitat
Ophrys apifera	Bee Orchid	H84, H94	Chalk/limestone grassland
Primula veris	Cowslip	H84,	Limestone grasslands
Primula vulgaris	Primrose	H84,	Woodland, parkland, demesne, roadsides, hedgerow, grassy slopes
Epipactis apifera	Marsh Helleborine	H84	Lowland marshy alkaline ground such as fens and flooded railway cuttings.

Table 4.8.4: Protected Flora Recorded from Grid Squares Covering the Study Area

Protected Species

Just like flora, fauna are protected under the Wildlife (Northern Ireland) Order 1985. Of the species listed on Schedule 5, bats, badger and otter are likely to occur within the study area.

Bats feed on invertebrates (principally flying insects) and most species seek out their prey in areas that have good vegetation cover, including mature trees (woodland or forestry), hedgerow and scrub. They also frequently feed close to water as wetlands tend to support large insect communities. Bats fly along hedgerows and woodland edges as well as small lanes, minor roads and waterways, both to find and catch food and to commute between feeding areas and roosts and between alternative roosts. Good vegetative cover for bats is important and essential for much of their ecological requirements. Woodland is a highly beneficial habitat for bats; hedgerows along roads may serve as an extension of woodland edge.

The badger is one of the larger wild mammals in Ireland and is relatively common and widespread throughout most of the country. Badgers are omnivorous, feeding on insects, small mammals, grains and wild fruits but the main component of their diet is earthworms.

Consequently, their density is often higher in agricultural pasturelands and lower in areas where habitats provide a poorer food supply, such as bogs, moors and upland areas. The most frequent location of badger setts in the Northern Ireland countryside is within or close to hedgerows and treelines as these provide cover and safety from disturbance from agricultural and other activities. Setts are also frequently located in deciduous woodlands and areas of scrub, and can occur in urban areas as well as in the open countryside.

Otters live in a variety of habitats including freshwater river systems and lakes. They spend most of their time in or around water. Otters live at low population densities compared with other mammals due to habitat requirements and the linear nature of their territories. Large differences between male and female territories exist with females often having overlapping territories. Conversely, male territories rarely overlap.

Geology

Drift or quaternary geology represents the sub-soil material deposits or formations of the last 2 million years. Geological drift maps for the area indicate that the predominant drift deposit in the study area is glacial till (see Figure 4.8.3). This represents mainly ground moraine of various types and ages. Alluvium deposits are also conspicuous to the north and west of the study area and is characterised by various river deposits. Smaller parcels of bedrock at or near the surface lie to the north and south of the study area.

The constraints study area consists of eight main lithologies, five of which are overlain by the four Route Corridors as illustrated in Figure 4.8.2. The most extensive from the Carboniferous Armagh Group comprises fossiliferous, pale to dark grey, bedded marine limestones, thin shales, pale yellow to grey grainstones, calcareous grits, and sandstones and siltstones that occur locally at the base.

Evident to the east of this assembly is an area of Dobbin Sandstone Formation which is a soft, red, fine-grained, micaceous sandstone. Further east lies the Drumman More Sandstone Formation which is part of the Armagh Group. This formation is virtually unfossiliferous consisting of pale grey, non-calcareous, micaceous, fine to medium-grained sandstone with carbonised plant fragments. This black mudstone with thin coal beds at the top contains abundant miospores.

The Derrycreevy Sandstone Formation which forms part of the Sherwood Sandstone Group of the Triassic period, lies to the north of the study area. This formation is characterised by red, fine to medium-grained sandstones and red-brown micaceous siltstones and mudstones. Within this are green reduction spots with occasional ripple marks and worm trails. Within the study area also lies a small area of Permian Callan Group Mall Member. This formation consists of soft, grey, sandy limey rock.

Soils and Agricultural Land Classification

Soils and agricultural land classification has been introduced to Northern Ireland and is known as the Agricultural Land Classification (ALC). Guidelines for using the system were produced by the Department of Agriculture Northern Ireland (DANI, now known as DARD) in 1997 (Cruickshank 1997).

This classification is used to understand the quality of agricultural land in an area. The classes are based largely on the climatic, topographic and soil type, altitude and slope characteristics of the land. The system seeks to measure the way in which these parameters interact to pose limitations upon the versatility and flexibility of the land to grow crops. The ALC has five main classes with the third class sub-divided into two. Grade 1 is the highest grade and represents

soils with no physical limitations to the range of crops that can be grown. Grade 5 is the lowest grade and is severely constrained and would normally be limited to rough grazing. The respective classes and their description are shown in Appendix C10 (Cruickshank, 1997).

Agricultural Land Classification and Soil Series have been illustrated in Figure 4.8.4 and Figure 4.8.5. A large area in the centre of the study area has been classified as Urban with Agricultural Land Classification 5U denoting almost no arable agricultural potential.

An extensive area of Brown Earth Red Limestone Till lies to the north and east of the study area and has been classed as Very Good Agricultural Quality (ALC Grade 2). Surface Water Gleys in the study area have been classified as Good Quality Agricultural Land (ALC Grade 3A).

Several parcels of Moderate Quality Agricultural Land (ALC Grade 3B) are scattered to the north and west of the study area which is predominantly Ground Water Gley, Class 2 Alluvium and to a lesser extent Ground Water Gley, Class 2 Red Trias Sandstone/Limestone Mixed Till and Undifferentiated Alluvium.

4.8.2 Impacts

Ecological effects can occur by several different mechanisms. The most common direct effect is the loss of habitats of ecological value. Other effects can contribute either in isolation or in combination, and may lead to a reduced richness of biodiversity within a functioning road corridor. These effects can include:

hydrological (surface water or groundwater) regime changes;
increased air pollution of sensitive sites;
point or diffuse pollution of watercourses;
habitat fragmentation by a road corridor;
barriers to the dispersal of flora and fauna;
direct mortality of fauna through road deaths; and
increased noise disturbance causing a decline in breeding species.

Impacts on soils in the study area as a result of the proposed route corridors may include the loss or destruction of good quality agricultural land. Operation of the proposed route corridors may lead to soil compaction which may have implications on soil drainage.

Route Corridor 1

The proposed route commences as a junction with Monaghan Road before continuing north to join with Killylea Road. This broad corridor follows the contours through undulating hillsides to the west of the city passing through mainly improved agricultural landscape. This corridor crosses the Callan River, a small tributary of the Callan and the Ballynahone River. Having linked with Killylea Road Corridor 1 continues east on-line onto Friary Road. From here Route Corridor 1 goes off-line continuing north along the old disused railway corridor Area of Ecological Constraint (AEC) intersecting a number of routes including, Navan Street, Windmill Hill, Cathedral Road, and Moy Road. Having crossed Moy Road the route veers north east and crosses Loughgall Road before continuing along Station Road. As the route diverges from Station Road it goes off-line to continue east where it crosses the Ballynahone River and then intersects with the northern section of the disused railway corridor AEC until it terminates with a junction to Portadown Road.

Construction activities may also impact upon surface and groundwater features. This corridor predominantly transverses till deposits although small parcels of alluvium are crossed by the southern section of the Route Corridor. To the south of the study area, the route travels across

the Carboniferous Armagh Group. As the Route Corridor travels east, it overlies the Dobbin Sandstone Formation and a small area of the Permian Callan Group Mall Member. The Route Corridor continues north over the Dobbin Sandstone Formation until it travels east over the Drumman More Sandstone Formation and a small area of the Carboniferous Armagh Group.

Route Corridor 1 overlies small parcels of Ground Water Gley, Class 2 Alluvium (ALC Grade 3B) and Surface Water Gley, Class 1 Red Trias Sandstone/Limestone Mixed Till (ALC Grade 3A) to the south of the study area. As the route travels north it borders an area of Brown Earth Red Limestone Till. After travelling over Ground Water Gley Class 2 Alluvium the route veers east over a parcel of Surface Water Gley, Class 1 Red Trias Sandstone Till. The route then continues over unclassified urban land. Towards the northern section of the Route Corridor, the route overlies a large parcel of Very Good Agricultural Quality, Brown Earth Red Limestone Till.

In summary, route corridor 1 passes through habitats varying from low to high local ecological value, but also passes through more of the urban fabric of Armagh than other corridors, and is ascribed a low value in line with TAG Unit 3.3.10. Route Corridor 1 will not have a major impact on the geology of the study area. It is preferred that the route overlies poor quality agricultural land or urban land to reduce the impact on good quality agricultural land. Despite travelling across poor quality urban areas the eastern section of the route will have a slight negative impact on Very Good Quality (ALC Grade 2) agricultural land.

A potential impact of slight adverse is predicted for Route Corridor 1.

Route Corridor 2

The proposed route commences as a junction with Monaghan Road continuing north to join with Killylea Road. This broad corridor follows the contours through undulating hillsides to the west of the city passing through mainly improved agricultural landscape. This corridor crosses the Callan River, its tributaries and the Ballynahone River. The route continues east crossing Navan Fort Road, improved agricultural land, and amenity grassland. Having crossed Railway Street Route Corridor 2 continues on-line along Station Road. As the route diverges from Station Road it goes off-line to continue east where it crosses the Ballynahone River and then intersects with the northern section of the disused railway corridor AEC until it terminates with a junction at Portadown Road.

Construction of the proposed route may result in direct impacts upon surface and groundwater features. Runoff from construction areas and temporary discharges to watercourses may occur which could reduce water quality in the area if not managed appropriately.

Much of Route Corridor 2 transverses till deposits although parcels of alluvium are crossed to the south west of the study area. Similar to Route Corridor 1, Route Corridor 2 also travels across the Carboniferous Armagh Group to the south of the study area. As the Route Corridor travels east, it overlies the Dobbin Sandstone Formation and a small area of the Permian Callan Group Mall Member. The Route Corridor continues north over the Dobbin Sandstone Formation. As it travels east, it overlies the Drumman More Sandstone Formation and a small area of the Carboniferous Armagh Group.

Route Corridor 2 overlies a parcel of Ground Water Gley, Class 2 Alluvium and Surface Water Gley, Class 1 Red Trias Sandstone/Limestone Mixed Till to the south of the study area. As the route travels north it borders an area of Brown Earth Red Limestone Till, travelling over Ground Water Gley Class 2 Alluvium and Surface Water Gley, Class 1 Red Trias Sandstone Till. As the route travels east across the study area it overlies unclassified urban land. As the northern section of the route corridor continues eastwards, it overlies a large parcel of Very Good Agricultural Quality Brown Earth Red Limestone Till.

In summary, route corridor 2 passes mainly through agricultural and amenity grasslands and therefore through habitats of ecological value less frequently; however the route will also cross many surface watercourses, including the Callan and Ballynahone Rivers. This corridor follows a mosaic of habitats varying from low to high local biodiversity interest, and is ascribed a low value in line with TAG Unit 3.3.10. Route Corridor 2 will not have a major impact on the geology of the study area. Although this route corridor overlies a substantial area of urban land, it also overlies Very Good Quality agricultural land to the east of the study area.

A potential impact of slight adverse is predicted for Route Corridor 2.

Route Corridor 3

This is the longest route corridor within the study area. Originating at a junction with Monaghan Road, Corridor 3 follows a relatively rural route west and north of Armagh City urban area. Heading north the route will cross Killylea Road and Navanfort Road. Continuing north the route joins with Ballycrummy Road until the junction with Cathedral Road. Having crossed Cathedral Road the route continues north and north east where it crosses Moy Road, Drumcarn Road, Lisdonwilly Road, Loughgall Road, and Drummanmore Road until it terminates with a junction to the Portadown Road. This Route passes through a Drumlin landscape of agricultural fields, crossing through a small section of the disused railway AEC at its northern end. As this is the longest route it has the potential to cross more hedgerows, ditches, and field boundaries than the other corridors. Just after the route crosses the Drumcarn Road it crosses the Callan River.

This Route Corridor predominantly overlies glacial till but also overlies several parcels of alluvium deposits. To the north of the study area, a small parcel of bedrock is crossed by the Route Corridor. The entire western section of Route Corridor 3 transverses the Carboniferous Armagh Group. To the north of the study area, the Route Corridor travels east briefly across the Derrycreevy Sandstone Formation. As the route veers south, it overlies the Carboniferous Armagh Group and continues east over the Drumman More Sandstone Formation.

Route Corridor 3 overlies small parcels of Ground Water Gley, Class 2 Alluvium and Surface Water Gley, Class 1 Red Trias Sandstone/Limestone Mixed Till to the south of the study area. As the route travels north it borders an area of Brown Earth Red Limestone Till, extending north over Surface Water Gley, Class 1 Red Trias Sandstone Till. As the northern section of the Route Corridor travels east across the study area, it overlies Ground Water Gley, Class 2 Alluvium and Brown Earth Red Limestone Till. The route also travels across small areas of unclassified urban land. As the northern section of the Route Corridor travels in a south east direction, it overlies Undifferentiated Alluvium, Brown Earth Red Trias Sandstone/Limestone Mixed Till and Brown Earth Limestone Till. Route Corridor 3 overlies Very Good Quality, Good Quality and Moderate Quality soils.

In summary, the route corridor 3 passes mainly through agricultural grasslands and crosses a small tributary of the Callan River in the west, and then crosses the main Callan River north of the city. This corridor crosses more field boundary trees and hedgerows than the other corridors. This corridor is a mosaic of habitats varying from low to high local biodiversity interest, and is ascribed a low value in line with TAG Unit 3.3.10. Route Corridor 3 will not have a major impact on the geology of the study area. As the route avoids the land classified as urban, almost the entire route will impact on Moderate Quality, Good Quality and Very Good Quality Agricultural Land.

A potential impact of moderate adverse is predicted for Route Corridor 3.

Route Corridor 4

This route Corridor will cross through suburban and urban areas in the west, north central and east of Armagh City. The proposed route commences as a junction with Monaghan Road continuing north to join with Killylea Road. This broad corridor follows the contours through undulating hillsides to the west of the city passing through mainly improved agricultural landscape. This corridor crosses a small tributary of the main Callan River, but no main watercourses. North of the Cathedral Road the route continues east along the disused railway corridor AEC until it hits the Moy Road. The route then heads north east crossing Railway Street and Station Road. As the route diverges from Station Road it goes off-line to continue east where it crosses the Ballynahone River and then intersects with the northern section of the disused railway corridor AEC until it terminates with a junction to Portadown Road.

Construction of the proposed route may result in direct impacts upon surface and groundwater features. Runoff from construction areas and temporary discharges to watercourses may occur which could reduce water quality in the area if not managed appropriately. The route will also cross many surface watercourses, including the Callan and Ballynahone Rivers.

Route Corridor 4 overlies Ground Water Gley, Class 2 Alluvium and Surface Water Gley, Class 1 Red Trias Sandstone/Limestone Mixed Till to the south of the study area and borders an area of Brown Earth Red Limestone Till. As the route travels north and extends east, it travels over Ground Water Gley, Class 2 Alluvium and Surface Water Gley, Class 1 Red Trias Sandstone Till. As the route travel east across the study area, it overlies unclassified urban land. As the northern section of the route corridor extends eastwards, it overlies a large parcel of Very Good Quality Brown Earth Red Limestone Till.

In summary, route corridor 4 passes through habitats of similar quality and variation as the other corridors, but also impacts upon more of the disused railway. It also crosses many surface watercourses, including the Callan and Ballynahone Rivers. It also goes through a large section of the old disused railway corridor AEC and an area of mature woodland associated with the Desert Lane Cemetery which are both examples of undesignated sites of local biodiversity interest, and is ascribed a low-medium local value in line with TAG Unit 3.3.10. Route Corridor 4 will not have a major impact on the geology of the study area. The route travels over a substantial parcel of land classified as urban but will also impact on Very Good Quality Agricultural Land.

A potential impact of slight/moderate adverse is predicted for Route Corridor 4.

4.8.3 Mitigation

The channels, banks, treelines and hedgerows of the Callan and Ballynahone Rivers hold potential for wildlife interest; however these rivers are situated chiefly within the urban context. The small sections of these rivers to the north and east of the study area are situated within an agricultural context and their embankments are therefore highly disturbed. The network of hedgerows and tree lines act as wildlife corridors and hold potential for faunal species. Their potential value is enhanced where a stream flows along field boundaries. These corridors hold potential to be used by birds, bats and small mammals.

Potential effects on non-statutory sites, areas of ecological value and protected species will be investigated at the next stage of environmental assessment upon selection of a corridor. Bats and otters are likely to be present along the river courses, while badgers are most often found in

agricultural landscapes and woodland settings. Surveys for scheduled species will be required under the Wildlife (Northern Ireland) Order 1985.

A full ecological assessment of lands in the selected corridor will be required under the Design Manual for Roads and Bridges (DMRB) Vol.10, Section 4, Parts 1-4, and in accordance with Institute for Ecology and Environmental Management (IEEM) (2006) methodology and standards. A Phase 1 survey will be carried out to identify the dominant species of the vegetation assemblages present according to standard methodology Joint Nature Conservation Committee (JNCC 2003). Optimum survey periods are included as Appendix C6 'Optimum Periods for Ecological Survey'.

The selection process should seek to minimise potentially impacts to sites of ecological value, i.e. The Disused Railway Habitat Corridor, Ballynahone River, Callan River, and also those which would avoid areas identified as holding a high potential for wildlife activity such as agricultural field boundaries, treelines and hedgerows. A full ecological assessment of lands affected by the selected corridor will be required, in particular to determine the level of use by mobile faunal species and identify the dominant species of the vegetation assemblages present.

It is important that the fisheries interests should be protected throughout the period of works in the vicinity of the Ballynahone River, Callan River and their tributaries. There is a risk that suspended solids, oils, cement washings or other discharges to the watercourses may result in fish kills and all appropriate pollution prevention measures should be taken. Timing of works may impact on fishery interests during periods of migration, and mitigation measures should be put in place to prevent unnecessary harm.

In circumstances where 'hard rock' may be affected there may be scope for mitigation through provision of new exposure for study. The most effective mitigation measure in areas where active geological processes are taking place, such as bank erosion, is to site and design new roads carefully, which avoids future problems and minimises initial impact. However, in cases where disturbance of existing processes is inevitable, appropriate engineering techniques should be employed which will ameliorate or mitigate the effects.

If it is deemed necessary to treat any of the contaminated land this may be carried out 'in-situ' if there is sufficient land available to create a permanent disposal site. Careful consideration will need to be given to the exact design of this to avoid leakage or seepage from the site.

4.9 Water Environment

This water environment chapter has been undertaken in accordance with the guidance set out in the Department of Transport (DoT) published Transport Analysis Guidance (TAG Unit 3.3.11) also referenced was the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 10, Road Drainage & the Water Environment.

The assessment process at the Stage 1 Scheme Assessment stage considered location of historic flood plains and watercourses in close proximity to the four route corridors. Pollution from road drainage can originate from numerous sources including accidental spills, general vehicle and tyre degradation, oil and fluid leaks. This section should be read in conjunction with Section 4.8 Biodiversity. This section should be read with reference to figures 4.9.1, 4.9.2 & 4.9.3.

4.9.1 Baseline Conditions

Rivers in the Study Area

The four route corridors are located within the Lough Neagh South Catchment area. There are commercially and ecologically important waterbodies within the vicinity of each route corridors. Drumman More Lake is situated just off the Drummanmore Road approximately 0.58 km north of the A3 Portadown Road. Drumman Beg Lake is also located off the Drummanmore Road, 0.34 km from the smaller Drumman More Lake. Both these lakes are likely to contain coarse fish and are fed by streams and drainage ditches to the south. Castle Dillon Lake is the largest water body within the vicinity and is located 1.19 km north-east of the route corridors intersection point with the Portadown Road. This lake is an important bird sanctuary as well as providing a habitat for various fish species & aquatic plant.

Figure 4.9.1 highlights watercourses and notes locations with a recorded historic flooding experience. The Ballynahone River has its origins in Woodford, off the Markethill Road and travels in a northerly direction and turns west after passing Deans Hill. It converges with the Callan River close to the junction of the Lisdonwilly Road and the Loughgall Road. The Callan River crosses the A3 Monaghan Road approximately 0.42 km east of Milford. It flows in a northerly direction passing Tullyelmer House before turning east and flowing for approximately a further 1.3 km until it meets with the Ballynahone River. The Callan River contains stocks of Brown Trout, Lough Neagh Dollaghan and other coarse fish species; it is designated salmonid under the terms of the EU Freshwater Fish Directive and is required to comply with a range of quality standards. The watercourse then flows in a generally northerly direction for approximately 13.7 km meeting with the River Blackwater. This in turn then flows approximately 11.5 km and enters Lough Neagh.

Hydrogeology of the Study Area

Figure 4.9.2 denotes areas of hydrogeological importance in the Armagh City area. The northern fringes of the City are dominated by a locally important aquifer. A variable sequence of limestones, muddy limestone, shales, mudstones, sandstones and rare thin coals are components of this type of Visean and Tournasian formation. Located to the north of the four route corridors and the point of intersection with the Portadown Road is a Visean Sandstone aquifer. This aquifer is of local importance due to potential borehole yields. Southwest of this formation lies a section of Alluvium and a region underlain by impermeable rock (Silurian & Ordovician). The latter is principally constructed of grey wackes, shales, sandstones and mudstones.

In the central region of Armagh City, a highly productive (not extensive) Sherwood Sandstone is dominant. This aquifer is made up of fine-to-medium grained sandstone with marl and mudstone partings. Alluvium occurs along the route of the Callan River which is generally fine grained. Alluvium is typically made up of a variety of materials. The finer material, or silt, consists of sand and mud. Larger particles, or gravel, are also typically present in a wide range of sizes. Groundwater in the alluvium is, for the most part, moderately mineralised but is prone to contamination by influence of nitrogen enrichment from surface run-off. Two boreholes (See figure 4.9.2) are indicated on the Hydrogeological Map of Northern Ireland 1994.

Groundwater Vulnerability

Figure 4.9.3 Groundwater Vulnerability highlights vulnerability classes in the study area. The eastern section of the Armagh City consists of a fractured or potentially fractured rock (Type BI), which does not have high primary permeability. Soils are of intermediate leaching potential at this location. These include soils that hold moderate ability to attenuate diffuse contaminates or in which it is possible that some non-absorbed diffuse contaminants and liquid discharges could penetrate the soil layer. A highly permeable formation (Type AH) is located in the central region of Armagh City. A known or probable presence of significant fracturing is characteristic of this formation type and the soils are exceptionally vulnerable to liquid discharge. A Type B High groundwater formation exists at the western edge of the Type A Highly Permeable formation. These fractured or potentially fractured rocks are overlain by intermediate leaching potential soils.

Designations

Under the terms of the EC Freshwater Fish Directive (78/659/EEC), a number of rivers have been designated as either salmonid (suitable for game fish) or cyprinid (suitable for coarse fish).

The Callan River is a designated salmonid watercourse. Killeen Water is a protected area under the Urban Wastewater Treatment Directive (91/271/EEC) due to it being located in a nutrient sensitive area. It was designated as being UWWTD Transitional Water in December 1994.

Water Quality Data

The Environment & Heritage Service Water Quality Unit regularly monitors the river network in Northern Ireland. The main arterial rivers are referred to as primary rivers and they are monitored at primary monitoring stations. Regular monitoring of smaller rivers with a mean daily flow of at least 5,000 cubic metres per day also takes place. The smaller rivers selected for monitoring are divided into ‘secondary’ (greater than 3 metres wide) and ‘minor’ (between 1.5 and 3 metres wide). Primary and secondary rivers are currently monitored and classified both chemically and biologically while minor rivers are monitored and classified biologically.

Biological Water Quality

Various macroinvertebrates are present in rivers and they vary in their sensitivity to pollution. Therefore, they can act as an in line monitoring system for pollution events and especially for substances which may not be detected by chemical monitoring. Macroinvertebrate data is summarised using the Biological Monitoring Working Party (BMWP) biotic score system. This separates invertebrate groups (taxa) according to their sensitivity to pollution with more sensitive taxa being allocated higher scores and more tolerant taxa lower scores. In general, higher total biotic scores describe better quality invertebrate communities reflecting the better end of the pollution spectrum.

Biological Class	Water Quality
A	Very Good
B	Good
C	Fairly Good
D	Fair
E	Poor
F	Bad

Table 4.9.1: Biological Classification Bandings

Class A – The biology is similar to (or better than) that expected for an average, unpolluted river of this size, type and location. There is a high diversity of taxa, usually with several species in each. It is rare to find a dominance of any one taxon.

Class B – The biology shows minor differences from Class A and falls a little short of that expected for an unpolluted river of this size, type and location. There may be a small reduction in the number of taxa that are sensitive to pollution, and a moderate increase in the number of individuals in the taxa that tolerate pollution (like worms and midges). This may indicate the first signs of organic pollution.

Class C - The biology is worse than that expected for an unpolluted river of this size, type and location. Many of the sensitive taxa are absent or the number of individuals is reduced, and in many cases there is a marked rise in the numbers of individuals in the taxa that tolerate pollution.

Class D – The biology shows considerable differences from that expected for an unpolluted river of this size, type and location. Sensitive taxa are scarce and contain only small numbers of individuals. There may be a range of those taxa that tolerate pollution and some of these may have high numbers of individuals.

Class E – The biology is restricted to animals that tolerate pollution with some taxa dominant in terms of the numbers of individuals. Sensitive taxa will be rare or absent.

Class F - The biology is limited to a small number of very tolerant taxa, often only worms, midge larvae, leeches and the water hog-louse. These may be present in very high numbers but even these may be missing if the pollution is toxic. In the very worst case there may be no life present in the river.

Chemical Water Quality

In Northern Ireland, the chemical General Quality Assessment (GQA) scheme has classes categorising samples from Very Good to Bad quality using a method of definition which is recognised nationally. These standards are based on concentration of BOD (Biological Oxygen Demand), ammonia, and dissolved oxygen. These have been selected as indicators of the extent to which waters are affected by wastewater discharges and run-off containing organic, biodegradable material. These three determinants give the most useful chemical assessment of river water quality for the purposes of GQA.

GQA Class	Dissolved Oxygen (% saturation) 10-percentile	BOD (mg/l) 90-percentile	Ammonia (mg N/l) 90-percentile
A (Very Good)	80	2.5	0.25
B (Good)	70	4	0.6
C (Fairly Good)	60	6	1.3
D (Fair)	50	8	2.5
E (Poor)	20	15	9.0
F (Bad)	Less than 20	-	-

Table 4.9.2 General Quality Assessment Scheme (GQA) Classification.1

1 River Quality in Northern Ireland 1995 Report

The Callan River and the Ballynahone River

Both of these watercourses are monitored at several locations along their length. Table 4.9.3 shows details of chemical and biological monitoring results for these rivers. Although three of these stations are upstream of the study area they still provide an estimate of general water quality in the region.

Location	Grid Ref.	Chemical	Biological
Butter Water at Ballynahone Bridge	H863429	2004 & 2005 - C	2001 – B(1) 2002 – B(1) 2003 – B(1) 2004 – C(1) 2005 – B(1)
Callan River at Derryscollop	H867558	2001-02 – B 2003-05 – C	2001 – B(1) 2002 – C(3) 2003 – B(3) 2004 – C(2) 2005 – C(2)
Callan River at Paper Mill Bridge	H857392	2001-05 – B	2001 – C(1) 2002 – B(3) 2003 – B(3) 2004 – B(2) 2005 – B(2)
Callan River at Dundrum	H868344	2002-05 – B	2001 – B(1) 2002 – B(3) 2003 – A(2) 2004 – A(2) 2005 – (A2)

Table 4.9.3 Chemical & Biological Monitoring Results for the Callan River and the Butter Water.

Flooding and Flood Plains

Consultation with Rivers Agency has identified predictive flooding and these are illustrated in figure 4.9.1. Although they hold no specific flood levels for the predictive flooding areas Rivers Agency generally advise that any development or infilling of a site for development should be restricted to land that lies above the 100-year flood level.

4.9.2 Impacts

Route Corridor 1

The Callan River, Ballynahone River and numerous minor watercourses and drainage ditches are found throughout Route Corridor 1. The route corridor traverses a minor stream/field drain and a minor tributary of the Callan River on the section between Monaghan Road and Killylea Road. The route corridor then continues along existing carriageway and crosses an existing bridge over the Callan River. The Ballynahone River is traversed at Lisanally Lane over an existing culvert. Minor field drains are crossed both to the east and west of Mullinure Lane. To the east of Drummanmore Road a minor drainage ditch is crossed near the Portadown Road.

With regard to hydrogeology and groundwater vulnerability the route corridor crosses a variety of formations. At the start of the corridor GSNI and hydrogeological mapping indicates the presence of Alluvium and Visean & Tournasian Formations. The groundwater vulnerability is noted as being Type B with a mix of low and high permeability. The route corridor then traverses an area of Sherwood Sandstone – Type A highly Permeable Aquifer. The majority of this area is heavily urbanised.

Two sections of Visean Sandstone are crossed by Route Corridor 1 west of Mullinure Lane and in close proximity to Drummanmore Road. The groundwater vulnerability traversed is a formation Type B Intermediate Permeability.

This corridor crosses a section of historic flooding area at Lisanally Lane.

Any detrimental effect upon the Ballynahone River will ultimately affect water quality of the Callan River as it is a designated Salmonid watercourse under EC Freshwater Fish Directive (78/659/EEC). Route Corridor 1 is predicted to have slight adverse impact.

Route Corridor 2

The Callan River, Ballynahone River and numerous minor watercourses and drainage ditches are found throughout Route Corridor 2. The route corridor traverses a minor stream/field drain and a minor tributary of the Callan River on the section between Monaghan Road and Killylea Road. This Route Corridor crosses the Callan River at Callan Bridge Road. The Ballynahone River is traversed at Lisanally Lane over an existing culvert. Minor field drains are crossed both to the east and west of Mullinure Lane. To the east of Drummanmore Road a minor drainage ditch is crossed near the Portadown Road.

With regard to hydrogeology and groundwater vulnerability the route corridor crosses a variety of formations. At the start of the corridor GSNI and hydrogeological mapping indicates the presence of Alluvium and Visean & Tournasian Formations. The groundwater vulnerabiilty is noted as being Type B with a mix of low and high permeability. The route corridor then traverses an area of Sherwood Sandstone – Type A highly Permeable Aquifer. A majority of this area is heavily urbanised.

Two sections of Visean Sandstone are crossed by Route Corridor 2 west of Mullinure Lane and in close proximity to Drummanmore Road. The groundwater vulnerability traverses a formation Type B Intermediate Permeability.

This corridor crosses a section of historic flooding area east of Callan Bridge Road and another area near to Lisanally Lane.

This route corridor crosses the Callan River, an important fisheries river and a designated Salmonid watercourse under EC Freshwater Fish Directive (78/659/EEC). Route Corridor 2 is predicted to have moderate adverse impact.

Route Corridor 3

The Callan River, Ballynahone River and numerous minor watercourses and drainage ditches are found throughout Route Corridor 3. The route corridor traverses a minor stream/field drain and a minor tributary of the Callan River on the section between Monaghan Road and Killylea Road. A culverted minor watercourse is traversed before the junction of the Ballycrummy Road and the Cathedral Road. A minor tributary of the Callan River is traversed at Moy Road. Another minor drainage stream is crossed by this route between Moy Road and Drumcairn Road. Route Corridor 3 then crosses the Callan River to the east of Lisdonwilly Road.

With regard to hydrogeology and groundwater vulnerability the route corridor crosses a variety of formations. The groundwater vulnerability is noted as ranging from Low to High Type B permeability.

Alluvium, Visean & Tournaisian formation are crossed through the route corridor with a small area of Visean Sandstone situated in the east of the route corridor. The corridor also lies in close proximity to a borehole with a pumping yield of >19l/s.

This corridor crosses a section of historic flooding area east of Liberty Hall. Other historic flood areas are traversed to the west of Drumcairn Road and to the west of Lisdonwilly Road. A considerable area is crossed in close proximity to Court Hill.

This route corridor crosses the Callan River and its tributaries. The Callan River is an important fisheries river and a designated Salmonid watercourse under EC Freshwater Fish Directive (78/659/EEC). Route Corridor 3 is predicted to have major adverse impact.

Route Corridor 4

The Callan River, Ballynahone River and numerous minor watercourses and drainage ditches are found throughout Route Corridor 4. The route corridor traverses a minor stream/field drain and a minor tributary of the Callan River on the section between Monaghan Road and Killylea Road. A culverted minor watercourse is traversed before the junction of the Ballycrummy Road and the Cathedral Road. The route corridor then continues and crosses the Callan River to the north west of Glen Court. The Ballynahone River is traversed at Lisanally Lane over an existing culvert. Minor field drains are crossed both to the east and west of Mullinure Lane. To the east of Drummanmore Road a minor drainage ditch is crossed near the Portadown Road.

With regard to hydrogeology and groundwater vulnerability the route corridor crosses a variety of formations. At the start of the corridor GSNI and hydrogeological mapping indicates the presence of Alluvium and Visean & Tournasian Formations. The groundwater vulnerability is noted as being Type B with a mix of low and high permeability. The route corridor then traverses an area of Sherwood Sandstone – Type A highly Permeable Aquifer. The majority of this area is heavily urbanised.

Two sections of Visean Sandstone are crossed by Route Corridor 4 west of Mullinure Lane and in close proximity to Drummanmore Road. The groundwater vulnerability traverses a formation Type B Intermediate Permeability.

This corridor crosses a section of historic flooding area west of Desart Lane and another area near to Lisanally Lane.

This route corridor crosses the Callan River, a designated Salmonid watercourse under EC Freshwater Fish Directive (78/659/EEC). Route Corridor 4 is predicted to have moderate adverse impact.

Impact Conclusion

Overall, Route Corridors 2, 3 & 4 have been characterised as having a Moderate Adverse Impacts. It is predicted that Route Corridor 1 will have a Slight Adverse Impact due to the extensive urban area it traverses.

4.9.3 Mitigation

Potential for Water Contamination

Any river crossings, excavations and construction operations close to rivers or streams have the potential to impact on water quality and fisheries. Contaminated storm waters are liable to arise from site excavations, site preparations, use of surface materials and from spillage of oils or other harmful substances.

The Scottish Environmental Protection Agency (SEPA) lists the main sources of pollution from construction sites adjoining rivers as follows:

The discharge or entry into waters of contaminated site run-off or pumped contaminated surface/ground waters,
Direct disturbance of the beds of rivers & streams by excavation or fording,
Loss of oil from machinery or storage areas,
Cement and cement wash from batching plants, storage areas and other areas where cement grout or concrete is being applied.

Any works in the vicinity of the Callan River & Ballynahone River and their tributaries would have to be sensitive in terms of drainage design and all necessary precautions should be taken in the construction and operational phases of the project. The need for such care would be further highlighted by the presence of a river intake for public supply, if present.

The relevant legislative controls for the pollution of water include the Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003, the Water (Northern Ireland) Order 1999 and the Fisheries (Amendment) (Northern Ireland) Order 1991. The Rivers Agency (NI) advise that any proposals within the study area (either temporary or permanent) which involve interference with any watercourse such as culverting, bridging or discharge of stormwater runoff require written consent from Rivers Agency. Failure to obtain such consent would be in breach of Schedule 6 of the Drainage (Northern Ireland) Order 1973, which could result in the Agency instigating legal proceedings.

The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003 and the Water (Northern Ireland) Order 1999 is aimed at promoting the conservation of the water resources of Northern Ireland and promoting the cleanliness of water in waterways and underground strata. Under this Order the matters to be taken into account by the Department of the Environment and its functions include:

the needs of industry and agriculture,
the protection of fisheries,

the protection of public health,
the preservation of amenity and the conservation of flora and fauna,
the conservation of geological and physiographical features of special interest and any feature of archaeological, historical, architectural or traditional interest.

The Fisheries (Amendment) (Northern Ireland) Order 1991 is aimed at the promotion and development of angling and the protection of fisheries.

Direct disturbance of the beds of rivers and streams by excavation or fording can result in a negative impact on streambed communities. If construction vehicles have to cross any of the waterbodies during the construction a maximum of one crossing point should be used. This should be furnished with temporary bridging structure to avoid erosion to riverbanks. If this is not achievable, heavy tracking or other durable substrate should be place on the bed of the river and approaches at a suitable fording point to prevent erosion of the riverbed.

Where the river substrate is of solid and well-embedded stone and gravel it may be deemed suitably robust to handle vehicular traffic at a certain designated point (s). However, soft sediment in the banks or approaches to the crossing point should be protected from erosion by suitable geotextile or other surface stabilising materials. Stream crossings should be undertaken during the summer period.

Other potential measures to prevent contamination of surface waters are for example, specific measures to intercept contaminants such as:

bunds;
interceptors;
attenuation ponds; and
swales.

The location and sensitive design of river or stream crossings are important. The Department of Agriculture Fisheries Division would require method statements in relation to crossings and liaison arrangements would have to be agreed.

References

DMRB (2000). Design Manual for Roads and Bridges Volume 11: Environmental Assessment. The Stationery Office, London, UK.

SEPA (Scottish Environmental Protection Agency) (1996). Guidelines for Water Pollution Prevention from Civil Engineering Contracts. Scottish Environmental Protection Agency.

4.10 Physical Fitness

There is an increasing recognition between transport the environment and health. Transport affects health in a number of ways, both positive (recreation, physical fitness and enabling access to employment, shops, the countryside etc) and negative (traffic injuries, air pollution, noise, stress, loss of land and severance of communities by roads).

All these issues are covered elsewhere in the report under their own objectives or sub-objectives with the exception of physical fitness. Subsequently, this section considers the impact of the proposed scheme in relation to physical fitness in accordance with TAG Unit 3.3.12 Physical Fitness.

The recommended minimum level of daily activity for adults is 30 minutes or more of moderate activity (such as walking or cycling).

The health implications of the proposed scheme may be identified through assessment of changes in the opportunities for increased physical activity through cycling and walking. Provision of increased opportunities to walk and cycle may have additional benefits including improvements to the physical environment within communities, fostering wellbeing and community spirit which also have implications for health.

At this stage of the assessment detailed information in relation to journey times, key destinations and the existing provision for pedestrian and cyclist facilities is not known. As such, only general, qualitative comments may be made about the impact of the proposed road in relation to physical fitness.

4.10.1 Baseline Conditions

The Sustrans National Cycle Network (NCN) Route 91 dissects the southern portion of Armagh City, roughly running parallel to Friary Road and Killylea Road; this existing provision is illustrated in Figure 4.10.1.

Furthermore, it is assumed that the urban area within the vicinity of the route corridors accommodates pedestrian footpaths alongside the existing road network. Also, it is assumed that key destinations are located primarily in the urban area of Armagh City.

4.10.2 Impacts

The development of a new road brings with it the opportunity to provide improved/new footpaths and cycleways and as such, ensure positive physical fitness benefits through the provision of attractive, recreational facilities. These benefits may be implemented within the design of any of proposed route corridors.

Route Corridor 1

Route Corridor 1 traverses a number of roads (including Navan Street, Cathedral Road, Station Road and Moy Road) located within Armagh City. Given the location of such roads in relation to urban land use (in particular residential), there is potential for obstruction of the existing movements of cyclists and pedestrians.

The NCN 91 is severed by this corridor at Windmill Hill resulting in further impact upon existing cyclist movements.

Route Corridor 2

This corridor crosses Killylea Road, Moy Road, Callan Bridge Road and Cathedral Road. Given the location of these roads in relation to urban land uses, Route Corridor 2 may cause obstruction to the movements of cyclists and pedestrians along these roads.

The NCN 91 is severed by this corridor at Killylea Road resulting in further impact upon existing cyclist movements.

Route Corridor 3

Route Corridor 3 traverses land outside the main urban area of Armagh City, impacting upon what is largely agricultural land. Whilst crossing many of the same roads as both corridor 1 and 2, Route Corridor 3 results in a lesser impact upon pedestrian and cyclist movements, due to the relative isolation from land uses which may act as key destinations.

This corridor does however traverse the NCN 91 at Killylea Road resulting in an impact upon existing cyclist movements.

Route Corridor 4

This corridor crosses Killylea Road, Moy Road, Callan Bridge Road and Cathedral Road. As a result, this corridor may cause obstruction to the movements of cyclists and pedestrians along these roads which are located within, or in close proximity to urban land uses.

As with corridor 2 and 3, the NCN 91 is severed by this Route Corridor 4 at Killylea Road resulting in further impact upon existing cyclist movements.

Impact Conclusion

Despite the potential severance associated with the proposals, each of the corridors presents the potential to incorporate improved facilities such as dedicated footpaths and/or cycleways. Each of the route corridors is therefore assessed as having an impact level of slight beneficial.

The inclusion of such facilities should be considered in greater detail in subsequent stages of the assessment process.

4.10.3 Mitigation

Where the proposed route corridors traverse roads, provision should be made to allow existing pedestrian and cyclist users the same (or improved) level of access to and from key destinations as they are already afforded. The inclusion of safe and convenient crossing facilities should alleviate the potential impact of severance.

4.11 Journey Ambience

Journey Ambience examines the potential impacts of the physical/visual elements of any proposed scheme on driver stress and the visual outlook from the road corridor, as required by TAG Unit 3.3.13, The Journey Ambience Sub-Objective.

4.11.1 Baseline Conditions

Driver Stress is defined for environmental assessment as the adverse mental and physiological effects experienced by a driver traversing a road network.

Under existing conditions, the volume of traffic especially during peak periods can lead to traffic build-ups. The effect of this can be to lengthen journey times and add to vehicle travellers' frustration and stress.

Factors that influence driver stress levels include:

Road Layout;
Geometry;
Surface Riding Characteristics;
Junction Frequency; and
Speed and flow per lane.

For drivers, these factors can cause a feeling of discomfort, annoyance, frustration and fear, resulting in physical and emotional tension. Frustration is caused on the existing road network in sections of road in the study area by volume of traffic, slow moving traffic and unreliable journey times. The level of stress experienced varies between individuals, depending on characteristics such as skill, experience, temperament and knowledge of the route. Research into driver behaviour indicates that there is a drop in driving standards with increased driver stress and drivers tend to be more aggressive towards other road users. However, in the east of the study area the routes pass through a largely rural area which provides unrestricted views of the area.

4.11.2 Impacts

Due to improved road design and safety standards, driver stress on any new routes and existing relieved routes is envisaged to reduce when compared to the present situation. The proposed scheme should improve traffic conditions around the main routes in close proximity to the scheme. It also has the potential to alleviate traffic volumes in the city centre.

It was not possible to conduct a detailed assessment of driver stress at Stage 1; however, some general information has been presented with regard to the generic impacts on vehicle travellers.

The type of development proposed can affect driver stress in a number of ways:

Route uncertainty caused by inadequate signing.
Fear of potential accidents caused by the presence of other vehicles, inadequate sight distances and the likelihood of pedestrians stepping onto the road.
Frustration caused by a driver's inability to drive at a speed consistent with his or her own wishes in relation to the general standard of the road. This may be a result of road layout, geometry, surface riding characteristics, junction frequency and speed and flow per lane.

There are a number of ways in which development can have an adverse or beneficial effect on vehicular travellers' view from the road:

They can change the extent and availability of the travellers' views, which is dictated by the relative level of the road and the surrounding landform, building, vegetation and environmental barriers.

They can enhance or detract from the travellers' experience by the removal of existing features. Examples of visual detractors whose removal could improve a view include; derelict buildings, waste ground, fly tipping, whilst examples of beneficial elements that may be removed, having an adverse effect include, mature trees, locally characteristic walls and other distinctive townscape elements.

They can introduce new features and landscape/townscape to the benefit of the traveller's experience.

Route Corridor 1

Route Corridor 1 runs northwards from the Monaghan Road across open countryside to join the Killylea Road. The proposed route corridor runs along the existing alignment of the Killylea Road before swinging south east to join the Friary Road. The route corridor then swings in a northerly direction crossing Navan Street, Windmill Hill, Cathedral Road before swinging in a north easterly direction to cross the Moy Road and Railway Street. The route continues in a north easterly direction to tie in with Station Road. The proposed route corridor runs along the alignment of Station Road and then continues in an easterly direction running parallel to the alignment of a disused railway line to cross the Mullinure Lane, and Drummanmore Road to tie in with the Portadown Road.

The proposed Route Corridor will open up a number of views from the road when crossing open countryside and running parallel to the disused railway. In addition lands between Druid's Villas and Culdee Drive, Convent Road and Cathedral Road Playing Fields, and Desart Lane Lower and the Cathedral will be opened up.

A potential impact of Slight Beneficial is predicted.

Route Corridor 2

Route Corridor 2 runs northwards from the Monaghan Road across open countryside to cross the Killylea Road and the Navanfort Road before swinging in a north easterly direction to cross the Callan Bridge Road and the Callan River. The route continues in a north easterly direction to cross the Cathedral Road, crossing through the grounds of College Farm Nursery School to cross the Moy Road and Railway Street. The route continues in a north easterly direction to tie in with Station Road. The proposed route corridor runs along the alignment of Station Road and then continues in an easterly direction running parallel to the alignment of a disused railway line to cross the Mullinure Lane, and Drummanmore Road to tie in with the Portadown Road.

The proposed Route Corridor will open up a number of views of the countryside to the west and north of Armagh when crossing open countryside and running parallel to the disused railway.

A potential impact of Moderate Beneficial is predicted.

Route Corridor 3

Route Corridor 3 runs northwards from the Monaghan Road across open countryside to cross the Killylea Road, and the Navanfort Road to tie in with the Ballycrummy Road. The route continues northwards to cross the Cathedral Road, running through open countryside to the west of the Callan River. The route corridor then swings in a north easterly direction, through open countryside, to cross the Moy Road, Drumcairn Road, the Callan River and the Loughgall Road before swinging south east across open countryside to cross the Drummanmore Road to tie in with the Portadown Road.

The proposed route corridor will open up a number of views of the city as well as the open countryside to the west and north of Armagh.

A potential impact of Major Beneficial is predicted.

Route Corridor 4

Route Corridor 4 runs northwards from the Monaghan Road across open countryside to cross the Killylea Road, and the Navanfort Road to tie in with the Ballycrummy Road. The route continues northwards to cross the Cathedral Road before swinging east to run along the alignment of a disused railway line, crossing the Callan River and Desart Lane, to tie in with the Moy Road. From the Moy Road the route swings in a north easterly direction to cross Railway Street and tie in with Station Road. The proposed route corridor runs along the alignment of Station Road and then continues in an easterly direction running parallel to the alignment of a disused railway line to cross the Mullinure Lane, and Drummanmore Road to tie in with the Portadown Road.

The proposed Route Corridor will open up a number of views of the countryside to the west and north of Armagh when crossing open countryside and running parallel to the disused railway.

A potential Impact of Moderate Beneficial is predicted.

Impact Conclusion

Overall Route Corridor 3 has been characterised as Major Beneficial with regards to potential impacts on journey ambience in the study area. Route Corridor 2 and 4 have been determined to have a Moderate Beneficial Impact, with Route Corridor 1 having a Slight Beneficial impact.

4.11.3 Mitigation

The contractor appointed to undertake the proposed work would be required to initiate a traffic management plan for the duration of the works which would reduce driver stress to the lowest possible level during construction phase. Views from the road should be aesthetically pleasing and in keeping with the surrounding landscape where possible.

Other potential mitigation measures include:

Establishment of an overall hard and soft landscape design strategy along the corridor to integrate any proposals into the wider surroundings.
Compensatory planting for loss of any important trees and/or hedgerows along the road corridor.
Offsite planting by agreement with landowners.

4.12 Disruption due to Construction

This section has been prepared in accordance with the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 3. An assessment of impacts due to construction covers the effect on people and the natural environment, which occur between the pre-construction works and the end of the contract maintenance period. Construction impacts are not confined to the road itself, but can also arise from advance works by service authorities. Impacts may also occur outside the area directly affected by the scheme. For example, diversions due to road works may take traffic along minor roads, causing associated air quality, traffic, and noise impacts. Although construction effects are usually temporary, they can be significant. It is important that nuisance and disturbance to the local community and vehicle travellers in Armagh and the surrounding area are kept to a minimum.

Guidelines set out in the DMRB recognise that at this stage only a broad assessment can be carried out. Within this assessment the following aspects have been analysed:

Any significant disruption to population centres;
Possible need for tunnelling, bridgework or other intrusive construction activities.

4.12.1 Baseline Conditions

A road network currently exists throughout the Armagh City area, broadly focused upon the more urbanised land uses of Armagh City. In particular the residential land uses (as shown in Figure 4.14.1 Land Use), maintain a complex road network.

The west and north of the study area can be broadly described as having fewer roads due to its rural nature. Key roads within the study area are outlined in Figure 4.1.1.

4.12.2 Impacts

Potential temporary impacts associated with the construction phase could include the following:

Noise and vibration arising from plant operation, on and off site HGV and other delivery vehicles.
Local air quality impacts arising from plant operation, delivery vehicles and potential delays to traffic flows arising from lane closures.
Water quality impacts associated with disturbed ground and excavations, surface water run off and temporary discharges to watercourses.
Disruption to road users due to traffic management schemes to allow construction access.
Visual amenity impacts associated with plant and contractor's activity on site.
Temporary closures or diversions of footpaths, bridleways and highways.

Route Corridor 1

Corridor 1 traverses the suburban and urban areas of Armagh City throughout much of its length, though in the extreme west and north of the route it passes through relatively rural landscape. Due to the proposed location of this Corridor construction activities are predicted to

take place in close proximity to sensitive receptors in the locality, and therefore they are likely to impact temporarily on local air quality and noise levels.

Movement of plant, earth works and general construction activities are anticipated to cause disruption to the local road network as Corridor 1 will connect with and traverse a number of existing routes. The proposed route commences as a junction with Monaghan Road continuing north to join with Killylea Road. The main impact associated with this section of the route will be traffic disruption at the intersections with the two existing routes. Having linked with Killylea Road, Route Corridor 1 will continue east on-line along Friary Road which may cause significant disruption to traffic flows. At this point Corridor 1 goes off-line continuing north intersecting a number of routes including, Navan Street, Windmill Hill, Cathedral Road, and Moy Road. Having crossed Moy Road the route veers north east and crosses Loughgall Road to continue until it goes on-line with Station Road. As the route diverges from Station Road it again goes off-line to continue east where it intersects with Mullinure Lane and Drummanmore Road, until it terminates with a junction to Portadown Road. There is likely to be significant traffic disruption whilst construction activities are taking place at the intersections with each of the existing routes. Moreover, pedestrians and cyclists are also likely to be impacted upon as temporary road closures may disrupt access to footpaths and cycle routes.

Construction activities may also impact upon surface and groundwater features. There are numerous small watercourses and two larger rivers the Callan and Ballynahone, which the proposed route will intersect.

Visual amenity impacts may be significant throughout the construction period. The introduction of plant and construction activities into the suburban and urban areas of Armagh City will have a significant impact upon the local views. Moreover, this will have a negative impact upon the greenbelt of land which surrounds the urban extents of Armagh City, to the west and north of the scheme.

To facilitate the development of Route Corridor 1, adjacent properties in the Loughgall Road/Station Road area may be injuriously affected.

Route Corridor 1 has the potential to have a major adverse impact as a result of disruption due to construction.

Route Corridor 2

Route Corridor 2 originates at Monaghan Road to the west of Armagh City. From this junction the route continues north and north east crossing Killylea Road, Navanfort Road, Callan Bridge Road, Cathedral Road, Moy Road, and Railway Street. Having crossed Railway Street Route Corridor 2 goes on-line with Station Road, however it leaves this route to continue east. The northeast section of Route Corridor 2 crosses Mullinure Lane and Drummanmore Road, and terminates at a junction on Portadown Road. Temporary disruptions to traffic flows are likely to be significant along these links whilst construction takes place. Pedestrians and cyclists may also be impacted during this period as access to footpaths and cycleway are disrupted, also bridleways may be affected.

Construction activities, and operation of plant and other machinery may have a temporary impact upon air quality at sensitive receptors in the locality. Route Corridor 2 is proposed to traverse Armagh City and therefore construction activities will occur in close proximity to many sensitive receptors. Air quality impacts may include an increase in traffic related pollutants and deposition of nuisance dust. Moreover operation of machinery and movement of plant will have a direct impact upon noise and vibration levels in the vicinity of these works. Properties

adjacent to Cathedral Road and those adjacent to the route in the Loughgall Road/Station Road areas may be injuriously affected.

Construction of the proposed route may result in direct impacts upon surface and groundwater features. Runoff from construction areas and temporary discharges to watercourses may occur which could reduce water quality in the area if not managed appropriately. The route will also cross many surface watercourses, including the Callan and Ballynahone Rivers.

Armagh City is surrounded by a greenbelt which provides a significant area of continuous scenic views. Development of the route may impact upon the visual amenity of this area as construction work is carried out. In the suburban and urban areas of the City visual intrusion may be significant as construction activities take place in close proximity to sensitive receptors.

Corridor 2 has the potential to have a major adverse impact as a result of disruption due to construction.

Route Corridor 3

Originating at a junction with Monaghan Road, Corridor 3 follows a relatively rural route west and north of Armagh City urban area. Traffic flows may be disrupted at number of locations as the proposed route traverses existing routes in those areas. Heading north the route will cross Killylea Road and Navanfort Road. Continuing north the route joins with Ballycrummy Road until the junction with Cathedral Road. Having crossed Cathedral Road the route continues north and north east where it crosses Moy Road, Drumcarn Road, Loughgall Road, and Drummanmore Road until it terminates with a junction to the Portadown Road. Traffic disruption may be less significant with this Corridor as it avoids Armagh conurbation.

The rural setting of Corridor 3 also reduces the number of sensitive receptors within the vicinity of construction activities. However, it is anticipated that local air quality will be temporarily impacted at those receptors in proximity to the proposed works, through increased traffic related pollutants and nuisance dust. Noise and vibration impacts may also be experienced at those sensitive receptors also. Two properties, situated to the west and east of Drumcairn Road may be injuriously affected by this route corridor.

The visual amenity impacts of the construction works may be particularly significant as the route traverses for the most part undeveloped greenbelt land where no major construction works have previously taken place. Other features in the landscape such as surface water courses may be impacted temporarily whilst construction is underway. The Callan River represents the largest watercourse which will need to be navigated by the construction works.

Corridor 3 has the potential to have a moderate adverse impact as a result of disruption due to construction.

Route Corridor 4

This route Corridor will cross through suburban and urban areas in the west, north central and east of Armagh City. Traffic related pollutant concentrations may be increased due to the operation of plant and increased volumes of Heavy Goods Vehicles associated with the construction period. This may have a short term significant impact on local air quality in close proximity to sensitive receptors. Nuisance dust levels may also arise in proximity to the works if correct mitigation measures are not implemented. Noise and vibration levels are anticipated to be elevated also whilst construction is underway, due to the increased volume of construction traffic and operation of plant. Construction of Route Corridor 4 may injuriously affect properties to the north of Glen Court and in the Station Road area.

Impacts on local watercourses may also occur during the construction period. Runoff from the construction areas may seep to local streams and rivers such as the Callan and Ballynahone Rivers. Moreover earthworks may impact upon groundwater features.

It is anticipated that there will be significant disruption to traffic flows on existing routes during construction of Route Corridor 4. This route originates at a junction with Monaghan Road to the west of Armagh City. From this point the route continues north and crosses Killylea Road, Navanfort Road, and Ballycrummy Road before linking to a junction with Cathedral Road. Following this the route continues north before veering east where it crosses Moy Road and Railway Street. Having crossed Railway Street the route corridor will go on-line with Station Road in a north-easterly direction. Once again the road goes off-line and continues east where it crosses Drummanmore Road and terminates with a junction on Portadown Road. There is likely to be significant traffic disruption whilst construction activities are taking place at the intersections with each of the existing routes. Moreover, pedestrians and cyclists are also likely to be impacted upon as temporary road closures may disrupt access to footpaths and cycle routes.

The large scale of the proposals means that there may be significant impact upon the visual amenity of the area. Construction activities will occur both in the urban and rural areas which may impact on residents' views.

Route Corridor 4 has the potential to have a moderate adverse impact as a result of disruption due to construction

Impact Conclusion

Disruption due to construction of the proposed route corridors is anticipated to be most significant in association with route corridors 1 and 2. Although disruption will also be associated with the construction of corridors 3 and 4 the relatively more rural setting of these routes reduces their proximity to sensitive receptors.

4.12.3 Mitigation

Construction impacts include site-wide elements such as location of storage areas and site offices, stores and workshops. These should not be located in ecologically sensitive areas or where a loss of amenity is perceived.

Dust control measures are well developed and are capable of eliminating or reducing emissions to a level such that nuisance is unlikely to occur. Contractors will be required to use good engineering practice to minimise dust emissions. Typical measures to reduce dust and pollution during the construction phase include:

damping down of unsealed surfaces and stockpiles;
minimising the height of stockpiles;
wheel washing of mobile plant and HGV's before they leave the site;
sheeting of loads;
enclosure of potential point sources of dust (e.g. spoil loading areas); and use of solid hoardings around construction sites; and
engines not be left idling and vehicle movements to occur only as necessary.

Such construction site related issues will only become clear closer to the construction stage; however it is possible to incorporate suitable mitigation in the Employer's Requirements within

the contract documentation. Other potential mitigation measures that should be considered with reference to the construction phase of the project include:

Advanced programming and preparatory works to take consideration of factors such as ecological constraints and GI.
Traffic Management Systems and night works.
Identification in advance of footpath and road diversions or closures, and the identification of control points.
Early consultation with statutory consultees to identify particular issues of importance.
Best practice guidance should always be adhered to with regard to construction works.

4.13 Policies and Plans

Planning and transportation policies and plans play a major role in either facilitating or constraining the development of new road schemes. An assessment was conducted in accordance with the Design Manual for Roads and Bridges (DMRB – Vol 11, Sec 3, Part 12) in order ascertain how the proposed Armagh North & West Link fits in with current policies and plans on transportation. In carrying out this assessment, several principal documents were consulted including:

The Regional Development Strategy for Northern Ireland 2025 – Shaping Our Future (RDS);
Planning Policy Statement (PPS) 13 Transportation and Land Use;
Planning Policy Statement (PPS) 2 Planning & Nature Conservation;
Planning Policy Statement (PPS) 6 Planning, Archaeology and the Built Heritage;
Armagh Area Plan 2004;
Armagh Area Plan 2018 Issues Paper;
The Regional Transportation Strategy for Northern Ireland 2002-2012 (RTS);
Regional Strategic Transport Network Transport Plan 2015;
Sub Regional Transport Plan Draft 2015; and
Planning Applications within the study area.

4.13.1 Baseline Conditions

Planning Policy

The Regional Development Strategy for Northern Ireland 2025 – Shaping Our Future (RDS)

The RDS was published by the Department for Regional Development (DRD) in 2001 with the aim of guiding the future development of Northern Ireland to 2025. Moving beyond traditional physical land use planning, the RDS marked a shift towards strategic planning. The Strategy encourages a sustainable approach to planning which strives to integrate land use and transport. Also fundamental to the RDS, are the principles of facilitating economic prosperity, promoting quality of life and protecting the environment.

The RDS sets out a framework for the existing demographic, economic, social and environmental conditions within Northern Ireland. In relation to transportation, it highlights the need for an integrated transport network to improve accessibility and which reduces the need to travel. Furthermore, to promote balance and integrated growth across Northern Ireland, the RDS proposes a Spatial Development Strategy (SDS) comprising of the regions hubs, corridors and gateways (DRD, 2001).

The SDS for Northern Ireland is a framework for the future physical development of the Region based on urban Hubs and Clusters, key and link transport Corridors and the main regional Gateways of ports and airports.

The aim of the hub, corridor and gateway approach is to give a strategic focus to future development and achieve balanced growth within the Region by developing "a vibrant Rural Northern Ireland with balanced development spread across a polycentric network of hubs/clusters based on the main towns which will have a strategic role as centres of employment and services for urban and rural communities".

Armagh is identified as a Main Hub within the Regional Development Strategy. The Towns identified as main hubs have the potential to develop as 'growth poles' for the clustering of economic activity, thereby providing a counter-balance to the metropolitan heart of the Region centred on Belfast. These main towns will, therefore, be developed as the major locations providing employment, services, and a range of cultural and leisure amenities. They will also have a leading role in accommodating the need for urban housing at the district level. Armagh District has been allocated a District Housing Indicator of 4,800 units.

The RDS identifies a core transport network of important regional and metropolitan routes (road and public transport infrastructure) known as the Regional Strategic Transport Network (RSTN). The RSTN comprises 5 key Transport corridors, 4 link corridors and the Belfast Metropolitan Area (BMA) transport corridors, along with the remainder of the trunk road network. The Key Transport Corridors are the upper tier of the Region's long distance routes connecting a number of towns to the major regional gateways and the BMA.

Armagh is located off the South Western Corridor and the Eastern Seaboard Corridor.

The proposed scheme complements the RDS which states in TRAN 1.2 the need to upgrade and improve connections and also facilitate improvements to traffic bottlenecks, to help relieve congestion and facilitate transport efficiency.

Policy within the RDS also promotes integrated land use to reduce the need to travel and improve facilities for more sustainable modes of transport (TRAN 3.1). Particular emphasis is placed on promoting healthier options such as walking and cycling and providing safe and environmentally attractive paths and cycleways (TRAN 4.2).

However, despite the general compliance of the proposed scheme with the RDS, protection and management of the environment is also an underlying principle of the RDS. TRAN 1.2 specifically recognises the need to minimise environmental impacts of such proposals.

Planning Policy Statements

Planning Policy Statements (PPS) are policy documents designed to help implement strategic planning guidelines contained within the RDS. They are documents on particular aspects of land use planning and apply to the whole of Northern Ireland. Their contents are taken into account when preparing development plans and are material to decisions on planning applications and appeals.

PPS 13 is primarily concerned with Transportation and Land Use. General Principle 8 of PPS 13 indicates the need to protect land required for improvements in the transport network. Furthermore, General Principle 11 states, "innovative measures should be developed for the safe and effective management of traffic". The policy indicates that traffic management can

contribute to improved road safety and a more attractive environment for pedestrians and cyclists.

PPS 2 is primarily concerned with Planning and Nature Conservation. Policy 63 states that "careful consideration will be given to the nature conservation implications of any development proposal where it is known to the Planning Service that the development may threaten any protected species of flora or fauna, any area of wetland defined in the Ramsar Convention, or any other significant feature of nature conservation value".

PPS 6 is primarily concerned with Planning, Archaeology and the Built Heritage. Policy BH1 of PPS 6 indicates the need for preservation of archaeological remains of Regional Importance and their settings. Similarly, Policy BH2 relates to the need to protect archaeological remains of Local importance and their settings.

Policy BH3 of PPS 6 sets out the need for archaeological assessment and evaluation "where the impact of a development proposal on important archaeological remains is unclear, or the relative importance of such remains is uncertain".

Policy BH11 of PPS 6 sets out the Department's policy with regards to development affecting the setting of a listed building. This policy states that "The Department will not normally permit development which would adversely affect the setting of a listed building".

In Annex A of PPS 6 the Department sets out its policy with regards to Transport and Traffic Management. Specifically Paragraph A4 states "where a new route is shown to be necessary or where alterations to the existing traffic network are needed the Department will initially identify and evaluate the significance of any archaeological remains and features of the built heritage including listed buildings, conservation areas and other historic sites. New routes, alterations and any other transport infrastructure should respect such features, but in each case a suitable balance needs to be struck between conservation, other environmental concerns, economics, safety and engineering feasibility".

Armagh Area Plan 2004

A review has taken place of the Armagh Area Plan 2004.

The study area is located to the west and north of Armagh and contains a number of zonings as indicated on Figure 4.13.1. The study area straddles the development limit of Armagh. The Greenbelt is located to the west and north of the development limit.

The development plan states that "there will be a presumption in favour against the approval of development proposals outside the development limits. Such proposals will be considered within the terms of the Departments Rural Planning Policy". [Note: the Departments Rural Planning Policy has been superseded by the Regional Development Strategy].

The Armagh Conservation Area is located within the east of the study area. The conservation area was designated in 1981, the purpose being to preserve or enhance its special architectural or historic interest. The area has been extended to include St. Patrick's RC Cathedral and the Thomas Street/Ogle Street area including St. Malachys RC Church.

All new development proposals within the existing and extended conservation area will be critically assessed to ensure that they fit well into the historic environment in terms of design and land use.

Within the Development Limit the study area includes the following zones (see Figure 4.13.1).

Proposed Housing

Areas zoned for housing within the study area include:

Callan Bridge Road:- 5.4ha of land owned by the Northern Ireland Housing Executive which slopes up from Callan Bridge Road on both sides of the access road to Mullacreevie Park. Part of the lower end of the land may be liable to flooding.

Cathedral Road: - 5.3ha just north of Cathedral Road opposite its junction with Ballycrummy Road.

Desart Lane: - 1.7ha of land just west of Desart Lane. Part of the site is liable to flooding.

Mullinure Lane: - 21.0ha on both sides of Mullinure Lane, adjacent to the proposed North Link Road. Mullinure Lane itself will require to be widened and footpaths provided by the developer.

Mellifont Park: - 4.4ha just north of the Portadown Road. Access to the site will have to be onto the Portadown Road Opposite Its junction with Killuney Road and may have to take the form of a roundabout built by the developer to Roads Services standards. Development on the upper flatter part of the site will for the most part potentially be single-storey but this requirement will not apply on the lower western slopes. Existing established landscaping and hedgerows will have to be retained.

Portadown Road: - These zonings comprise two small areas north and south of the Portadown Road; (1.3ha and 1.4 ha respectively). Access to the Portadown Road may not be permitted from either site.

Proposed Industry

Loughgall Road: - 4.4ha of reasonably flat, low quality agricultural land adjacent to an existing small industrial area and reasonably accessible to the primary road network. In establishing development levels, regard will have to be given to localised flooding problems. This site is intended to help meet the industrial needs of the private sector.

Mullinure: - 9.0ha of land which is proposed by the Department as a long term industrial reserve. Its development will depend on the provision of the proposed North Link and the alleviation of on-site flooding and will be considered to be premature until both of these development constraints have been resolved. That stretch of Mullinure Lane north of the proposed North Link will also have to be improved. Most of the un-zoned land immediately south of the proposed site is hilly and unsuitable for industrial development. Future possible uses on this land will be considered on their particular merits having regard to adjoining uses.

Mixed Business Area

This peripheral central area along the Loughgall Road includes Armagh Business Centre, McKinny's Timber Yard, Ulsterbus Depot, Station Road Industrial Estate, and land between Gillis House and Loughgall Road, the latter area being in particular need of redevelopment and environmental upgrading.

The North link development will therefore encourage the development of mixed industrial, commercial and business uses within this area as accessibility will be improved. Such uses might well include retail warehousing and related commercial uses which are currently not

entirely acceptable within the commercial area of Armagh because of the physical and topographical constraints.

Amenity Open-Space

The old Railway Embankment in the northern part of Armagh is already used to some extent by walkers. It has potential to be developed for amenity open space use within a wider network of reclaimed embankments and cuttings.

River Callan: - There is a history of flooding associated with the Callan River which flows through the western part of Armagh. While the Plan proposes no significant development within its narrow flood plain, the river valley does have potential for amenity open space purposes subject to drainage considerations.

Open Space Wedges

An area of 20.2ha of steeply sloping land at Legarhill/Ballycrummy is unsuitable for development. This land primarily provides a visual break between the Mullacreevie and Legarhill housing areas. There may however be some potential for limited frontage development along Ballycrummy Road.

Road Proposals

The following policies and objectives contained within the Armagh Area Plan 2004 make specific positive reference to the proposed road scheme. As such the road scheme supports the objectives of the Armagh Area Plan 2004.

The principal objectives (Policy 3.2) of the Area Plan are: -

> "to encourage the efficient use of existing infrastructure and make provision for new infrastructure;
> to improve and extend the existing road system where necessary for the safe and convenient movement of people, goods and services and to make towns and villages generally accessible and convenient to use".

Section 29.0 of the development plan outlines the planning policy with regard to roads within the Armagh Area. This states that "the road proposals for Armagh comprise three main elements, the North Link, West Link and East Link."

The study area includes the North and West Link proposal in the Armagh Area Plan. Section 29.2 and 29.4 of the development plan states "The proposed North Link from the Portadown Road to the Loughgall Road will open up development opportunities to the north of Armagh and help reduce traffic along The Mall, Victoria Street and College Hill. The West Link bypassing Armagh Central Area will link Friary Road and through to the Loughgall Road and the proposed North Link. It will act as a distributor of traffic entering or leaving Armagh on its western side and help take traffic out of the historic core".

Section 29.6 of the Development Plan commits the Department to "take appropriate measures to minimise the impact of all new road schemes, including landscaping, to ensure the protection of the amenity land and existing development adjoining the proposed routes".

The principal objectives (Policy 3.2) of the Area Plan are:

> "to protect rural areas and to retain a clear distinction between urban areas and the open countryside by preventing urban sprawl and ribbon development;
> to conserve and enhance the natural and man-made environment and enhance the quality of life for the rural community;
> to preserve and enhance the archaeological and historical heritage of the District."

Armagh Area Plan 2018 Issues Paper

The preparation and publication of Issues Papers is part of an ongoing programme to provide full coverage of contemporary plans for all Council areas in Northern Ireland. It is a consultation document intended to promote focused debate on those issues that need to be addressed in preparing a Draft Plan.

The new Plan will cover the Armagh City & District Council area, an area extending to some 670 square kilometres and with a 2001 census population of 54,263 persons.

The Issues Paper states that Armagh City occupies a strategic location in the south of the region with good road connections to Dublin, Galway and the Irish Midlands. The Issues Paper also states that links are important for the creation of an integrated, sustainable transport network for Ireland as a whole and could result in further economic development and additional employment generation in the city and district.

The Issues Paper identified the following transportation issues:

> What opportunities exist in relation to the Plan area's advantageous location on the main Eastern Seaboard strategic transport corridor?
> Are there any specific measures which could be taken to encourage the use of alternative forms of transport?
> How should transportation policies influence the future location of development?

In relation to Armagh City Centre, the Issues Paper also identified the following transport issue:

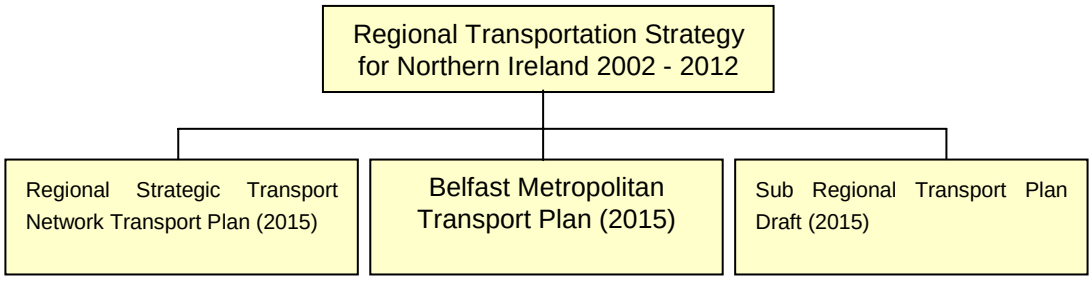
> How can the plan deal effectively with issues of traffic congestion, car parking and alternative means of transport within and around the city?

Transport Policy

Consideration has been given to transport strategies which influence the future development of the region. Transport strategies highlight future proposals for upgrading road networks and improvements to public transport.

The Regional Transportation Strategy (RTS) is a "daughter document" of the RDS. Delivery of the RTS will be realised at local levels through the Regional Strategic Transport Network Transport Plan (RSTN TP), the Belfast Metropolitan Transport Plan (BMTP) and the Sub-Regional Transport Plan (shown below).

Hierarchy of Transportation Policy in Northern Ireland



Regional Transportation Strategy for Northern Ireland 2002 – 2012

The RTS was approved by the Assembly in July 2002. It identifies strategic transportation investment priorities and considers potential funding sources and affordability of planned initiatives over the next 10 years. The purpose of the RTS is to contribute towards achieving the longer-term vision for transportation contained within the RDS. Its vision is to:

"have a modern, sustainable, safe transportation system which benefits society, the economy and the environment and which actively contributes to social inclusion and everyone's quality of life."

The Strategy has been developed by considering Northern Ireland as four discrete areas with particular transport needs, problems, priorities and solutions. The areas are the Regional Strategic Transport Network (RSTN) (as defined by the RDS), the Belfast Metropolitan Area (BMA), Other Urban Areas (cities and towns outside the BMA with populations over 5,000) and Rural Areas.

The Strategy provides a range of transportation initiatives across Northern Ireland. Some of the principle initiatives (of relevance to this study) include:

> Local improvements in towns across Northern Ireland to assist pedestrians and cyclists and to provide new bus services throughout the day;
> Strategic highway improvements to provide, for example, up to 13 bypasses, approximately 85km of dual carriageway, 36km of widened single carriageway and 11 major junction improvements.

Implementation of the Strategy will be through three Transport Plans covering the RSTN, the Belfast Metropolitan Area, and the Sub-Region. The transport plans will present detailed programmes of major schemes and transport initiatives that will support the objectives of the RTS and contribute to the RTS targets, taking full account of relevant development plans.

Regional Strategic Transport Network Transport Plan (2015)

The RSTNTP was prepared within the framework established by the Regional Development Strategy and the associated Regional Transportation Strategy.

The purpose of the RSTNTP is to plan the maintenance, management and development of Northern Ireland's Strategic Transport Network in accordance with the strategic direction and underlying principles of the RTS.

Section 5 of the RSTNTP details Strategic Road Improvements. Strategic Road Improvements (SRI's) are major projects where the scheme cost is estimated to exceed £1.0m. The main objectives of SRI's are to remove bottlenecks on the key network where lack of capacity is causing serious congestion, and to improve the environment by providing bypasses to towns situated on the RSTN, relieving the effects of heavy through traffic.

The RSTNTP proposes that the scheme should be added to the preparation Pool for construction.

Planning Applications

Planning applications for the study area have been examined at DOE Planning Service. A list of Planning Applications has been included as Appendix C9.

4.13.2 Impacts

Based on the information reviewed in the above documentation, an assessment was conducted in order to determine the potential impact of a route in each of the broad corridors presented.

Route Corridor 1

Route Corridor 1 runs through the Armagh Green Belt for a short distance. In addition the route crosses the Amenity Open Space zoning at the River Callan. Route Corridor 1 does however follow the alignment of the proposed West and North Link as indicated in the Development Plan and shown on Figure 4.12.1.

The Impact of Route Corridor 1 on Policies and Plans is therefore described as Major Beneficial.

Route Corridor 2

Route Corridor 2 runs through the Armagh Green Belt for a short distance similar to Route Corridor 1. The route however also crosses over the following development plan zonings:-

Open Space Wedge at Legarhill/Ballycrummy
Proposed Housing at Callan Bridge Road
Amenity Open Space zoning at Callan Bridge
Playing Fields at Moy Road

The remainder of the route follows the alignment of the proposed North and West Link as indicated in the Development Plan and shown on Figure 4.12.1.

The Impact of Route Corridor 2 on Policies and Plans is therefore described as Moderate Beneficial.

Route Corridor 3

Route Corridor 3 runs through the Armagh Green Belt for a short distance similar to Route Corridor 1, Route Corridor 2, and Route Corridor 4. However Route Corridor 3 continues to run through the Armagh Greenbelt to the North West and North East of Armagh for a considerable distance. In addition the route crosses over the following development plan zonings:-

Open Space Wedge at Legarhill/Ballycrummy
Proposed Housing at Cathedral Road

Industrial Zoning at Loughgall Road

The Impact of Route Corridor 3 on Policies and Plans is therefore described as Moderate Adverse.

Route Corridor 4

Route Corridor 4 runs through the Armagh Green Belt for a short distance similar to Route Corridor 1 and Route Corridor 2. The route however also crosses over the following Development Plan zonings:-

Open Space Wedge at Legarhill/Ballycrummy
Proposed Housing at Cathedral Road
Amenity Open Space zoning at Callan Bridge
Proposed Housing at Desart Lane (already constructed)
Playing Fields to the north and south of Moy Road

The remainder of the route follows the alignment of the proposed North and West Link as indicated in the Development Plan and shown on Figure 4.12.1.

The Impact of Route Corridor 4 on Policies and Plans is therefore described as Slight Beneficial.

Impact Conclusion

Overall Route Corridor 1 has been classified as Major Beneficial, Route Corridor 2 as Moderate Beneficial and Route Corridor 4 as Slight Beneficial.

Route Corridor 3 has the greatest impact on Policies and Plans and is classified as Moderate Adverse.

4.13.3 Mitigation

Mitigation measures will be introduced to minimise the impact of the proposed development on development plan zonings, policies and granted planning permissions. Specific measures to be considered when refining corridors include; avoiding zoned land, regular consultation with the Planning Service and frequent consultation in relation to the new updated Armagh Area Plan.

4.14 Land Use

The objective of this section of the report is to review the existing land use within the study area. An assessment was undertaken to identify the pattern and extent of residential, agricultural, industrial, recreational and open space land uses in the study area.

This assessment was carried out in accordance with the methodology outlined in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 6 – Land Use. Additional sources of information used in the assessment were:

Desktop Review of Ordnance Survey Mapping; and
Desktop Review of Aerial Photography.

This section should be read in conjunction with Figure 4.14.1 Land Use.

4.14.1 Baseline Conditions

Armagh is situated approximately 35 miles south west of Belfast. It is the ecclesiastical capital of Ireland, one of the earliest centres of Christianity in the British Isles and is of great historical, architectural and archaeological interest. The population of the city is approximately 15,000.

Armagh is located to the centre of Northern Ireland and as such links several key settlements via a network of major roads including the A3 (to Portadown, Craigavon and Belfast [via the M1]), the A28 (to Newry), the A3 (to Monaghan) and the A29 (to Dungannon).

Key roads within the vicinity of the four route corridors are highlighted in Figure 4.14.1.

Residential

There are numerous isolated and small clusters of dwellings set within agricultural land, particularly in the north and west of Armagh City. Many of these dwellings may be farmhouses.

There are concentrations of residential properties, closer to the centre of Armagh, along and radiating from a number of local roads including the following:

Keady Road;
Monaghan Road;
Killylea Road;
Callan Bridge Road;
Mullaghcreevie Park;
Cathedral Road;
Desart Lane;
Drumcairn Road;
Drumbreda Walk;
Alexander Drive;
Lisanally Lane;
Drummanmore Road; and
Portadown Road (roundabout)

Industrial and Commercial

Within Armagh District there has been a decline in the manufacturing sector in recent years, offset in the main by an increase in the service industry. The manufacturing sector in the district is dominated by small, light industrial enterprises.

Industrial land use within the study area has been identified at the following locations:

Windmill Hill;
Killylea Road / Ballyrath Road;
Navan Fort Road;
Culdee Drive;
Railway Street;
Alexander Drive;
Station Road; and
Loughgall Road.

The following large commercial land uses have also been identified:

The Mall Shopping Centre, the Mall;
Spires Retail Park, Moy Road; and
Shambles Market, Edward Street.

Agriculture

There are approximately 2000 farms in the wider Armagh District, giving full-time employment to approximately 1500 people as well as considerable amounts of part-time employment. Along with dairy and meat production, the Armagh area is also home to a significant number of the province's remaining traditional orchards.

Agricultural land dominates land use to the north and west, beyond the urbanised land use of Armagh City. This land comprises largely of improved pastures and rough grazing land with some fields of orchards also identified. Fields within the study area are both irregular in shape and scale, with most boundaries defined by mature hedgerows.

Recreation and Amenity Open Space

A number of recreational land uses have been identified within the study area, most notably the Mall which lies to the centre of the City, and County Armagh Golf Course, to the south east. Further to this, numerous playing fields have also been identified at the following locations:

Primary Road / High Street, The Athletic Grounds (Armagh G.A.A);
Nursery Road (St.Brigid's High School);
Callan Bridge;
Ballycrummy Road;
Moy Road;
Abbey Park (Armagh Harps G.F.C)
Alexander Drive;
Cathedral Road (including tennis courts);
Lisanally Lane (Lisanally Special School / Armagh College); and
Loughgall Road (St.Lukes).

Trees, Hedgerows and Woodland Areas

Mature hedgerows form the boundaries of the vast majority of fields of the agricultural land to the north and west of the City. Numerous standings of mature and semi-mature trees and areas of scrub, are located throughout this rural area, in particular along the disused railway line and the banks of the Callan River.

Cranagh Wood, located on the A3 (Armagh – Monaghan) is a Woodland Trust site of approximately 2.6 hectares. The site maintains over 5,500 trees, predominately oak and ash.

Other Land Use

Additional land uses, such as schools and healthcare facilities, identified within the vicinity of the route corridors are noted in the Table 4.14.1.

Reference Number (see Figure 4.14.1)	Land Use	
1	St.Patricks Primary School	Education
2	Armagh College of Further Education	
3	Firs Playschool	
4	City of Armagh High School	
5	Armagh College of Further Education	
6	Lisanally Special School	
7	Resource Centre	
8	Grammar School, Banbrook Hill	
9	Armagh College of Further Education	
10	Armstrong Primary School	
11	Royal School	
12	St.Catherines Convent College	
13	Primary School, Chapel Lane	
14	Christian Brothers School	
15	College Farm Nursery School	
16	Longstone Hospital	Health Care
17	St.Lukes Hospital	
18	Clinic, Linenhall	
19	Health Centre, Friary Road	
20	Nursing Home, Irish Street	
21	St.Patricks RC Cathedral	Places of Worship
22	Armagh Presbyterian, Mall West	
23	Armagh Presbyterian, Gosford Place	
24	St.Patricks Cathedral	
25	St.Malachys RC Church	

Table 4.14.1 Land Use in vicinity of route corridors.

4.14.2 Impacts

Each of the route corridors were assessed for potential impacts on land uses.

Route Corridor 1

Route Corridor 1 impacts upon agricultural land between its starting point (the A3 Monaghan Road) and the Killylea Road, traversing approximately 1km of agricultural land. Further agricultural land is crossed, just north of Station Road, where the corridor deviates from the disused railway line. Approximately 1.5 km of agricultural land is impacted upon in this area. Impact upon agricultural land use may be realised in terms of land loss, severance of land parcels and disruption to farming operations and future viability. The requirement of earthwork cuttings as part of an engineered route would result in a further increase of agricultural landtake.

Residential land use may be directly impacted at Navan Street, potentially injuriously affecting land and property.

Industrial and commercial properties at Moy Road, Railway Street and Station Road are impacted upon by Route Corridor 1, potentially injuriously affecting land and property. Armagh College of Further Education, also at Station Road may be impacted upon in similar terms. Buildings affected by Route Corridor 1 may have to be acquired under “material detriment”.

Route Corridor 1 does follow part of the existing road network (the Killylea Road – Friary Road), marginally reducing impact upon existing land uses.

A potential impact of moderate adverse is predicted for Route Corridor 1.

Route Corridor 2

Route Corridor 2 traverses just in excess of 2km of agricultural land, between the A3 Monaghan Road and its crossing of residential lands at Cathedral Road. Similarly to Route Corridor 1, this corridor impacts upon agricultural land just north of Station Road, where it deviates from the disused railway line. Approximately 1.5 km of agricultural land is impacted upon in this area. Impact may be in terms of land loss, severance of land parcels and disruption to farming operations and future viability. The requirement of earthwork cuttings, particularly to the west of the Callanbridge Road, would result in further increase of agricultural landtake.

Residential land, to the north and south of Cathedral Road, is traversed by this corridor. This impact may be in terms of injurious affection to land and property.

The playing fields to the south of the Moy Road will also be impacted upon by Route Corridor 2 which traverses both pitches in this vicinity resulting in loss of land, and potentially reducing the recreational viability of the facility.

Similarly to Route Corridor 1, the industrial and commercial properties at Moy Road, Railway Street and Station Road are impacted upon by Route Corridor 2, potentially injuriously affecting land and property. Again, as with Route Corridor 1, Armagh College of Further Education at Station Road may be impacted upon. Buildings affected by Route Corridor 2 may have to be acquired under “material detriment”.

A potential impact of moderate adverse is predicted for Route Corridor 2.

Route Corridor 3

Route Corridor 3 almost exclusively impacts upon agricultural land with the entirety of its 6.6km length avoiding the urbanised areas of Armagh City. The need for earthwork cuttings as part of an engineered route would further increase the level of agricultural landtake. Impact may be realised in terms of land loss, severance of land parcels and disruption to farming operations and future viability.

No clusters of residential land are crossed by this corridor but two individual properties on Drumcairn Road may be injuriously affected.

A potential impact of major adverse is predicted for Route Corridor 3.

Route Corridor 4

This corridor crosses over 2km of agricultural land, from its starting point (the A3 Monaghan Road) until it reaches the disused railway line (just north of the junction of Cathedral Road and Ballycrummy Road). Similarly to both 1 and 2, Route Corridor 4 impacts upon the agricultural land just north of Station Road, where the corridor deviates from the disused railway line; approximately 1.5 km of agricultural land is impacted upon in this area. Impact may be realised in terms of land loss, severance of land parcels and disruption to farming operations and future viability. As with the previous corridors, the requirement of earthwork cuttings as part of an engineered route would result in an increase of agricultural landtake.

No clusters of residential land are crossed by this corridor although two individual properties on Desart Lane may be injuriously affected.

Route Corridor 4 may affect land at the playing fields, identified immediately to the west of where the corridor crosses the Moy Road.
As with both 1 and 2, Route Corridor 4 impacts upon the industrial and commercial properties at Moy Road, Railway Street and Station Road, potentially resulting in injurious affection to land and property. As with 1 and 2, this corridor may result in Armagh College of Further Education at Station Road being injuriously affected. Buildings affected by Route Corridor 4 may have to be acquired under “material detriment”.

A potential impact of moderate adverse is predicted for Route Corridor 4.

Impact Conclusion

Although Route Corridor 3 impacts almost exclusively, upon just one land use (agriculture), its length of 6.6km, and the fact that it does not use any of the existing road network, results in the greatest level of impact, assessed as major adverse. The impact of the remaining corridors is assessed as moderate adverse.

4.14.3 Mitigation

Due to the fact that the proposed corridors (at least in part) will involve new construction, impact upon other land uses is unavoidable. Measures would be taken to minimise any impacts in terms of landtake and/or demolition of property. A range of mitigation measures could potentially include:

Compensation for the loss of existing features such as trees, hedgerows and vegetation in areas of locally valued or important landscape, through replacement planting;
Sensible integration of landscape/townscape features;
A sensitive approach to dealing with issues relating to the severance of agricultural land parcels in order to minimise the impact on the agricultural practices of land owners;
Sensible use of earthworks, embankments and retaining walls;
Reuse of quality topsoil and subsoil; and
The preparation of comprehensive strategies, involving consultation with landowners and farmers to minimise impacts, reinstate facilities, water supply and access to fields.

4.15 Environmental Conclusions

The following summary table illustrates the score for each of the broad corridors when each of the environmental sections is considered. The score for each of the environmental sections are added up to give an overall score for each corridor. The guide for the symbols presented in this table is given below.

Environmental Sections	Route Corridor 1	Route Corridor 2	Route Corridor 3	Route Corridor 4
Noise	×××	××	×	××
Local Air Quality	××	××	×	×
Greenhouse Gases	0	0	0	0
Landscape	××	××	××	×
Townscape	××	××	✓	×
Heritage of Historic Resources	×××	×××	×	×××
Biodiversity	×	×	××	××
Water Environment	×	××	×××	××
Physical Fitness	✓	✓	✓	✓
Journey Ambience	✓	✓✓	✓✓✓	✓✓
Disruption Due To Construction	×××	×××	××	××
Policies and Plans	✓✓✓	✓✓	××	✓
Land Use	××	××	×××	××
OVERALL SCORE:	**-13.5**	**-13.5**	**-12**	**-11.5**

Guide to symbols

✓ - Slight beneficial (+1)
✓✓ - Moderate beneficial (+2)
✓✓✓ - Major beneficial (+3)

× - Slight adverse (-1)
×× - Slight/Moderate adverse (-1.5)
×× - Moderate adverse (-2)
××× - Major adverse (-3)

0 - neutral

5.0 Safety

5.1 Introduction

The Safety objective is concerned with reducing loss of life, injuries and damage to property resulting from transport accidents and crime. It is divided into two sub-objectives:

Accidents; and

Security.

The cost of accidents of differing severity attracts varied monetary values. These are often included within a cost/benefit analysis. Improvement of safety for all road users therefore relates to the impact on road accidents, and subsequent casualties.

In the roads context, Security includes the perception or risk of personal injury, damage to or theft of vehicles, and theft of property from individuals or vehicles. There are three locations in which security issues may arise when using roads:

on the road itself (e.g. being attacked whilst broken down)

in service areas, car parks and so on (e.g. vehicle damage while parked at a service station, being attacked while walking to parked car)

at signals or junctions (e.g. smash and grab incident while queuing at lights)

The creation of a 'safe route' with high visibility standards appropriate to the design speed will ensure that accident numbers and corresponding casualties are minimised.

The personal security of car users increases as the instances that they are required to stop or slow down are reduced.

5.2 Accidents

Details of the accident history for the period 2000 to 2004 were obtained from Roads Service (see Drawing No. 400370-SK-003 in Appendix D). This information has shown that the study corridor (and the immediate vicinity) does not appear to suffer from a significant accident problem with a total of 18 accidents occurring in the period. Closer examination of the causation factors would suggest that in general the accidents are a result of driver error rather than any design faults at junctions and that there does not appear to be a common theme occurring. It is anticipated that the proposed link road would assist in reducing accidents in the city centre due to the removal of traffic.

Combined accident rates and costs (COM) have been applied in this assessment. COBA then attributes all accidents to links – recommended for large networks where 'accident only' junctions would be difficult to identify. No local accident data was included in the input files, therefore in the absence of this data, default values are used by COBA to calculate changes in accident costs.

The COBA outputs indicate that Route Corridor 1 provides the greatest benefits in terms of accident cost savings. Benefits from Route Corridors 2 and 4 are slightly reduced, while Route

Corridor 3 is the worst as it actually results in an increase in accident costs. Increases in costs are a consequence of more severe accidents due to the higher speed limits on rural roads.

5.3 Security

TAG lists a number of security indicators, which are applicable to public transport and road assessment. These include:

Site perimeters, entrances and exits
Formal surveillance;
Informal surveillance;
Landscaping;
Lighting and Visibility;
Emergency Calls

In the roads context, security includes the perception or risk of personal injury, damage to or theft of vehicles, and theft of property from individuals or vehicles. There are three locations in which security issues may arise when using roads:

on the road itself (e.g. being attacked whilst broken down);

in service areas, car parks, etc (e.g. vehicle damage while parked at a service station, being attacked while walking to parked car); and,

at signals or junctions (e.g. smash and grab incident while queuing at lights).

Some of the main security indicators, the locations to which they refer, and different levels of performance are indicated in Table 5.1.

Security Indicator	Relevant Locations	Poor	Moderate	Good
Formal Surveillance	Service areas, car parks, some roads	No CCTV system. Presence of security staff not apparent	CCTV in place, but number and location not optimal. Passive system monitoring by staff	Effective CCTV system in place, used for active real time monitoring.
Informal Surveillance	Service area, car parks	Poor design that hinders observation of public areas by staff	Neutral characteristics	Design features facilitate staff monitoring
Landscaping	Service areas, lay-bys	Landscaping features (slopes, trees) inhibit visibility. For lay-bys, not visible from road.	Generally good, but with a small number of features that conceal areas	Clear sight lines exist to all areas. No concealed areas. For lay-bys, clearly visible from a distance
Lighting and visibility	Service areas, car parks, lay-bys and possibly trunk and slip roads	Large areas obscured from view or unlit.	Few areas where lighting is dim or absent	Well lit, no areas obscured from view
Emergency call facilities	Car parks, lay-bys	Difficult to locate, damaged or non-functional	Reasonable level of service	Well located, easy to identify & in full working order
Pedestrian and cyclist facilities	Bridges and underpasses	Obscured from view, poorly lit	Reasonable features	Well lit, designed for visibility

Table 5.1 - Security requirement levels for off-carriageway road features

All Route Corridors are expected to result in improvements for cyclists and pedestrians due to increased facilities. In addition, it is anticipated that the personal security of pedestrians and cyclists will be a key consideration during the design of bridges and underpasses, providing areas which are well lit with optimum visibility.

It is anticipated that, in respect to landscaping, all areas will have clear sight lines with no concealed areas and will be clearly visible from a distance. In respect to lighting and visibility, areas such as bus lay-bys will be well lit and not obscured from view.

The importance of each indicator is likely to vary according to the location and nature of the road, thus, for example, emergency call facilities are likely to be more important than surveillance when considering a rural road.

5.4 Summary of Safety for each Route Corridor

The northern section of Route Corridors 1, 2, and 4 (from Portadown Road to the junction of Station Road and Moy Road) can be assessed similarly. The rural nature of this corridor improves safety as there is only one main junction (at Mullinure Lane) along its length. The future development of housing to the south of the Mullinure Lane junction could increase the pedestrian movements in the future but effects due to this will be investigated in the detailed design stage when appropriate mitigation measures will be suggested.

Route Corridor 3 lies predominantly in rural surroundings and as such performs well against accident conditions as the number of accidents occurring are less than those in urban areas. Although, it should be noted that accidents in rural areas are generally more severe than those in urban areas. General security is increased with this option, although the perceived feeling of safety may be reduced due to a feeling of isolation.

The section of road between Killylea Road and Monaghan Road is common to all four options. The only concerns regarding safety here will be at the two new junctions at Killylea Road and Monaghan Road. Steps to mitigate against these concerns and to reassure road users of their own personal security would include high standards of landscaping, lighting and visibility. These steps would also facilitate in minimising the number of accidents at these locations.

The rural sections of each corridor will have a separate cycleway from the main carriageway. By separating the cyclists and vehicles the opportunity for conflicts is reduced.

Route Corridor 1

Accidents:

From Station Road to Killylea Road this route corridor passes through an area constrained by the built environment. The close proximity of a number of schools, churches, recreational facilities and residential areas, and the severance caused by this route corridor means that there would be a greater potential for accidents involving pedestrians. This concern was highlighted at the Public Information Day held in March 2006.

Also, due to the number of junctions between Cathedral Road and Friary Road, there may be an increased risk of vehicular accidents such as shunts at give ways or traffic lights.

Potential steps to mitigate against these concerns include strategically positioned, well designed pedestrian crossings and the design of clearly laid out, well lit junctions.

This corridor has an adverse effect on Accidents.

Security:

The number of junctions within this route corridor creates the potential for smash and grab / car-jacking as cars wait at traffic lights or give ways. Also, an underpass located at Cathedral Road could have a negative effect on the personal security felt by pedestrians and cyclists along the proposed alignment.

Again, potential steps to mitigate against these problems include junctions and underpasses which are well lit with clear sight lines and good visibility. These steps would hope to allay any perceived fears held by all road users.

This corridor has a slight adverse effect on Security.

Route Corridor 2

Accidents:

As this corridor passes from the junction of Station Road and Moy Road towards the Ballycrummy Lane it crosses the Cathedral Road. The provision of adequate crossing facilities for pedestrians is imperative here due to a significant population density in the area. An adequately designed roundabout will ensure that both pedestrian and vehicular movements are catered for.

There are a total of eight junctions along this corridor. Adequately designed junctions that have high visibility standards will help minimise the number of accidents and corresponding casualties.

Although similar to Corridor 4 it is the population density, in particular around Cathedral Road junction, which makes this corridor less suitable.

This corridor has a slight adverse effect on Accidents.

Security:

Similarly to Route Corridor 1, junctions and any possible lay bys or service areas should be designed with the personal security of all road users in mind, specifying high standards of lighting, landscaping and visibility.

This corridor has a slight adverse effect on Security.

Route Corridor 3

Accidents:

This corridor passes a number of housing developments but as it is to the north and west of the existing city limits the opportunity for pedestrian crossings are limited to those at junctions, and these are not likely to be of any great magnitude. Pedestrian surveys will be carried out in the detailed design stages and this will record such movements. The safe design to incorporate these movements will minimise any accidents. The high speed limit means that accidents occurring on this corridor would be more severe than in an urban environment.

This corridor has an adverse effect on Accidents.

Security:

The rural nature of this corridor can reduce the perceived feeling of security for vehicular travellers. Should a car breakdown, or an accident happen, the feeling of vulnerability can increase due to the fact that there are less people about. This feeling is exacerbated at night, as the rural area may not be as well lit as the more urban areas. Possible steps to improve personal security include the provision of emergency call facilities and lighting at strategic positions along the route corridor.

This corridor has a slight adverse effect on Security.

Route Corridor 4

Accidents:

As this corridor passes from the junction of Station Road and Moy Road towards the Ballycrummy Lane it crosses the Cathedral Road. An adequately designed roundabout will ensure that both pedestrian and vehicular movements are catered for. There are a total of eight junctions along this entire corridor. Adequately designed junctions that have high visibility standards will help minimise the number of accidents and corresponding casualties.

This corridor has a slight adverse effect on Accidents.

Security:

Again, similarly to Route Corridors 1 and 2, junctions and any possible lay bys or service areas should be designed with the personal security of all road users in mind, specifying high standards of lighting, landscaping and visibility.

This corridor has a slight adverse effect on Security.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Route Corridor 4
Accidents	Adverse	Slight Adverse	Adverse	Slight Adverse
Security	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse

6.0 Economy

6.1 Introduction

The Economy Objective is concerned with improving the economic efficiency of transport. It was developed from the principles of *A New Deal for Transport,* the Government's White Paper on transport. Congestion and unreliability of journeys add to the costs of business, undermining competitiveness particularly in towns and cities.

The categorisation of the A3 as a Link Corridor identifies it as having a strategic importance in connecting Belfast, Portadown and Armagh to Monaghan and beyond. The effect of this road to the local and national economy is therefore likely to be beneficial.

The Economy Objective has 5 sub-objectives:

to get good value for money in relation to impacts on public accounts;

to improve transport economic efficiency for business users and transport providers;

to improve transport economic efficiency for consumer users;

to improve reliability; and

to provide beneficial wider economic impacts.

6.2 Public Accounts

At this stage of the scheme assessment it is assumed that all net costs will be incurred by local government bodies. No private sector investment has been taken into consideration. The effects of each corridor on the Public Accounts sub-objective will be assumed to be the same.

6.3 Economic Efficiency

The economic efficiency objective is assessed using a cost benefit analysis. Cost Benefit Analysis (COBA) is a comprehensive economic appraisal technique. It quantifies in monetary terms the major costs and benefits of a scheme. The key strength of COBA is that it considers on a consistent basis the benefits and costs of alternatives. Thus the outcomes for a range of scenarios are translated into comparable terms, which facilitate evaluation and decision-making.

The benefits of a scheme are calculated for the assessment period, normally sixty years, and are balanced against the construction and maintenance costs for the same period. The COBA Version 11 Revision 7 was used for the Armagh North and West Link assessment. The network was classified as Non Built-up Trunk (TNB) to best describe the scheme being assessed. COBA uses this classification to call default values for Seasonality Index and Vehicle Category Proportions.

Nodes were placed at major junctions which are represented in COBA by nodes joining links together. The Annual Average Hourly Traffic (AAHT) was used for the traffic flow input. No local accident data was included in the input file. In the absence of this data, default values are used by COBA to calculate changes in accident costs.

Construction and land costs were input in multiples of £1,000 undiscounted. COBA calculated the equivalent costs in the Present Year and allocates them to the correct year.

The Net Present Value (NPV) of any scheme can be calculated by subtracting the Present Value of Costs (PVC) from the Present Value of Benefits (PVB). This figure is expressed as a 2002 price (price discounted from the current year to 2002). A positive NPV indicates that the benefit of the proposed scheme outweigh the costs indicating that a scheme is potentially economically viable. The NPV and Benefit to Cost Ratio (BCR) for all four Route Corridors are provided in Tables 6.1 and 6.2.

Route Corridor	NPV	
	Low Growth	High Growth
1	236,920	262,124
2	247,506	275,632
3	177,346	209,660
4	198,844	224,872

Table 6.1 - COBA Analysis – NPV Results

Route Corridor	BCR	
	Low Growth	High Growth
1	7.848	8.723
2	7.263	8.125
3	7.182	8.232
4	7.518	8.454

Table 6.2 - COBA Analysis – BCR Results

As shown, all route corridors provide a positive return in relation to the investment associated with delivering the scheme.

Route Corridor 2 provides the highest NPV but has the lowest Benefit to Cost Ratio. However, Route Corridor 1 has a relatively high NPV and also the highest BCR value, thus suggesting that this Route Corridor provides the most beneficial return on investment.

6.4 Reliability

This sub-objective summarises the proposal's impact on the objective to improve journey time reliability for transport users, including both passengers and freight.

Current theoretical approaches suggest that slightly different definitions of 'reliability' are used for public transport and private vehicle travel.

For most public transport journeys, the existence of timetabled arrival times means that it is usual to consider reliability in terms of lateness, defined as the difference between travellers' actual and timetabled arrival times. Adopting this definition means that arrival before the timetabled arrival time is usually ignored. This is based on the assumption that the operation of public transport generally acts to avoid early arrival. Two measures of lateness must be

considered: average lateness; and the variability of lateness, measured by the standard deviation of lateness.

For journeys by private road vehicles (including road goods vehicles), it is reasonable to expect travellers to be aware of the average journey time, including variations caused by factors such as different traffic conditions at different times of the day. Thus reliability should be measured in terms of the unpredictable variability in travel times about these averages, measured by the standard deviation of travel time.

To estimate the monetised benefit of changes in the variability of lateness (for public transport) or of journey time (for private road vehicles), money values are needed. The concept of the reliability ratio enables changes in variability of lateness or of journey time to be expressed in monetary terms. The reliability ratio is defined as:

$$\text{Reliability Ratio} = \frac{\text{Value of SD of travel time or lateness}}{\text{Value of travel time or lateness}}$$

In addition, for public transport, the calculation of the monetised benefit of changes in average lateness also requires suitable money values. The value of average lateness may also be expressed in relation to the value of travel time:

Value of lateness = (factor) x (value of travel time)

Note that it is possible to estimate the benefits of changes in average lateness without also estimating the benefits of changes in the variability of lateness.

There are a number of junctions along each corridor that will control the travel time through the network.

Refer to Section 3.1.2, Table 3.1 for the junction strategy for Route Corridor 1.
Refer to Section 3.1.3, Table 3.2 for the junction strategy for Route Corridor 2.
Refer to Section 3.1.4, Table 3.3 for the junction strategy for Route Corridor 3.
Refer to Section 3.1.5, Table 3.4 for the junction strategy for Route Corridor 4.

It should be noted that at this stage, the junction strategies are preliminary. Also, detailed design would consider the type, size and capacity required by each junction in order to optimise journey times and reliability.

6.5 Wider Economic Benefits

This section provides a discussion of the linkages between transport and economic activity that are believed to operate.

The proposed Armagh North and West Link will enhance the already existing A3, ensuring that its categorisation as a Link Corridor remains undoubted. Whilst reducing the amount of strategic traffic travelling through Armagh city centre, the link road will also improve the local road network, and in doing so will promote Armagh as a more attractive location for development.

Transport investments can, and generally do, affect the economy. They can, in particular affect the location and pattern of economic activity. The wider economic benefits that are missing

from conventional appraisal reflect the main market imperfections: agglomeration externalities, imperfect competition and the economic benefits of increased employment and productivity.

The methodology is concerned with the measurable effects of transport schemes on the local economy. The emphasis is on specific effects which result from the transport scheme, based on reductions in travel times and/or congestion at peak times and working through the effects of these on jobs.

One part of the benefits delivered by transport improvements can be measured in the form of time savings to travellers. This can be either how travellers value their time and/or how much value a firm puts on their employees' time.

Conventional benefits to the wider economy are:

Business time savings;

Commuting time savings; and

Leisure time savings.

Additional to these conventional benefits are:

An increase in labour force participation;

People working longer;

Agglomeration benefits; and

Increased competition.

Good easy access to the key transportation corridors is an important consideration for industry. Any proposed development as set out in the Armagh Area Plan would benefit from the new link road as more strategic traffic would be passing in close proximity to it. This would help promote Armagh as an area for future investment.

From the point of view of employers, what matters are the accessibility attributes of a given location, and how the proposed scheme makes that location more or less attractive for the expansion of an existing business or the establishment of a new one. There are several aspects to this, and their importance in any instance will vary with economic sector:

Access to a suitable workforce. This is the number of suitable potential employees living within acceptable travel times and costs;

Access to or by customers. For retail businesses this will include the number of potential customers living within an acceptable distance. However for many sectors this will be viewed as the time and cost associated with moving goods between locations and in or out of sites. An aspect of this might be access to the national transport networks, airports and seaports;

Access to or by suppliers. Again, the interest will be in the times and costs of moving goods between locations and in or out of sites, possibly including access to the national transport networks, airports and seaports.

In summary, the wider economic impacts of a road scheme are affected by the improved accessibility it may provide. In terms of accessibility, Route Corridors 1, 2 and 4 are quite

similar in that they improve both local and strategic accessibility. In contrast, Route Corridor 3 only improves strategic accessibility.

The advantage of enhanced local and strategic accessibility and reliability means that journey quality as well as journey times to, around, and within a city are improved. This can have significant benefits for a city. Improved accessibility and reliability means that journey times both within the city and to other towns and cities are reduced, thus making it a more attractive place to live and do business. This, coupled with improved access offered to customers and suppliers, means that business within Armagh will have the opportunity to expand and develop. This creates the possibility of job creation and increased employment within the area.

Improving only strategic accessibility will improve journey times around the outskirts of the city, although accessibility to the heart of the city would not be enhanced. As a result, the benefits resulting from improved local accessibility would not be realised.

It is envisaged that at a future stage, in accordance with TAG guidance, an Economic Impact Report (EIR) would be produced which would be more specific in terms of measuring accessibility in relation to wider economic impacts.

6.6 Summary of Economy for each Route Corridor

By examining each of the economy sub-objectives it can be said that, in terms of economic efficiency, each of the route corridors provide good cost to benefit ratios. But, when also considering reliability and wider economic impacts, Route Corridors 1, 2 and 4 are more favourable than Route Corridor 3. Although these corridors pass through the city urban environment, causing initial disruption, particularly at Station Road, a link road capable of catering for both local and strategic movements provides numerous economic benefits for both business and the local community. It is anticipated that any disruption caused to existing businesses within the Station Road area would be compensated by the construction of service roads to these premises.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Route Corridor 4
Public Accounts	Neutral	Neutral	Neutral	Neutral
Economic Efficiency	Major Beneficial	Beneficial	Beneficial	Beneficial
Reliability	Slight Beneficial	Beneficial	Slight Beneficial	Beneficial
Wider Economic Impacts	Beneficial	Beneficial	Slight Beneficial	Beneficial

Table 6.3 – Summary of Economy on each Route Corridor

7.0 Accessibility

7.1 Introduction

Accessibility is the ability of a scheme to improve access to facilities for those without a car, and to reduce severance.

The aspects of accessibility are:

Access to the transport system;

Option values; and

Severance.

7.2 Assumptions and Limitations

At this stage there have been no discussions with Translink regarding plans for the public transport system. Assumptions are made that the scheme will have a slightly positive effect on the public transport system due to any increased reliability in journey times into Armagh, and also for cross border trips to Monaghan and beyond. Many issues relating to accessibility will be revisited at a detailed design stage.

7.3 Access to the Transport System

At this stage of the study, it is not envisaged that any of the corridors will make provision for improvements to the public transport system, such as bus shelters, accessibility improvements or reduced fares. Further design will necessitate consultation with Translink regarding existing public services and routes. This may have an impact on the localised width of the proposed road to accommodate bus lay-bys.

Each corridor has a neutral effect on Access to the Transport System.

7.4 Option Values

It is not envisaged that the any of the proposed corridors will alter the availability of transport services within the area as none of the corridors are likely to have any provision made for the improvement of public transport. At present there are no plans to restore any section of the Portadown to Armagh Railway. No change in the mode of transport options available to the community of Armagh have been assessed during this study. None of the proposed corridors will have any effect on the option values.

Each corridor has a neutral effect on Option Values.

7.5 Severance

The extent of community severance that might occur is considered during two forms of analysis: transport scheme appraisal and environmental assessment.

Transport scheme appraisal aims to estimate the potential costs and benefits of a scheme prior to construction. Environmental assessment is undertaken as a matter of regulation to inform the land use planning process of significant environmental effects that a scheme may have (Reference: Chapter 4.0).

Severance measures 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. Transport schemes can contribute to community severance by bringing about the existence of:

Physical barriers – such as the introduction of new traffic infrastructure

Psychological or perceived barriers – such as traffic noise or road safety fears

Social impacts – such as the disruption of 'neighbourhood lifestyle' or inhibition of social interaction.

The physical and psychological dimensions can be seen to relate to the development of barriers to an individual's movement (either real or perceived). The social dimensions relate to the impacts that a barrier has on the community as a whole.

Physical and Psychological severance barriers are seen to both reduce accessibility to key services (such as health, education, employment opportunities and food shops) and also to damage local social networks and community 'cohesion' by inhibiting social interaction.

Physical barriers

Physical severance can be divided into two types of barrier:

Static severance

This barrier is caused by the introduction of a new road and controlled crossing points through an area where there are existing patterns of social interaction.
"A man-made structure artificially divides an area into two separate parts so that it is difficult for one side to interact with the other"

Dynamic severance

This barrier is caused by the traffic on a road creating a 'dynamic time-dependent barrier'. In essence, this means that pedestrians may experience an intermittent barrier to movement (across the road) caused by the flow of traffic.

The following impacts of physical barriers on individuals have been identified:

Pedestrian or trip delay: the lengthening of a person's journey caused by the transport infrastructure (e.g. a road and the position of formal crossing points)

Trip diversion: a person is diverted from taking the most desirable route (in terms of journey time)

Psychological barriers

These are felt to be factors, which affect how people perceive the experience of moving through an area. Research with pedestrians identified the following perceptual impacts of traffic, which may contribute to a psychological barrier developing:

Traffic noise: this relates mainly to longitudinal severance, a situation where pedestrians or cyclists are deterred from travelling along a road because of the noise emitted by the traffic (due to its speed or volume)

Traffic pollution: this refers to the deterrent effect on pedestrians and cyclists travelling along or across a road due to poor air quality caused by heavy traffic

Perceived danger: the deterrent effect on pedestrians and cyclists of fear being hit by speeding or heavy traffic

A combination of either or both physical and psychological barriers can create:

Trip suppression: this results in an individual being completely deterred from making a journey due to factors associated with the transport infrastructure.

Cumulative effects of physical and psychological barriers on the individuals living in an area can have a social impact on the local residential community as a whole.

All of the above factors were cited as problematic by members of the public during the Public Information day.

Social impacts of community severance

A range of reasons have been identified as to why behaviour changes, both in relation to new roads and to roads that become increasingly busy over time:

There was a reduction in the desire or ability to socialise or go for a walk in the affected area;

Parents restricted children from playing outside or crossing the road due to road safety fears;

People shut themselves off from their surroundings and modified their lifestyles and working patterns to counter the negative effects of congestion; this included changing their shift patterns at work and the use of different areas for shopping and recreation;

Community severance and accessibility of key services

Physical and psychological severance barriers are seen to both reduce accessibility to key services (such as health, education and employment opportunities and food shops) and also to damage local social networks and community 'cohesion' by inhibiting social interaction. Both these factors are felt to contribute to the social exclusion experienced by particular groups of people (predominantly those on low incomes). Those people living in areas suffering from a wider range of social exclusion issues are felt to be disproportionately affected by the impacts of severance.

7.6 Summary of Accessibility for each Route Corridor

Route Corridor 1

As there is no anticipated change in access to the transport system and option values, this summary will focus solely on the issue of severance.

Severance

Physical: It is assumed, as with all route corridors, that severance in rural areas will be minimal due to the limited number of pedestrians in theses areas. This option will create both static and dynamic severance for residents and the general public within the area of Cathedral Road and Windmill Hill. At present the area provides a recreational area with no restrictions on pedestrian movements, but a road constructed within this route corridor will create pedestrian trip delay and trip diversion.

Psychological: This route corridor will increase both traffic noise and pollution within this area, although any perceived danger felt by pedestrians will be minimised by wide footways and cycleways

Social: The constraining nature of the built environment between Moy Road and Convent Road means that landtake on either side of the corridor may be necessary. To the west, gardens belonging to private residences may be affected. To the eastern side, recreational amenities belonging to the Cathedral Road Recreation Centre may be affected.

Concerns over the social impact of this corridor have been voiced by local residents at the public information day.

This corridor has a major adverse effect on Severance.

Route Corridor 2

Physical: This corridor passes through areas of housing that have recently been constructed. This corridor will lead to both static and dynamic severance for residents of both the Desart Lane and Glen Mhacha developments.

Psychological: As with Route Corridor 1, this route corridor will increase both traffic noise and pollution within this area, although any perceived danger felt by pedestrians will be minimised by wide footways and cycleways

Social: Route Corridor 2 passes through the playing fields to the south of Moy Road rendering them useless. The relocation of playing fields will have a negative effect on social aspects of the local community. The effect on the social aspect of the local community will be negative, meaning the relocation of playing fields. This alignment also severs existing developments which could lead to families with children wishing to leave the area due to the perceived danger of a major road.

This corridor has an adverse effect on Severance.

Route Corridor 3

Physical: The proposed route corridor will not sever any existing residential areas, and due to the rural nature of the road, there will be minimal pedestrian activity in the area.

Psychological: Again, the rural nature of the road means that the proposed alignment would not be in the general vicinity of existing residential developments. This means that any increase in traffic noise or pollution would have minimal effects on the local community.

Social: This route corridor may affect access to the Pearse Og GAA Club playing fields on Ballycrummy Road, although adequate design during the realignment of the exiting access should mitigate against any problems.

This corridor has a neutral effect on Severance.

Route Corridor 4

Physical: This route corridor passes along the outskirts of developments at Desart Lane and Cathedral Road, and so does not effectively cause any additional severance of any existing residential areas

Psychological: As with Route Corridors 1 and 2, this route corridor will increase both traffic noise and pollution within this area, although any perceived danger felt by pedestrians will be minimised by wide footways and cycleways

Social: This corridor intersects the playing fields to the south of Moy Road belonging to St Patrick's Grammar School and also cuts across a small section of Desart Lane. This may require this section of Desart Lane servicing six houses may need to be accessed from the Moy Road in the future.

This corridor has a slight adverse effect on Severance.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Route Corridor 4
Access to Transport System	Neutral	Neutral	Neutral	Neutral
Option Values	Neutral	Neutral	Neutral	Neutral
Severance	Major Adverse	Adverse	Neutral	Slight Adverse

Table 7.1 – Summary of Accessibility on each Route Corridor

8.0 Integration

8.1 General

This objective determines to what extent the proposal is integrated with other transport modes, land-use, social inclusion, health proposals and policies and other transport related proposals. Three sub objectives are considered:

Transport interchange;

Land-use policy; and

Other Government policies.

8.2 Transport Interchange

The Transport Interchange sub-objective examines any intervention, which facilitates the transfer of passengers/vehicles from one mode of transport to another, and the number of people likely to be affected by this. An example of this is a park and ride scheme where, at a specified point approaching a heavily congested town or city, drivers are encouraged to park their vehicles in secure parking and continue the rest of their journey by public transport. Under the Transport Interchange sub-objective the quality of these interchange facilities are appraised for their safety, reliability, quality and effectiveness.

As none of the proposed corridors are likely to include a passenger or freight transport interchange, they will not have an impact on the transport interchange objective.

Each corridor has a neutral effect on Transport Interchange.

8.3 Land-use Policy

The Land Use sub-objective provides a summary of assessments made of the extent to which the proposal is integrated with existing land use proposals and policies as well as transport proposals and policies, at local, regional and national levels, and whether the existing proposal facilitates, hinders or does not affect these proposals.

The Armagh Area Plan 2004 is the most current policy document. The Armagh Area Plan 2018 is currently being compiled. The Issues Paper and Strategic Topic Research Summary Report have already been published.

To achieve the aims of the Area Plan there are a number of principal objectives that are to be realised:

To encourage the efficient use of existing infrastructure and make provision for new infrastructure;

To promote vibrant towns and villages by increasing their attractiveness as places to live, work, use and invest;

To protect rural areas and to retain a clear distinction between urban areas and the open countryside by preventing urban sprawl and ribbon development;

To conserve and enhance the natural and man-made environment and protect important wildlife areas;

To preserve and enhance the archaeological and historic heritage of the District;

To improve and extend the existing road system where necessary for the safe and convenient movement of people, goods and services and to make towns and villages generally accessible and convenient to use.

Further details of the policies affecting this scheme can be found in Section 4.13 – Land Use Policy.

8.4 Other Government Policies

The Regional Transportation Strategy (RTS) for Northern Ireland 2002 – 2012 was published in 2002 and identifies strategic investment priorities and considers potential funding sources and affordability of planned initiatives over the next 10 years.

The RTS is a "daughter document" of the Regional Development Strategy (RDS) which sets out the spatial development framework for Northern Ireland up to 2025. The Strategy encourages a sustainable approach to planning which strives to integrate land use and transport. Fundamental to the RDS is the aim to improve integration by promoting more effective Government policy on education, health, economic growth, access to employment and targeting social need.

The RDS provides a statutory strategic planning framework to address a range of economic, social, environmental and community issues, which are relevant to delivering the objectives of achieving sustainable development and social cohesion in Northern Ireland. Importantly, it provides a framework within which choices can be made on key decisions about the infrastructural development of Northern Ireland.

The purpose of the RTS is to support the RDS and to make a significant contribution over the 10 years towards achieving the longer-term vision for transportation contained within the RDS:

"to have a modern, sustainable, safe transportation system which benefits society, the economy, and the environment and which actively contributes to social inclusion and everyone's quality of life"

The RTS was based on the principles set out in GOMMMS and the five objectives for transport as set out in the Government's White paper *"A New Deal for Transport: Better for Everyone"*, namely the environment, safety, economy, accessibility, and integration.

The Programme for Government and Public Service Agreements (PSAs) set the context for policy-making in the devolved administration. A key starting point in the development of a new policy, or the review of an existing policy, is therefore the extent to which the issue and the associated policy is consistent with the overall direction of the Programme for Government.

In addition to policies which are developed on a planned basis emanating from identified need, there are occasions on which new policy initiatives arise from unexpected or uncontrollable sources.

Possible Impacts on Government Departments

The table below illustrates how the impact score is rated in terms of other Government Policies.

Contribution to Other Government policies	Overall Impact Score
More key policies benefited than hindered by the scheme. Contributes to and is consistent with Government policy	Beneficial
Roughly equal number of policies benefited as are hindered or no policies affected	Neutral
More key policies hindered than benefited by the scheme. Broadly inconsistent with Government policy	Adverse

Table 8.1 Possible impact scores on Other Government Policies

The table below illustrates the impact of this Scheme on the Government department policies.

Government Department	Overall Impact
Department of Agriculture and Rural Development	Neutral
Department of Constitutional Affairs	Neutral
Department of Culture Arts and Leisure	Neutral
Department of Education	Neutral
Department of Enterprise Trade and Investment	Beneficial
Department of Environment	Neutral
Department of Finance and Personnel	Neutral
Department of Health, Social Services, and Public Safety.	Beneficial
Department of Employment and Learning	Neutral
Department of Regional Development	Beneficial
Department of Social Development	Beneficial
Department of Trade and Industry	Beneficial

Table 8.2 Possible impacts on Government Department Policies

8.5 Summary of Integration for each Route Corridor

Table 8.3 summarises the appraisal of the effects of each Route Corridor on the Integration sub-objectives, Transport Interchange, Land Use Policy and Other Government Policy.

Sub- Objective	Route Corridor 1	Route Corridor 2	Route Corridor 3	Route Corridor 4
Transport Interchange	Neutral	Neutral	Neutral	Neutral
Land Use Policy	Beneficial	Slight Beneficial	Slight Adverse	Slight Beneficial
Other Government Policy	Beneficial	Beneficial	Beneficial	Beneficial

Table 8.3 Summary of Integration on each Route Corridor

9.0 Supporting Analyses

9.1 Introduction

The guidance in TAG specifies three important Supporting Analyses to supplement the over-arching objectives. These require assessments to be made of:

Distribution and Equity impacts;

Affordability and Financial Sustainability; and

Practicality and Public Acceptability issues.

9.2 Distribution and Equity

Distribution and equity supporting analysis considers distribution of the impacts of each corridor, thereby enabling a judgement to be made about the fairness of the impacts on those affected.

This supporting analysis has been prepared in accordance with the principles of Section 75 of the Northern Ireland Act 1998 and taking account of the New Targeting Social Need Policy (TSN) outlined in the Programme for Government.

The Armagh Area Plan 2018 – Public Consultation document highlights a number of issues under Equality and TSN. Whilst primarily concerned with people with disabilities, it also mentions older, less mobile people or parents with prams. Issues arising from the TSN will be assessed during the detailed design stage.

Businesses in Station Road are affected by three of the Route Corridors. Route Corridor 3 is the only Corridor that does not impact on Station Road.

Three Route Corridors impact on residential areas but to varying degrees. Route Corridor 2 directly impacts on the greatest number of residents, followed by Route Corridor 4, and then Route Corridor 1. This is largely due to Corridor 1 being a protected line under the Area Plan. Corridor 1 has the potential go indirectly affect a greater number of residents. The demographics of areas affected will not be known until the route corridors become more defined as route options.

All four Route Corridors affect the residents of Drummanmore Road due to the proposed underpass.

Each of the Corridors makes provision for users other than those using private cars, in particular cyclists and pedestrians. Linkage into the existing cycle network will be encouraged.

9.3 Affordability and Financial Sustainability

The affordability and financial sustainability sub-objectives relate to the investment and operating costs and revenue streams. This scheme will be considered in isolation as a highway improvement scheme with no immediate provision for enhanced public transport services.

Financial sustainability is a measure of the extent to which the initiatives are self-supporting from revenues. No revenue streams will be created as part of the scheme.

9.4 Practical and Public Acceptability

In the past, some studies have been less effective than they might have been because their recommendations breached some constraint. Some strategies or plans may be desirable but not fundable, or may create a majority of winners with a minority of uncompensated losers who will form a vocal opposition. Other strategies may be contingent on future funding to complete a network which cannot be guaranteed, or may be risky against certain scenarios. Therefore, there needs to be an overall assessment of the practicability of each strategy or plan and, where relevant, what countervailing or complementary measures are needed to make the strategy or plan practical. Ideally, these measures should be built into the strategy or plan for testing, but it is recognised that this may not always be possible.

Practicality

The following check list is recommended in TAG to determine the practicality of the scheme:

Feasibility

At this stage it can be assumed that any of the four corridors under consideration are technically feasible and do not involve complex or unusual construction works.

Enforcement

Feedback from local residents indicated that there were major concerns about the speed limit of the proposed road. A speed limit of 60mph is envisaged for the rural sections of the scheme with 40mph in the urban zones (possibly reduced to 30mph in the vicinity of Windmill Hill / Navan Street). It is desirable that new schemes are self-enforcing, however it remains to be seen if there is any scope to implement such measures in a cost-effective manner.

Area of interest ("breadth" of the decision)

The scale of this scheme covers a large area and will affect a large proportion of Armagh in one way or another. The corridors proposed have been assessed in tandem with the current Armagh Area Plan. The revised Area Plan will need to be assessed once details from it are known as a new road has the potential to attract new industrial developments. It is likely that organisations like InvestNI would be interested in the location of a new road. Due to the proximity of the corridor to locations of cultural heritage local archaeological bodies are likely to have an interest in the scheme.

Complexity ("depth" of the decision)

The decision required at this stage is which route corridor will satisfy not only the Governments five key objectives, but also the degree to which the solution satisfies local objectives and the amelioration of problems.

Time-scale

The opening year of the scheme is planned as 2009 subject to satisfactory and timely Statutory Approvals.

Phasing

There are a number of schemes in and around Armagh that are included in the Strategic Road Improvement Programme 2015. The North and West Link Road is currently in the Preparation Pool (within 5 years), whilst the Armagh East Link Road is in the Forward Planning Schedule (5 to 10 years). The A3 Portadown to Richill dualling was recently added to the SRI Programme subject to consultation. The phasing of the North and West Link Road underlines its importance in the overall Regional Strategic Transport Network.

Partitioning

The splitting of the North and West Link road into two smaller components would bring little merit to Armagh City. The significance of any contribution of two such link roads can only be realised if they are constructed in unison. At this stage it is not believed that any partitioning of the scheme will bring any benefit.

Complementary

The benefits of this scheme have been considered in isolation, however, note has been made of any impact that the Armagh East Link may have on the future operation of the North and West Link. Both schemes should assist in reducing the traffic trough Armagh's historic centre.

Conflicts

There have been no other measures that have come to light recently that would suggest that the A3 will cause any conflicts with any other policies, strategies or plans.

Political nature of policies and proposals

It is important that technical choices, which are primarily concerned with the specification of schemes and measures, are not confused with political choices, relating to policies.

The choice of preferred corridor will be based on the appraisal criteria and is not influenced by political choices.

Public Acceptability

A Public Information day was held on 13th March 2006 to inform the general public and public representatives of the proposals under consideration and to listen to their views. The alignment as shown in the Armagh Area Plan 2004 was presented at that time (Reference: Public Consultation Day Report [1])

[1] Public Information Day Report – published June 2006

An information leaflet was produced and participants were invited to comment on the proposal, both verbally on the day and in writing by completing a response sheet. One of the questions asked if people agreed in principle to the proposal. The results from the returned questionnaires are shown below:

Total Number of Questionnaires Returned	Agreed in Principle to Scheme	Disagreed in Principle to Scheme	Uncertain
48	30 (63%)	15 (31%)	3 (6%)

Table 9.1 – Public Information Day Questionnaire Breakdown

It will be impossible to please all stakeholders, however an approach where the opinions of the public have been duly considered is essential. To influence public acceptability, the appraisal of the corridors must be transparent against the five key Government criteria as well as against local objectives and problem amelioration to produce the most acceptable solution in a fair and balanced manner. It is not yet known how difficult the statutory procedures will prove to be. It is anticipated however, that a Public Inquiry will be necessary.

The Practicality of each of the four corridors does not vary significantly, however the Public Acceptability does. Corridor 3 is the most acceptable amongst the public and despite not being presented at the Public Information Day in March 2006, was suggested on a number of occasions as an alternative to the Area Plan Alignment. There are a number of opposition groups formed from residents along the western section of Corridor 1. This has led to Corridor 1 being the least favourable. Corridor 4 is seen as causing less severance than Corridor 2. Corridor 4 is the second most favourable corridor as a result of this.

9.5 Achievement of Local Objectives

The principal objectives as set out in the Armagh Area Plan 2004 can be found in section 8.3.

Other local objectives are discussed in this section.

The northern section of the link road is required to open up development opportunities to the north of Armagh and help reduce traffic along The Mall, Victoria Street and College Hill.

The western section of the link road is required to act as a distributor of traffic entering of leaving Armagh on its western side and is also required to help take traffic out of Armagh's historic centre.

The Area Plan states that new road schemes must take into consideration the amenity of land and existing development adjoining the proposed routes.

The efficiency, capacity and local safety of the primary and district distributor roads within Armagh are to be maintained by severely limiting the number of accesses onto them.

The current Area Plan encourages the development of mixed industrial, commercial and business uses within the vicinity of Station Road.

The requirements of the northern section are all met by Route Corridors 1, 2 and 4. Route Corridor 3 is currently outside the development limits of the current Area Plan, although this may change in the future when the revised Area Plan (2018) is published.

The requirements of the western section of the Link Road are met most comprehensively by Route Corridor 1. Route Corridors 2, 3, and 4 perform less well, respectively, due to their locations being further west. This does not remove the problems associated with traffic using the local roads in and around Navan Street and Windmill Hill.

10.0 Conclusions

The appraisal framework adopted for this scheme followed the principles of TAG using the three strands of appraisal as follows:

Effectiveness of problem solving;
Achievement of Government's five key objectives; and
Achievement of Local Objectives.

The conclusions of the appraisal can therefore be said to consist of six broad areas.

Each route corridor was appraised against Engineering Assessment, Environmental, Safety, Economy, Accessibility, and Integration. The summary of these are shown in Table 10.1.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Route Corridor 4
Engineering	2	4	3	1
Environmental	3	3	2	1
Safety	4	1	3	1
Economy	1	2	4	2
Accessibility	4	3	1	2
Integration	1	3	4	2

Table 10.1 - Conclusion Table for each Route Corridor

1 = most favourable route corridor
4 = least favourable route corridor

The **Engineering Assessment** concluded that **Route Corridor 4** performed most favourably against the assessment criteria, followed by Route Corridor 1. Whilst Route Corridor 4 only performs the most favourably when assessed against structural criteria, it performs consistently well across the other five engineering criteria. Route Corridor 3 performs least favourably when assessed against the six engineering criteria.

The **Environment** objective scored each Corridor to a similar magnitude, however, within this it concluded that **Route Corridor 4** performed most favourably against the assessment criteria, followed by Route Corridor 3. Route Corridors 1 and 2 perform least favourably. All four corridors have rural elements and these generally result in similar scorings. The impact of the corridor on townscape varies between Corridor 3 and the other three as Corridor 3 is entirely in a rural locale. Conversely it is Corridor 3 that performs least favourably with respect to land use.

The **Safety** objective concluded that **Route Corridors 4 and 2** performed most favourably against the assessment criteria followed by Route Corridors 3. Route Corridor 1 performs least favourably. Security issues are scored similarly for all four corridors at this stage, however there are perhaps most security issues in Corridor 1 especially with its proximity to the more densely populated areas along the western section. The rural areas all have a reduced sense of personal security due to their remoteness.

The **Economy** objective concluded that **Route Corridors 1, 2, and 4** all performed favourably. Route Corridor 3 performed least favourably against the assessment criteria. This assessment is based primarily on the BCR outputs from COBA but also considers reliability and wider economic

impacts. Preliminary cost estimates indicate that Corridors 1 and 4 would be the least expensive to construct with Corridor 2 approximately 15% more expensive, and Corridor 3 approximately 18% more expensive.

The **Accessibility** objective is mainly concerned with severance and concluded that **Route Corridor 3** performed most favourably against the assessment criteria followed by Route Corridor 4. Route Corridor 1 performs least favourably. The severance issues have more effect in urban areas where the road is seen or perceived as a barrier impacting on social interaction. Fewer numbers of people are affected by severance in rural areas but these effects can affect livelihood as agricultural land is impinged on, rendering some fields redundant.

The **Integration** objective concluded that **Route Corridors 1** performed most favourably Route Corridor 4 performed second most favourably. Route Corridor 3 performed least favourably against the assessment criteria. With Transport Interchange not being affected by any Corridor and each Corridor meeting the requirements of Government Policies, Integration has been assessed primarily on how each Corridor meets the requirements of the Land-use policies. Being very similar to the Armagh Area Plan corridor, Route Corridor 1 is best placed to meet its objectives.

When comparing the overall assessment for each Corridor, it can be seen that Route Corridors 1 and 2 appear to perform similarly. It should be noted, however, that Route Corridor 1 performs poorly in areas where good forward planning and liaisons with affected parties could lead to a reduction in the severity of these effects through carefully planned mitigation measures, mainly with regard to perceived safety and severance issues.

Land costs may change over time with the publication of the Armagh Area Plan 2018. Traffic volumes and behaviour may also change in future years as a result of proposed zoning in the Area Plan 2018. These issues cannot be commented on at this stage but may have a bearing in future stages of the scheme development.

The performances of both **Route Corridor 1** and **Route Corridor 4** against the Government's five key objectives and against the Engineering Assessment are such that both should be developed through DMRB Stage 2 Assessment to provide the most robust preferred route possible.