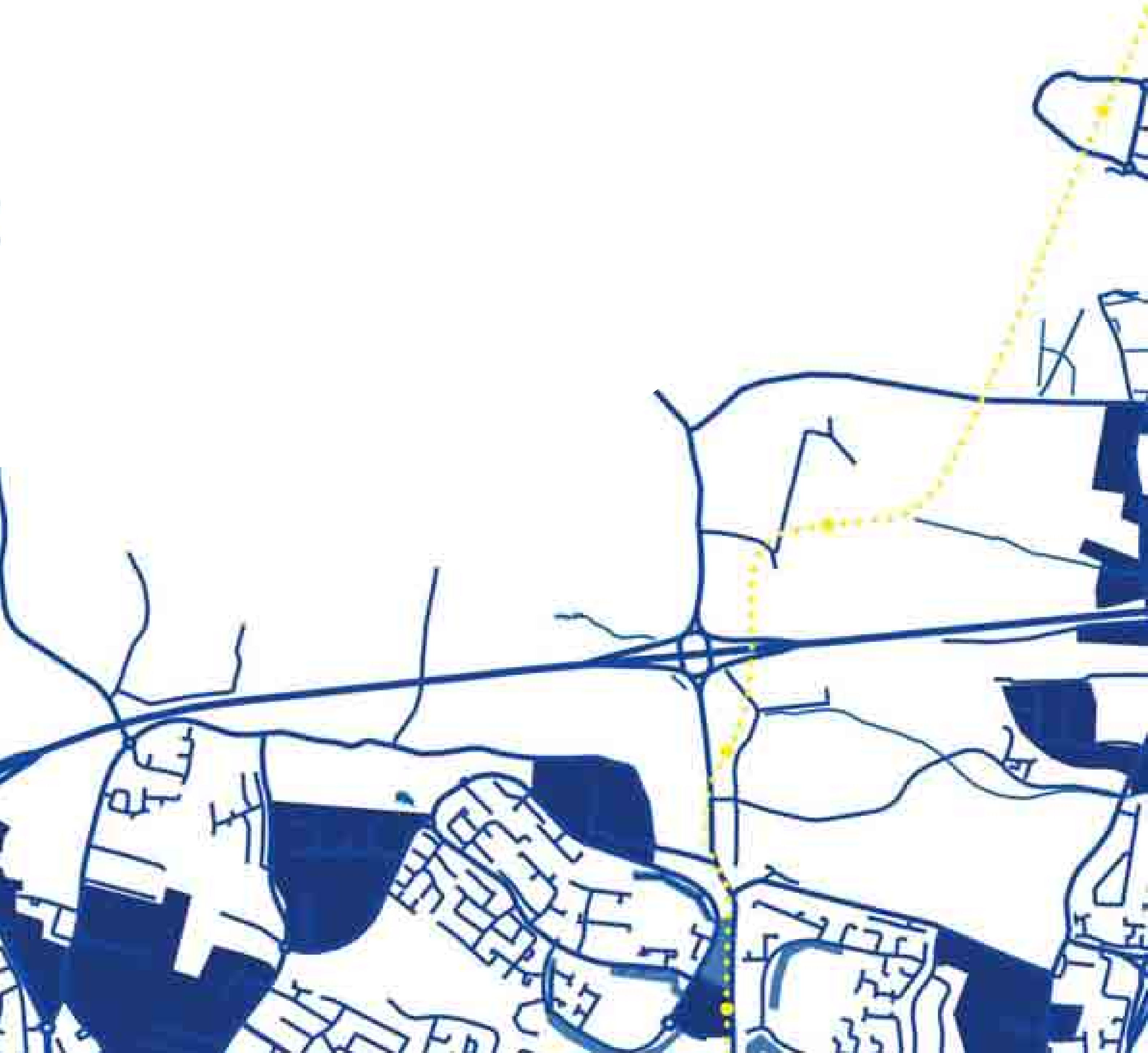
ENVIRONMENTAL IMPACT STATEMENT – METRO NORTH

DUBLIN AIRPORT

AREA MN103 (PART 2 – CHAPTER 6 to 12)

VOLUME 2 – BOOK 3 OF 7

06 HUMAN BEINGS: RADIATION AND STRAY CURRENT



This chapter of the EIS evaluates the potential for radiation (nuclear and electromagnetic) and stray current impacts to arise due to the construction and operation of the direct current, light rail traction systems associated with the proposed scheme in Area MN103.

6.1 INTRODUCTION

This chapter of the EIS evaluates the potential for radiation (nuclear and electromagnetic) and stray current impacts to arise due to the construction and operation of the direct current, light rail traction systems associated with the proposed scheme in Area MN103.

6.2 STUDY AREA

The study area for this chapter is set out in Table 6.1. EMI decreases very quickly with distance from the source at a ratio based on the square of the distance between the source and the receptor.

Disruption of normal household appliances usually occurs when magnetic field strengths of 10 μT or more are present. However, very sensitive equipment such as electronic/laser equipment may be affected if the magnetic field strengths are greater than 0.16 μT. For schemes such as the proposed scheme, in the absence of stray current, magnetic field strengths of 0.16 μT do not persist at distances of more than 100m from the track. Stray current is generally minimised via technical and structural mitigation during construction. Consequently, in the case of this specific scheme and the potential sources that exist, EMI is highly unlikely to have any impact on even the most sensitive equipment at distances of more than 100m.

Table 6.1 Study area

Aspect	Width of study area (on both sides of the alignment)
Potential impacts from Radiation and Stay Current	100m

6.3 IMPACT ASSESSMENT METHODOLOGY

The potential for EMI impacts has been assessed by:

- Step 1: Selecting representative locations (cross sections) of the alignment for detailed analysis;
- Step 2: Identifying representative scenarios for detailed analysis (including failure modes and non-routine events such as accelerating, braking and coasting);
- Step 3: Simulating/calculating the magnetic fields for the chosen locations and scenarios;
- Step 4: Extrapolating the obtained results to assess the potential risk along the entire alignment.

The source and type of potential impacts is described in Section 6.4.1. Mitigation measures to be put in place are defined in Section 6.4.2. The residual effect of each impact is then evaluated in Section 6.4.3 in terms of magnitude and significance.

6.3.1 Magnitude

The criteria used to assess the different impacts associated with this scheme are shown in Table 6.2. The criteria have been defined in consideration of research carried out by the Technical Academy in Wuppertal (1998) in relation to potential EMI impacts from Stadtbahn projects, which are comparable to the proposed scheme.

Table 6.2: Criteria for assessment of impact magnitude.

Criteria	Impact magnitude
Magnetic fields of > 180 μT (*1)	very high
Magnetic fields of > 40 μT	high
Magnetic fields of > 10 μT	medium
Magnetic fields of >0.1 μT	low
Magnetic fields of < 0.1 μT	very low

(*1) In EN 50061 the limit of immunity of pacemakers against magnetic fields is defined as 1 mT. However, the reference document from Technical Academy in Wuppertal demonstrates that pacemakers will be impacted by this value (see the reference document from Technical Academy in Wuppertal).

6.3.2 Significance

The significance of all impacts is assessed in consideration of the magnitude of the impact and the functional value of the receptor upon which the impact has an effect.

6.4 IMPACT ASSESSMENT

6.4.1 Impact identification

The infrastructure equipment associated with the proposed scheme does not include any sources of nuclear radiation and therefore this issue has been scoped out of this assessment and is not considered any further. Any issues relating to radon are detailed in the Soil and Geology chapter of this EIS (Volume 2, Chapter 9).

Electromagnetic radiation can be associated with EMI coupling effects. EMI coupling effects are defined in accordance with EN 50121 as follows:

- Inductive coupling;
- Capacitive coupling;
- Conductive coupling;
- Magnetic and electromagnetic radiation.

Inductive coupling arises from alternating current (AC) systems, such as the power supplies of lighting, ventilation and other auxiliary systems. These types of system are not used in direct current, light rail traction systems and therefore inductive coupling is not relevant to this proposed scheme and is not considered any further. Capacitive and conductive coupling are not be considered because EMI source levels associated with this scheme are too small to generate an impact in this regard.

Any piece of electromagnetic equipment is designed to function in an environment where the earth's magnetic field is present, which is approximately 50μT. The magnitude of the electromagnetic fields in the vicinity of the proposed alignment will be equal to the earth's magnetic field plus any electromagnetic fields generated or propagated by the proposed scheme.

Elements of the proposed scheme that can potentially act as sources and propagators of EMI comprise:

- Construction equipment (tunnel boring machines, lighting, pump stations etc.):
- The bulk power supply and distribution system;
- The traction power supply system (TPSS). When a LMV demands traction energy, the current flows from the traction power station along the Overhead Catenary System (OCS) to the LMV and from the LMV via running rails back again to the substation. This traction current has the potential to generate electromagnetic fields. The TPSS includes substations, feeders, OCS, running rails (regarding return and stray current) and feeding/return current cables between the OCS and running rails to the substation.
- The rolling stock traction equipment, including inverters, traction motors and auxiliaries;
- The signalling and communications equipment.

It is assumed that all equipment is designed according to the standards of the EMC Directive 2004/108/EC and therefore will not cause any significant impact. In light of this fact, only the direct current, light rail traction systems associated with the proposed scheme are considered as potential sources in this assessment.

6.4.2 Mitigation measures

- Measures to minimise stray current have been incorporated into the design specifications and will be implemented during the construction and operation of the proposed scheme. These measures may include the use of a stray current collector system, together with other design measures such as resilient insulating polymer around the rails.
- Monitoring of the earthing system in the tunnel sections is to be carried out to locate any faults in the earthing system. Active and passive measures such as insulated shielding or cathodic protection can be applied to protect any critical components.
- The system contractor(s) will ensure that the electrical systems and equipment associated with this scheme comply with the EMC Directive 2004/108/EC.
- With regard to some types of sensitive electric appliances, relocation of the affected appliance (even a short distance from a railway boundary) may be possible.

6.4.3 Assessment of residual impacts

6.4.3.1 Project scenario: construction phase

Potential levels of EMI and stray current during the construction phase (including the testing and commissioning of the LMV and traction power supply system) are expected to be within those limits detailed in Section 6.3.

6.4.3.2 Project scenario: operational phase

The assessment of residual impacts takes into consideration the reference standards, regulations and guidelines detailed in Table 6.3.

Table 6.3 Reference standards, regulations and other relevant documents

Reference document
2004/108/EC EMC Directive
EN 50121-1 – 5: Railway applications - Electromagnetic compatibility
EN 50122-2: Railway applications - Fixed installations, earthing and bonding – Part 2: Provisions against the effects of stray currents caused by d.c. traction systems
IEC 60050 (161) International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility
Research report: Meßtechnische Ermittlung der elektromagnetischen Felder im Bereich von Gleichstrom-Nahverkehrsbahnen – Forschungsbericht FE-Nr. 70506/96 – Technische Akademie Wuppertal
RPA document: EMC analysis of results of magnetic fields monitoring at IBTS building during Luas Day-One-Run - 03/08/04
RPA document: EMC analysis of results of the system with the outside world 20/06/03
RPA document: Gníomhaireacht Um Fháil Iarnród, Title: New LMV Specification – Appendix 4 – Luas power system

The potential for significant impacts to occur due to stray current is considered to be low provided that the mitigation measures detailed in Section 6.4.2 are put in place.

The EMI calculations arising from direct current (DC) power supply system are based upon the following physical phenomena:

Magnetic fields occur if an electrical current passes through a conductor. The field intensity (strength) depends upon the magnitude of the current and the distance between that conductor (source) and the destination point (receptor). A planar view of two conductors is shown in Figure 6.1. The magnetic field intensity has its maximum magnetic strength at the centre of the conductor, which reduces with increasing distance from its centre.

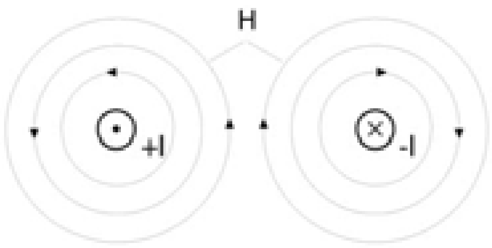


Figure 6.1
Electric conductors with magnetic field streamlines

In case of a conductor with an efficient length, the magnetic field intensity can be calculated as:

$$H = I / (2 * \pi * r)$$

Where:

H: magnetic field intensity [measured in amps per metre];

I: traction current (Amps A): and

r: distance between source point and destination point (radius of streamlines).

At any determined point in space, magnetic fields of various sources may interfere with each other. The resulting magnetic field may be amplified or compensated as a result of these interferences.

It is not possible to quantify magnetic field intensity directly; rather the impact of the magnetic field (magnetic flux density) can be detected. This is dependent on the magnetic field intensity:

$$B = \mu r * \mu 0 * H$$

Where:

B: magnetic flux density (measured in Tesla [T]);

μ0: absolute permeability (physical constant);

μr: relative permeability (coefficient of materials).

Selection of representative locations
Four locations along the proposed alignment have been chosen for detailed investigation of EMI. These locations are:

- Seatown Stop (at-grade);
- Albert College Park (cut and cover tunnel);
- Mater (bored tunnel and stop);
- Rotunda Hospital (bored tunnel).

For each of the above locations, specific factors, such as depth of the tunnel sections and distance to housing areas were identified and taken into consideration. The modelling results for these four locations are representative of that which will be experienced across the entire scheme.

Identification of representative scenarios
To cater for the variation and combination of EMI from different LMVs, the calculations for the foreseeable worst case levels are based upon the following operational scenarios:

- one LMV starting and accelerating (peak current) on one track at the same time as one LMV is running at maximum speed (continuous current) on the other track (This is a pessimistic worst case traction power demand at the same longitudinal location on both tracks along the alignment);
- traction power supply system is fed from only one substation (e.g. in case of maintenance), the traction current of both tracks will be in the same direction

During normal operation the traction power supply is fed from two substations (one at each end of each section), which means that the electric loads are split/shared between two adjacent substations.

For completeness, the emergency failure condition of a short circuit failure of the OCS system has also been considered.

Predicting the magnetic fields for the chosen scenarios and locations
The electromagnetic calculations carried out were based upon the key assumptions set out in Table 6.4 and 6.6. The results are set out in Table 6.7 to 6.11.

Table 6.4 LMV Performance

	Per LMV	Per train (Two coupled LMVs)
Peak Current	1800A	3600A
Continuous RMS Current	1200A	2400A
Maximum braking current	1800A	3600A

Table 6.5 Power Supply Performance

Maximum short circuit current	20000A

Table 6.6 Track and OCS Parameters

Vehicle width	2.4 metres
Track gauge	1435 mm
Track centre distance	4 – 10 metres
Contact wire height	6.0 metres (at grade) and 3.9 metres (within tunnel)

Table 6.7 EMI at Seatown – Normal Operation

Normal operation	1 x 3600 A and 1 x 2400 A	1 x 3600 A and 1 x 2400 A
Destination point	Ground floor of residential houses next the alignment	First Floor of residential houses next the alignment
Distance between top of rail and destination point	20 metres (vertical [y]) and 0 metres (horizontal [x])	20 metres (vertical [y]) and 4 metres (horizontal [x])
Load current	2800A	2800A
EMI	38.1 μT	39.5 μT
Impact magnitude	medium	medium

Table 6.8 EMI at Seatown – Fault Operation

Fault operation	20 000 A	20 000 A
Destination point	Ground floor	First floor
Distance between top of tail and destination point	20 metres (vertical [y]) and 0 metres (horizontal [x])	20 metres (vertical [y]) and 4 metres (horizontal [x])
Load current	20 000A	20 000 A
EMI	129.9 μT	129.9 μT
Impact magnitude	high	high

Table 6.9 EMI at Albert College – Normal Operation

Normal operation	1 x 3600 A and 1 x 2400 A
Destination point	Ground floor
Distance between top of rail and destination point	30 metres (vertical [y]) and 9.7 metres (horizontal [x])
Load current	2800A
EMI	7.4 μT
Impact magnitude	low

Table 6.10 EMI at Mater Hospital – Normal Operation

Normal operation	1 x 3600 A and 1 x 2400 A
Destination point	Ground floor
Distance between top of rail and destination point	100 metres (vertical [y]) and 25.5 metres (horizontal [x])
Load current	3600A
EMI	0.6 μT
Impact magnitude	low

Table 6.11 EMI at Rotunda Hospital – Normal Operation

Normal operation	1 x 3600 A and 1 x 2400 A
Destination point	Ground floor
Distance between top of rail and destination point	0 metres (vertical [y]) and 22.9 metres (horizontal [x])
Load current	3600A
EMI	15.3 μT
Impact magnitude	medium

Extrapolating of the obtained results to assess the potential risk along the entire alignment

The results presented in the tables above show that during normal operations, the electromagnetic impact of the proposed scheme is low and medium, which results in a small increase in the electromagnetic environment in the vicinity of the proposed scheme.

Whilst, a 'hard' short circuit failure of the OCS system (failure condition) leads to a high impact magnitude, this is an extremely unlikely event. This type of fault has never occurred on the Luas scheme since this system commenced operations. If this fault did occur, the duration of the failure would last no longer than 20ms, (the time it takes for the fault to be detected and switched off). This means, that only very short peaks of magnetic fields would occur.

6.4.4 Summary of residual impacts

The technical design of the proposed scheme conforms to current best practice. The described radiation impacts can be regarded of Low significance and do not present any significant safety risk. The potential for significant impacts to occur due to stray current is considered to be low provided that the mitigation measures detailed in Section 6.4.2 are put in place.

07 HUMAN BEINGS: TRAFFIC

This chapter of the EIS examines the transportation impact of the proposed scheme. The impacts on vehicular, pedestrian and cycling traffic and safety arising out of the construction and operation of the proposed scheme are described for Area MN103.

7.1 INTRODUCTION

The proposed scheme will have a city wide impact on traffic movement during its construction and operational phases. The impacts will be very beneficial during its operational phase as there will be a general reduction in the number of cars on the road network as some car users will switch to use the proposed scheme. However, the impact will be negative during its construction phase as the construction programme and activity would create considerable levels of traffic disruption, without the introduction of the mitigation measures described herein.

As the cumulative impact of the proposed scheme can only be understood through a strategic understanding of the impact, it is necessary to firstly examine the predicted impacts of the construction and operational phases for the full alignment, as this will inform the local area impact. To fully understand the true extent of the transportation impact, the assessment is, therefore, presented in a two tier manner. The first tier presents the strategic nature of the impact and the second tier presents the localised impact.

The strategic assessment involves identifying the impact of the proposed scheme in its entirety for both construction and operational phases. This provides an understanding to the extent of the zone of influence the impact has and informs on the requirement for overarching strategic mitigation measures. The second tier impact assessment focuses on each of the designated assessment areas and provides a more detailed understanding of the localised impact on all modes of transport.

The predicted construction impact of the proposed scheme could be significant without mitigation measures, as some of the stops will be constructed in sensitive areas where there are high levels of transportation activity. The construction methodology and programme takes cognisance of the potential construction impact on all road users, and has evolved to a point where the potential impact has been minimised to the furthest extent possible. Inherent within the construction methodology and programme of the proposed scheme are generic objectives and associated mitigation measures that aim to minimise the overall strategic transportation impact on all road users. The strategic mitigation measures are also applicable to the operational phase of the proposed scheme.

The strategic mitigation measures are needed to ensure transportation impacts are minimised for all road users throughout the proposed alignment during both construction and operational phases. On an area by area level, further additional mitigation measures will be required to cover localised transportation impacts not addressed within the strategic mitigation measures.

7.1.1 Transport assessment methodology

Figure 7.1 illustrates the transportation assessment methodology. The stages of the methodology are as follows:

Stage 1 of the process is the Impact Assessment Criteria which defines the parameters against which the impact is measured. These criteria were derived from international best practice and industry standard guidelines. A categorisation of effects was established against which the impacts of the construction and operation of the proposed scheme could be assessed on a strategic and local level. These criteria inform both the Strategic Assessment of the Full Alignment and the Area by Area Impact Assessment.

Stage 2 is the Strategic Assessment of the Full Alignment. Within this stage a comprehensive Strategic Mitigation Methodology was developed for the full alignment, the aim of which is to establish traffic management principles that will ensure that the impact of the proposed scheme will be minimised as much as possible. The predicted strategic impact then focuses on traffic statistics, traffic flow change and re-distribution, journey time and speed differences in order to demonstrate the predicted impacts of construction and operation. Following this assessment, recommendations for a series of further mitigation measures are identified in order to reduce the severity of the construction impact.

Stage 3 is the localised impact assessment on all road users which presents the predicted impact of the proposed scheme within each study area. A local area assessment is presented for each study area to identify the severity of the construction and operational impact. A detailed assessment is made of the impact on general traffic movements, access requirements, public transport services, the pedestrian and cycling environment and on the impact of construction and background HGV traffic on each area. Further area specific mitigation measures, not covered by the strategic mitigation methodology, are presented to address the impact on the local area. Finally, when all mitigation measures have been considered the residual impacts on a local area basis are identified.

7.1.2 Structure of transportation assessment section

The transportation assessment section is structured as follows:

- Impact Assessment Criteria;
- Strategic Mitigation Methodology;
- Predicted Strategic Impact;
- Strategic Further Mitigation;
- Predicted Local Area Impact;
- Local Further Mitigation Measures.

Transportation Mitifgation Methodology

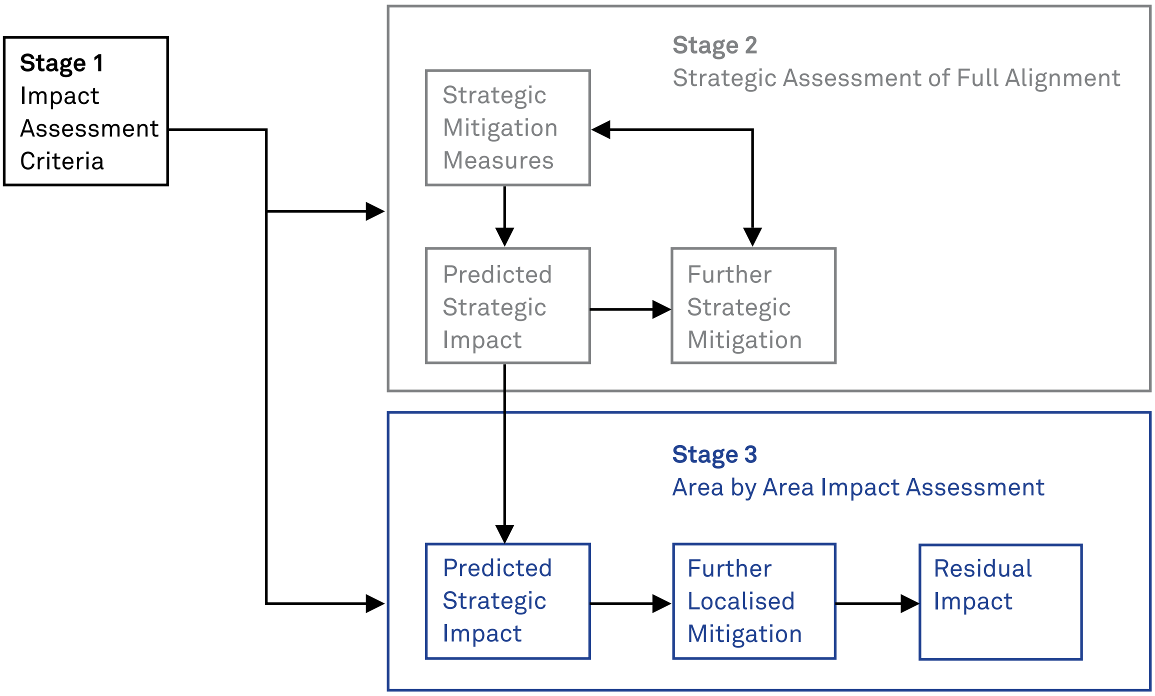


Figure 7.1 Transportation impact assessment process

7.2 IMPACT ASSESSSMENT CRITERIA

The Impact Assessment Criteria are based on advice contained in EIS guidance sources. Among the most important references are the Environmental Protection Agency's 'Guidelines on the information to be contained in Environmental Impact Statements (2002)', and the UK Department of Transport's 'Design Manual for Roads and Bridges' (DRMB Volume 11) which offers comprehensive advice for the staged assessment of major road schemes. Detailed information on the developing engineering design is used to 'scope' the potential key issues relating to vehicular and pedestrian traffic. The Impact Assessment Criteria are categorised as follows:

- Data sources used;
- General Assessment Criteria used for the Transport Assessment;
- Categorisation of Effects;
- Impact on Vehicular Traffic (Vehicular Traffic can be classified as all mechanised modes using the road network including: Car, Light Vehicles, Heavy Goods Vehicles, Buses and Taxis);
- Criteria for Driver Delay;
- Impact on Pedestrian and Cyclist Amenities;
- Impact of Severance on Pedestrians and Cyclists;
- Consideration of Impact on Vehicular, Pedestrian and Cyclist Traffic and Safety.

7.2.1 Data sources

The principal sources of data for pedestrian and vehicular traffic, for accidents, and for transportation modelling are as follows:

7.2.1.1 Traffic data (vehicle flows)

The principal source of traffic data for the assessment is the the proposed scheme Traffic Model (MNTM), a traffic model developed specifically for the task of assessing the traffic related impact of the proposed scheme for both construction and operational years. This has been supplemented by individual traffic link and junction counts undertaken by the Railway Procurement Agency (RPA). Pedestrian and cycle counts have also been collected in sensitive areas in the city centre and Swords.

7.2.1.2 Accident data

An Garda Síochána has provided RPA with traffic accident data which in itself is derived from the National Roads Authority Accident database, for the period 2002-2006. This information, which relates to personal injury accidents, is derived from the national Garda reporting system which categorises accidents as fatal/serious/minor.

7.2.2 General assessment criteria used for the transport assessment

The criteria used for the assessment of the proposed scheme are based on EIS advice from industry standard best practice guidelines. Furthermore, the assessment is benchmarked against previous EIS assessments undertaken in Ireland and internationally to ensure that best practice has been maintained. The sources for this advice are as follows:

- The Environmental Protection Agency's 'Guidelines on the information to be contained in Environmental Impact Statements (2002)' and Advice Note on Current Practice;
- The US Highway Capacity Manual, 2000, providing advice on measuring pedestrian impact and level or service parameters for pedestrian movement;
- The UK Department of Transports 'Design Manual for Roads and Bridges' (DRMB Volume 11) which offers comprehensive advice for the staged assessment of major road schemes;
- The Institute of Environmental Management and Assessment (IEMA) – Guidelines for Traffic Impact Assessment (1994).

The advice contained within these documents forms the basis for the impact assessment of the proposed scheme.

Generally, the transport assessment for both construction and operational phases should have regard for the following:

- Data collection for vehicular, pedestrian and cyclist traffic;
- An understanding of the potential impacts generated by the proposed scheme;
- A development of mitigation measures to minimise the impact generated by the proposed scheme during both the construction and operational phases;
- An identification of predicted impacts for the construction and operational stages;
- A development of further mitigation measures (or remedial measures);
- An understanding of the additional mitigation residual impact.

Additionally, factors influencing the transport assessment during the construction phase include the:

- Sequence of construction activities and construction duration;
- Construction methodology;
- Construction compound locations.

7.2.3 Categorisation of effects

A transportation impact is determined significant by reference to the following criteria:

- The extent of the impact (the geographical area and size of population affected);
- The magnitude and complexity of the impact;
- The probability of the impact;
- The duration, frequency and reversibility of the impact.

The determination of significance rating for all road users is defined in the table below. They are categorised broadly into Slight, Moderate or Severe (see Table 7.1). Further additional significance ratings are provided for pedestrians and cyclists in Section 7.2.6.

Table 7.1 Categorisation of impact significance[1]

Level	Description
Slight	'Slight' impacts are those which, by and large, should be capable of being 'designed out' in the detailed design and construction planning. In particular, construction activity will generate many 'slight' effects that are typically of short duration and can be remedied with suitable traffic management measures and the provision of temporary bridges and footways.
Moderate	'Moderate' impacts are those which, depending on their intensity or the sensitivity of location to vehicular or pedestrian activity or the duration of the effect, should be recorded in an assessment, but which do not rank as severe themselves.
Severe	The 'Severe' level equates to impacts that are residual or of long duration, of a high magnitude and/or affecting a substantial population.

[1] Adapted from The Environmental Protection Agency's 'Guidelines on the information to be contained in Environmental Impact Statements (2002)' and Advice Note on Current Practice and The UK Department of Transports 'Design Manual for Roads and Bridges' (DRMB Volume 11) which offers comprehensive advice for the staged assessment of major road schemes.

7.2.4 Determination of impact significance on vehicular traffic

The significance of vehicular traffic impact is determined by changes to traffic flow, as follows:

- Highway links where traffic flows will increase by more than 30% (or the number of heavy goods vehicles will increase by more than 30%).
- Any other specifically sensitive areas where traffic flows will increase. (Specifically sensitive areas would include accident blackspots, conservation areas, hospitals, links with high pedestrian flows etc.).

Table 7.2 further outlines the criteria for classifying the impact of increases in traffic flows.

Table 7.2 Categorisation of impact significance for vehicular traffic[2]

Traffic Flow Increases	
<10%	Traffic flow increases directly attributable to the proposed scheme of less than 10% are not considered likely to give rise to any potential significant effects.
10% to 30%	Traffic flow increases of 10% to 30% are only considered to give rise to significant effects in specifically sensitive areas. For accidents, this is defined as any road link with more than 15 accidents in the last five year period for which data is available.
>30%	Traffic flow increases directly attributable to the proposed scheme of more than 30% are considered likely to give rise to potentially significant effects.

[2] Adapted from The Environmental Protection Agency's 'Guidelines on the information to be contained in Environmental Impact Statements (2002)' and Advice Note on Current Practice and The UK Department of Transports 'Design Manual for Roads and Bridges' (DRMB Volume 11) which offers comprehensive advice for the staged assessment of major road schemes.

7.2.5 Determination of impact significance on driver delay

A further determination of impact significance for vehicular traffic is the effect on driver delay which is deemed to exist where:

- there is predicted to be a decrease in link speeds of more than 5kph;
- there is predicted to be a increase in journey length of 500m.

7.2.6 Determination of impact significance on pedestrians and cyclists

The significance of pedestrian and cyclist movement impact is primarily determined by reference to the following criteria:

- There is predicted to be a increase in total traffic flow of more than 30% and the increase is more than 40 movements per day;
- There are 'material' levels of pedestrians;
- The sensitivity of the area is 'high' (e.g. conservation area, major community facility).

Severance can be defined as the sum of divisive effects that a project may impose on a community in terms of access to and movement between locations such as residences, workplaces, commercial/retail areas, schools, community facilities, etc. Catchment areas for community and religious facilities can be established by reference to parish boundaries. The significance of the severance impact is determined with regard to the following:

- The number of people who would be impacted;
- The presence of particularly vulnerable groups such as children, the aged or the disabled amongst those likely to be impacted.

The significance rating of pedestrian and cyclist impact is primarily determined by reference to Table 7.3.

Table 7.3 Categorisation of impact significance for pedestrians and cyclists[3]

Extent of Impact	Description
Slight	In general the current journey pattern is likely to be maintained, but there will probably be some hindrance to movement, for example: - Pedestrian at-grade crossing of a road with <8000 Annual Average Daily Traffic – AADT; - A new bridge will need to be climbed or a subway traversed; - Increases in pedestrian journeys of at least 250m
Moderate	Some residents, particularly children and elderly people are likely to be dissuaded from making trips, for example: - Two of the impacts listed under Slight; - Pedestrian at-grade crossing of a road with between 8,000 and 16,000 AADT; - Journeys will be increased by 250m to 500m
Severe	People are likely to be deterred from making trips to an extent sufficient to induce a re-organisation of their habits, for example: - Pedestrian at-grade crossing of a road with >16,000 AADT; - An increase in length of journeys of over 500m; - Three or more of the hindrances listed under slight; - Two or more of the hindrances listed under Moderate.

[3] Adapted from The UK Department of Transports 'Design Manual for Roads and Bridges' (DRMB Volume 11) which offers comprehensive advice for the staged assessment of major road schemes.

7.2.7 Consideration of impact on vehicular, pedestrian and cyclist traffic and safety

7.2.7.1 Baseline environment

The proposed scheme penetrates a large number of areas with very different environments. These environments vary in terms of the road network, the existing concentration of traffic movements and the existing make up of that traffic (i.e. cars, pedestrians, cyclists, buses).

The assessment of vehicular and pedestrian traffic and safety, for each of the seven areas, is carried out with regard to the following inputs:

- All day traffic flows at locations along the full alignment;
- Public transport infrastructure and services;
- Pedestrian counts in areas of high pedestrian concentrations;
- Cyclist counts;
- Accident history along the full length of the proposed alignment.

Construction phase
The construction phase will include utilities diversions and enabling works, which, by their nature are of short duration and will have localised impacts which will be mitigated. This phase also includes the main construction works for the proposed scheme, which are of longer duration and which have a potentially greater impact along the full length of the proposed scheme. The assessment therefore considers the main construction works.

The transport and traffic assumptions and modelling assessment undertaken represent a conservative view of the likely traffic conditions that will be experienced during the construction phase of the proposed scheme. The construction phase at each construction site (at a road junction or stop location) that is considered to have the most potentially significant impact on traffic was modelled. In reality the construction phases for each site that have the most significant impact on traffic movement are very unlikely to occur in tandem. However to ensure a robust traffic assessment and to ensure that mitigation requirements are not underestimated it was viewed as essential to examine worst case construction impact scenario. For the purposes of assessing the impact during construction, worst case scenarios are assumed. The construction assumptions are as follows:

- The phases of construction that will have the most severe impact at key junctions occur concurrently;
- Network changes including infrastructure/road closures/ prohibited turning movements and other traffic restrictions are implemented;
- Construction Strategy – maximum length of time that specific areas will be affected;
- Construction vehicle routes and volumes – peak construction vehicle movements occur at each stop simultaneously.

The assessment of the impact on vehicular and pedestrian traffic and safety, for each of the seven areas, is carried out with regard to the following:

- Modelled traffic flows (AM Peak 08:00 to 09:00) extracted from the MNTM;
- Public transport infrastructure and services;
- Pedestrian and cyclists;
- Mobility Impaired / Disabled (MID);
- Access and servicing requirements.

Operational phase
The assessment of impact on vehicular and pedestrian traffic and safety during the opening year (2014) and forecast year (2029), for each of the seven areas, is carried out with regard to the following inputs:

- Modelled traffic flows (AM Peak 08:00 to 09:00) extracted from the MNTM;
- Modelled traffic flows (Off-Peak 14:00 to 15:00) extracted from the MNTM;
- Road network changes;
- Traffic management alterations;
- Public transport infrastructure;
- Details of pedestrian facilities – pedestrian bridges, crossing locations, etc;
- Details of cycle facilities – cycle lane provision and cycle parking;
- Mobility Impaired / Disabled (MID);
- Access and servicing requirements

7.3 STRATEGIC MITIGATION METHODOLOGY

7.3.1 Introduction

This Mitigation Methodology forms the basis for developing a comprehensive set of mitigation measures to minimise the impacts generated by the proposed scheme during both construction and operational phases. Mitigation measures are defined for any adverse impacts that are deemed to be of Moderate or greater significance prior to mitigation. The extent to which mitigation is needed increases as the severity of the impact increases.

7.3.1.1 Mitigation objectives

As it is anticipated that the construction phase of the proposed scheme will have a greater impact than the operational phase, a greater emphasis has been placed on construction mitigation objectives, although many are also applicable to the operational phase.

Light Metro Vehicles (LMVs) and HGV

- Minimise impact on current delivery arrangements for affected businesses;
- Minimise impact on current levels of on-street car parking provision;
- Maintain access to all off-street car parks;
- Minimise impact on quality of access/egress to off-street car parks;
- Minimise impact on current car journey times.

Buses

- Minimise impact on current bus service coverage;
- Minimise impact on current bus stop facilities;
- Minimise impact on current bus journey times;
- Minimise impact on routes between bus garages and termini;
- Minimise impact on current conditions on bus paths for turnaround of buses at the end of their routes.

Taxis

- Minimise impact on current taxi service coverage;
- Minimise impact on taxi passengers.

Pedestrians and cyclists

- Maintain a safe environment for pedestrian and cyclist movement in the vicinity of each construction site;
- Maintain pedestrian access to all buildings in the vicinity of construction works;
- Minimise impact to pedestrian and cycle networks.

Emergency vehicles

- Maintain emergency service access to all buildings in the vicinity of construction works;
- Minimise impact to current emergency services journey times.

Mobility impaired

- Ensure full mobility impaired/disabled (MID) compliance for all facilities.

7.3.1.2 Categorisation of mitigation measures

According to the EPA Guidelines, the central purpose of the Environmental Impact Assessment is to identify potentially significant adverse effects/ impacts at the pre-consent stage and to propose measures to mitigate or ameliorate such impacts. There are two established strategies for impact mitigation which are used for this assessment, namely reduction and remedial measures. The difference between these two measures is highlighted by the examples given below:

- Strategic Reduction Measures – e.g. introduction of the proposed scheme Traffic Management Plan prior to construction of the proposed scheme;
- Strategic Remedial Measures – e.g. adjustment of traffic signals to improve traffic flow;
- Localised Reduction Measures – e.g. reduce the construction area in order to maintain a footpath;
- Localised Remedial Measures – e.g. when the construction area covers the footpath resulting in its closure, then the impact will be lessened by widening the opposite footpath.

In general, strategic reduction mitigation occurs before construction, while remedial measures are implemented during construction on an on-going basis. Mitigation is mainly achieved by remedial measures i.e. measures which can be put in place to negate the impacts of the proposed scheme on the environment.

Maintaining the safety of all road users is the primary objective during the construction of the proposed scheme; and is considered in the preparation of recommendations for mitigation measures.

In order to successfully limit the impact of the construction period on the environment, a number of key mitigation measures are required, as outlined in the following sections.

7.3.2 Strategic construction mitigation measures

The mitigation required during the construction phase of the proposed scheme will be substantial. Due to the scale of the proposed scheme and its associated construction impact, it is important to develop an overarching Mitigation Methodology covering the full alignment of the proposed scheme. The aim of the methodology is to establish traffic management principles that will ensure that the construction impact of the proposed scheme will be minimised to the greatest extent possible. The principles of the Mitigation Methodology must be adhered to by the contractor. As part of the development of the Mitigation Methodology, international best practice guidelines were reviewed to produce a comprehensive list of mitigation objectives and an associated set of mitigation measures which can be applied to achieve them. These are outlined below.

7.3.2.1 Reduction measures (construction phase)

Reduction measures – general

- Construction of the proposed scheme will lead to some level of disruption throughout the study area. A number of mitigating measures have been proposed to address the impacts of the construction phase, which will minimise hindrance to general activity in the area while allowing the construction period to be progressed as fast as is feasible. Appropriate safety measures will be put in place to mitigate in general any safety risks to the general public. A scheme of traffic management measures will be adopted to manage traffic impacts. Development of this scheme will involve on-going consultation with all relevant stakeholders including Dublin City Council, Fingal County Council, Dublin Bus, the Dublin Transportation Office, An Garda Síochána, Dublin Chamber of Commerce, Dublin City Business Association, etc;
- Prior to the commencement of each construction phase, the necessary enabling works will be implemented. These will primarily take the form of additional road works and traffic signal changes;
- Co-ordination by RPA representatives of works by the utility companies and their contractors;
- Co-ordination by RPA representatives of the works of the infrastructure contractor;
- Prior to the commencement of the construction phase, a comprehensive publicity campaign will take place. This campaign will be launched through the local and national press and through radio and the internet, and will provide updates on the progress of the construction phases and on further mitigation measures that may be needed during the course of the construction programme. Overall, the public information campaign will inform the general public on:
    - The envisaged city centre traffic management plan (road closures, designated diversionary routes for general traffic, new bus routings and stop locations, new access arrangements, new taxi rank locations and pedestrian and cycling infrastructure);
    - The enabling works required before construction work commences and the associated timeframe;
    - The construction programme, including timeframe, construction vehicle routes, working hours and works areas;
    - The other general mitigation measures required to minimise the disruption;
    - To ensure a coordinated response to the construction activities, there will be frequent communication with, and information exchanged between interested parties (i.e. Local Councils, National Roads Authority, Local Chamber of Commerce, etc);
    - All traffic management implementation measures will be discussed and agreed with the relevant roads authorities, An Garda Síochána and other agencies such as the National Roads Authority as required.

Reduction measures – construction traffic

- Construction vehicles routes have been identified to direct construction traffic onto suitable roads, and to minimise the negative effects of increased HGV traffic on the environment;
- There will be strict controls and regulations at the entrance/exits of sites for construction vehicles in order to ensure the safety of other road users.

Reduction measures – general traffic

- Where practicable, construction work requiring short term disruption and road closures will be undertaken at times that minimise their impact, and will be agreed with the relevant planning and roads authority;
- Temporary ramps across trenches may be provided to facilitate the movements of diverted traffic.

Reduction measures – pedestrians and cyclists

- Pedestrian routes will be maintained throughout the construction period, either around or through the construction site, where safety risks to the general public will not increase as a result of construction activity;
- In very sensitive areas, such as the city centre, the designated access and pedestrian routes around the construction sites, particularly at and/or along the hording lines, must not be perceived as uninviting by pedestrians. The environment around the sites, therefore, will be designed to ensure that pedestrians and cyclists feel they are entering a safe and accessible environment. This will ensure that impact to businesses and shops adjacent to the works areas is minimised.

7.3.2.2 Remedial measures (construction phase)

Where significant adverse effects on the environment are identified, the impact will be limited by undertaking remedial works.

Remedial measures – general

- Alternative arrangements will be provided if road closures are unavoidable i.e. diversions, signage strategies for access traffic and through traffic;
- The Dublin City Council urban traffic signal control system will be used to optimise the flow of traffic along the diversion routes to mitigate queuing and delay which would otherwise be expected during peak periods. This may affect the level of green time afforded to pedestrians;

- Agreement will be sought from the relevant road authority and An Garda Síochána for the introduction of stricter speed limits on roads adjacent to construction sites to ensure the safety of all road users:
  - 50kph speed limit in the city centre will be reduced to 30kph;
  - 80kph on all other routes will be reduced to 50kph.
- The public will be provided with advanced warning of any proposed diversions and disruption through:
  - Signage on site;
  - Continuous updates on construction progress on the project website and external media.
- Temporary reinstatement of road surfaces to facilitate pedestrians, cyclists and MIDs will be provided;
- There will be safety procedures and fencing around trenches at all times in order to ensure the safety of road users.

Remedial measures – construction traffic
- Construction vehicles will be covered to ensure loss of material is minimised;
- Wheel wash facilities or road cleaning will be provided at work sites, as required;
- The numbers of employee vehicles travelling to and from construction sites on a daily basis will be limited through:
  - Car sharing;
  - Transporting workers to site via car pools and mini-buses from designated collection points (such as Luas and DART stations or other appropriate locations);
  - Offering subsidised travel via public transport.

Remedial measures – general traffic
- To maintain traffic flow and minimise delay, the introduction of traffic management measures will be implemented as agreed with the road authority and An Garda Síochána, including prohibitions of turning movements, loading and waiting restrictions, reconfiguration of traffic signals etc.

Remedial measures – public transport
- The requirement and potential for additional mitigation measures to facilitate enhanced public transport operations along the corridor to encourage a transfer from car to public transport will be examined;
- Bus stops affected by the construction of the proposed scheme will be temporarily relocated in order to ensure the safety of passengers and the continued operation of services.

Remedial measures – pedestrians and cyclists
- Temporary pathways and cycle tracks will be installed where appropriate and provision will be made to ensure access for the mobility impaired is maintained;
- Where the existing level of service cannot be maintained in the vicinity of the construction sites, an alternative route will be designated, be clearly visible, be safe and be signed and have the level of service required to cater for the pedestrian demand.

7.3.3 Strategic operational mitigation measures

During its operational phase, the proposed scheme will have an overall beneficial impact on traffic. There may, however, be localised increases in traffic volumes around each stop associated with increased pedestrian activity, Park & Ride, and drop off facilities.

The aim of the Strategic Mitigation Methodology is to establish traffic management principles that will ensure that the operational impact of the proposed scheme will be minimised as much as possible.

7.3.3.1 Reduction measures (operational phase)

Reduction measures – pedestrians and cyclists
Subject to agreement of the relevant road authority and An Garda Síochána, where necessary, the following measures will be implemented:

- The number of pedestrian crossing facilities will be increased in the immediate vicinity of stops where appropriate;
- Sufficient pedestrian access between the drop-off points and the stops will be provided where appropriate;
- Suitable parking and storage facilities for bicycles will be provided in prominent locations at Stops and Park & Ride facilities for public use.

Reduction measures – public transport
- At designated stops, bus and car interchange facilities will be provided;
- Enhanced bus priority facilities will be introduced at selected locations, subject to agreement with the relevant roads authority.

Reduction measures – mobility impaired
- All proposed pedestrian crossing facilities installed will incorporate audio/tactile units to facilitate mobility and visual impaired persons;
- Adequate ramps / lifts will be provided at each stop platform to enable access for mobility impaired / disabled persons;
- Mobility impaired / disabled compliance will be ensured at stops and Park & Ride facilities.

7.3.3.2 Remedial measures (operational phase)

Remedial measures – general traffic

- Variable Message Signs will be located at appropriate locations to advise motorists on appropriate access routes to the Park & Ride sites, and on available car park capacity at the site;
- The Dublin City Council urban traffic signal control system will be used to optimise the flow of traffic along the routes, particularly during peak traffic times, to reduce the impact of queuing and delay during the operational phase.

Remedial measures – pedestrian and cyclists

- Appropriate signage will be installed to advise pedestrians of appropriate crossing locations and access routes to each stop.

7.4 PREDICTED STRATEGIC IMPACT

7.4.1 Introduction

The proposed scheme will have both a local and strategic impact on all road users. The scale of the proposed scheme, its anticipated construction impact footprint and the envisaged operational benefits means that there will be a significant predicted impact during both construction and operational phases. There will either be considerable vehicular re-assignment away from roads where construction is taking place or, during its operational phase, reductions in car numbers within the study area. The cumulative impact of the proposed scheme can only be understood through a strategic understanding of the impact.

7.4.2 Source of the predicted strategic impact

The proposed scheme will have two very distinct impact phases. The construction phase could have significant negative impacts on all road users, which will be limited through the introduction of mitigation measures. During the operational phase the proposed scheme will have very significant beneficial impacts. Understanding, managing and reducing the impact generated by the construction phase of the proposed scheme is of particular importance to ensure that general traffic can move at reasonable speeds and that vulnerable road users can move in a safe manner around the construction sites. In its operational phase, understanding the strategic traffic impact is of lesser importance as the proposed scheme will generally reduce the level of traffic.

7.4.2.1 Construction phase

The construction impact is largely created by the construction of the stops, particularly in the city centre at St. Stephen's Green, O'Connell Bridge and Parnell Square where road capacity will be reduced substantially. The construction of these stops requires large areas of road space to be removed for long periods of time (for example, at Westmoreland Street and Parnell Square East) which will severely reduce the operating capacity available for all road users. Other construction activity, such as cut and cover tunnelling, through Ballymun and construction activity through junctions along the R132 in Swords will create further capacity limitations for all modes of travel in these areas. In all areas along the alignment of the proposed scheme, appropriate mitigation measures are required.

Each of the proposed scheme's construction sites will also generate substantial levels of spoil removal and construction vehicles which will impact on both the local and strategic road network. The cumulative impact of all the construction sites (and the associated number of construction vehicles generated) on traffic movement throughout the Dublin Area has been assessed. The routes proposed to facilitate construction vehicle activity are illustrated in Annex I of this EIS (Volume 3, Book 2 of 2).

The combination of the construction site impact and the construction vehicle activity creates a situation were significant mitigation is required to create a workable transport environment within the vicinity of the proposed alignment and also in areas where vehicles re-distribute to completely avoid the construction sites.

7.4.2.2 Operational phase

The operational phase of the proposed scheme will have a substantial overall beneficial impact as it will allow people within its walking, cycling and bus interchange catchment (and those who can avail of the Park & Ride facilities at Belinstown, Dardistown and Fosterstown Stops) to use a high quality public transport service. Furthermore, during its operational phase, vehicular traffic on the surrounding road network will be reduced as some people who would otherwise have driven will use the service provided by the proposed scheme. It is estimated that the proposed scheme will remove in the region of up to 5,000 cars from the road network, in the morning peak period (07.00-09.00), during its operational phase as a result of mode shift from car to the proposed scheme.

During the proposed scheme's operational phase, some stops will generate additional pedestrian, cyclist, bus and car trips on the local surrounding road infrastructure when compared to the situation without the proposed scheme. Some level of mitigation is required to ensure that the local environment around each stop is configured to accommodate the additional demand and that complementary facilities are in place at and around each stop.

7.4.3 Assessment of the predicted strategic impact

Given the proposed scheme's length and catchment it will have a city wide impact on traffic movement during its construction and operational phases. The traffic modelling process adopted to assess the impact of the proposed scheme ensures that both local and strategic impacts are understood and mitigation measures tested. Furthermore, the impact of the proposed scheme during its operational phase will become more beneficial over time as other elements of the Transport 21 network are built which will connect with the proposed scheme thereby enhancing accessibility from within its catchment area. This will further increase its attractiveness to commuters and continue to reduce car use within the proposed scheme's catchment.

To assess the strategic impact of the proposed scheme for the construction and operational phases the following traffic modelling statistics, extracted from the MNTM, are presented:

- General traffic statistics for the full Greater Dublin Area for average network speed, queuing, distance travelled and time travelled;
- General traffic flow plots representing traffic changes between the do-minimum and do-something scenarios on strategic roads within the Greater Dublin Area;
- Journey time and speed changes on a number of key routes that will be affected by the proposed scheme;
- Strategic Bus operation speeds and queuing statistics.

Pedestrian and cyclist impacts are considered under local predicted impact, described later.

7.4.3.1 Strategic traffic statistics for Greater Dublin Area

A number of summary traffic statistics were extracted from the MNTM traffic model. These statistics include the following:

For general vehicular traffic assessment:

- Queuing – This statistic relates to the time spent in congestion within the modelled period. The units of measurement are in Passenger Car Unit (pcu) hours.
- Travel Time – This statistic relates to the time spent travelling within the modelled period. The units of measurement are in pcu hours.
- Travel distance – This statistic relates to the distance travelled by vehicles across the GDA within the modelled period. The units of measurement are in pcu kilometres.
- Average Speed – This statistics represents the average speed across the road network. The units of measurement are in kilometres per hour (kph).

For bus movement assessment:

- Average Bus Speeds – This statistic represents the average bus speed across the road network. The units of measurement are in kilometres per hour (kph);
- Bus kilometres lost to queuing – This statistic provides information on the kilometres lost to congestion in the modelled hour for buses. The units of measurement are in kilometre hours.

These statistics provide good indicators to the overall performance of the road network and, therefore, are a very useful way of presenting and understanding the overall strategic predicted impact of the proposed scheme during both construction and operational phases. The statistics are presented for the AM Peak hour (08.00-09.00) only as this time period represents a heavily congested road network and negative or positive impacts generated by the proposed scheme can be clearly identified.

7.4.4 Predicted strategic construction impact

The predicted strategic impact has been determined based on the worst case scenario without mitigation measures, but with local diversionary measures in place.

Table 7.4 shows the strategic modelled impact of the proposed scheme during its construction phase. In general, queuing, time spent travelling and distance travelled would increase as a result of the construction activities. Queuing would increase by over 22% with time spent travelling increasing by over 15%. The time spent queuing as proportion of overall travel time would increase from 24% to 27% as a result of the construction phase.

The increase in travel time and travel distance indicates that without mitigation measures there would be considerable re-routing of vehicles through the network as drivers try to avoid construction areas. This would impact on parallel routes contributing to further delay and congestion.

The average speed for travel across the network would deteriorate by over 11%, a reduction of 3kph. Based on these statistics, the strategic impact on the city wide road network during the construction phase would be Severe without the proposed mitigation measures.

Table 7.4 Strategic construction impact 2011 (AM peak hour) – general traffic

Indicator	Do-Minimum	Do-Something	% Change
Queuing Statistic (pcu hours)	21,000	25,700	+22.4%
Travel Time (pcu hrs)	86,700	100,200	+15.6%
Travel Distance (pcu kilometres)	2,190,000	2,250,000	+2.8%
Average Speed (kph)	25	22	-11.1%

Table 7.5 presents the impact of the proposed scheme without public transport mitigation measures. This would have a city wide impact on bus movement during the construction phase. The average bus speed throughout the city is predicted to decrease by 27%, a drop of 4kph. Furthermore, the bus kilometres lost to queuing per hour is predicted to increase by over 250% as a result of construction.

Table 7.5 Strategic construction impact, 2011 (AM peak hour) – bus only

Indicator	Do-Minimum	Do-Something	% Change
Bus Speed (kph)	19	15	-27%
Bus kilometres lost to queuing per hour	1,900	4,800	+252%

The traffic modelling statistics shown above clearly show that the strategic, or city wide, predicted impact of the construction phase would be Severe on all vehicular modes of transport without the proposed mitigation measures.

7.4.5 Predicted strategic operational impact

The predicted strategic impact has been determined based on the assumed scenario and traffic management measures being restored to baseline arrangements.

Tables 7.6 and 7.7 present the strategic impact of the proposed scheme during its operational phase for the assumed year of opening, 2014, and the forecast year, 2029. In 2014, the operational impact of the proposed scheme on the highway network would be very positive. The queuing, travel time and distance travelled statistics would all decrease substantially from the Do-minimum scenario. Queuing would decrease by over 21% with time spent travelling decreasing by over 9%. The time spent queuing as a proportion of overall travel time would decrease from 25% to 22% as a direct result of the proposed scheme. The average speed on the network would increase by 8% in 2014, or by 2kph.

In 2029, the statistics show a similar positive impact as 2014. In 2029, the proposed scheme forms part of a much bigger public transportation network than in 2014 (in 2029, the full Transport 21 public transportation network is assumed). Furthermore, in 2029, the demand for travel in the Dublin area is much higher than in 2014 and, therefore, the number of vehicles on the highway network is greater. This is particularly reflected in the growth in queuing between 2014 and 2029 (i.e. 23,400 to 66,500 in the do-minimum scenarios). The queuing, time spent travelling and distance travelled statistics would all decrease from the do-minimum scenario. Queuing would decrease by approximately 9% with time spent travelling decreasing by up to 32%. The average speed on the network would increase by 17% in 2029, or by 3kph.

Table 7.8 and Table 7.9 present the predicted impact during the operational phase that the proposed scheme will have on buses. In 2014, the average speed of bus increases by 6%, or 1kph. The bus kilometres lost to queuing decreases by 21%. In 2029, there is predicted to be a 14% increase in average bus speed, or 2kph. Bus kilometres lost to queuing in 2029, decreases by 10%.

Table 7.6 Strategic operational impact 2014 (AM peak hour)

Criteria	Do-Minimum	Do-Something	% Change
Queuing Statistic (pcu hours)	23,400	19,400	-21%
Travel Time (pcu hrs)	95,200	86,900	-9.5%
Travel Distance (pcu kilometres)	2,320,600	2,250,300	-3%
Average Speed (kph)	24	26	+8%

Table 7.7 Strategic operational impact 2029 (AM peak hour)

Criteria	Do-Minimum	Do-Something	% Change
Queuing Statistic (pcu hours)	66,500	60,600	-9%
Travel Time (pcu hrs)	173,700	117,800	-32%
Travel Distance (pcu kilometres)	3,155,500	2,510,300	-20%
Average Speed (kph)	18	21	+17%

Table 7.8 Strategic operational impact 2014 (AM Peak Hour) – bus only

Criteria	Do-Minimum	Do-Something	% Change
Bus Speed (kph)	18	19	+6%
Bus kilometres lost to queuing per hour	2,300	1,900	-21%

Table 7.9 Strategic operational impact 2029 (AM Peak Hour) – bus only

Criteria	Do-Minimum	Do-Something	% Change
Bus Speed (kph)	14	16	+14%
Bus kilometres lost to queuing per hour	4,100	3,700	-10%

Overall, the predicted operational impact of the proposed scheme would be very positive. In both 2014 and 2029, significant beneficial impacts are demonstrated to the road network in terms of increasing average speed, decreasing congestion and reducing the distance and time spent travelled. There would also be a very beneficial impact to bus movement as the proposed scheme reduces the number of cars on the road network reducing congestion generally and thereby allowing buses to move more freely. The positive impact of the proposed scheme will also grow over time as more elements of the Transport 21 public transport network come on stream allowing better interchange and enhancing accessibility.

7.4.6 Strategic traffic flow changes and re-distribution

Another means of presenting the strategic impact of the proposed scheme is by comparing the traffic flow changes on the highway network and ascertaining where vehicles will redistribute during construction and operational phases.

Traffic flow plots have been extracted from the MNTM traffic model and are presented in Figure 7.2 to Figure 7.17. These plots illustrate the changes in traffic flow, for different areas in Dublin, between the do-minimum and the do-something scenarios for the construction year 2011 and the operational years 2014 and 2029 respectively. The flow changes are presented in terms of coloured bandwidths, green representing an increase in traffic flow and blue a decrease in traffic flow. The thickness of the bandwidth demonstrates the proportionate level of change (i.e, the thicker the greater the increase or decrease in traffic flow).

7.4.6.1 Changes in traffic flow during construction of the proposed scheme

Figure 7.2 and Figure 7.3 illustrate the traffic flow changes in Swords and its surrounding areas. Generally, traffic would try to avoid the construction works on the R132 and divert to the other roads such as the R108, R129 and the M1. Main Street in Swords would also experience an increase in traffic flow.

Figure 7.4 illustrates the traffic flow changes across the Dublin area within the vicinity of the M50. This plot shows that without the proposed mitigation measures there would be a substantial reduction in traffic using the Ballymun Road particularly in a southbound direction as drivers would try to avoid the construction activities. The Port Tunnel becomes an attractive diversionary route for some drivers accessing the city centre and the south east city areas. Furthermore, the upgraded M50 would allow some drivers to drive longer distances to avoid the congestion caused by construction activities.

Generally, as Figure 7.4 demonstrates, there would be some increase in traffic on all areas of the city as traffic would redistribute across the road network to avoid the construction sites and to minimise journey time.

Figure 7.5 provides a more detailed view of traffic distribution changes in the Ballymun, Finglas, Glasnevin and Drumcondra areas. Generally, traffic travelling Southbound along the Ballymun Road reduces and diverts to parallel routes such as the N2, Port Tunnel and Drumcondra Road.

Figures 7.6 and 7.7 provide a more detailed view of traffic distribution changes in the city centre. Without the proposed mitigation measures there would be substantial reductions in traffic volumes on Dame Street, College Green, O'Connell Bridge, O'Connell Street and Nassau Street. There would be increases in northbound traffic on Patrick Street, High Street, Bridge Street, Church Street and on Tara Street. Southbound traffic increases would occur on Amiens Street, Talbot Memorial Bridge, City Quay, and Lombard Street. East west traffic movements on the north and south quays would also increase particularly on Georges Quay, Burgh Quay, Eden Quay and Custom House Quay.

Other areas of the city experiencing increases in traffic flow include Bridgefoot Street and Queen Street to the west and East Wall Road to the east.

In summary the city wide predicted impact of the construction phase on vehicular routing would be extensive. Drivers would look for quicker alternative routes through the city, in all areas, avoiding the construction sites to complete their journey.

7.4.6.2 Changes in traffic flow during operation of the proposed scheme

During the operational phase of the proposed scheme the impact on traffic flow would be a general reduction in the levels of traffic within the areas served by the proposed scheme. This will be more pronounced in outlying areas such as Swords were the existing public transport service is poor and car use is high, particularly for commuting. In other areas further into the city served by the proposed scheme the impact on car use would be reduced as some users would transfer from other public transport modes such as bus.

Figure 7.8 presents the traffic flow distribution pattern for the Swords area for the opening year of the proposed scheme. Generally, the R132 experiences a reduction in traffic flow as a result of the proposed scheme. The increases in traffic flow on the M1 can be attributed to a redistribution of general traffic availing of increased road capacity which would be created by the modal shift from car to the proposed scheme.

Figure 7.9 provides a view of the traffic flow changes in the Ballymun, Glasnevin, Finglas and Drumcondra areas. There are general reductions in traffic flow on the M50, M1, Port Tunnel, Ballymun Road, Finglas Road and on many other roads within the catchment area of the proposed scheme corridor.

Figures 7.10 illustrates the traffic flow and distribution impact of the proposed scheme from a city wide perspective. There are reductions in traffic flow on the M50.

Figure 7.11 and 7.12 illustrate the impact on traffic flow and distribution in the city centre. Generally the impact of the proposed scheme within the city centre area in terms of reducing traffic flow would be positive. In 2029, the traffic flow changes and distribution results are similar to those of 2014. Figures 7.13 to 7.17 illustrate these changes from Swords to the city centre. The impact of the proposed scheme in 2029 would be positive in terms of reducing traffic flow within the catchment area.

Figure 7.2
Traffic flow changes – do-minimum vs. do-something 2011 (Swords area)

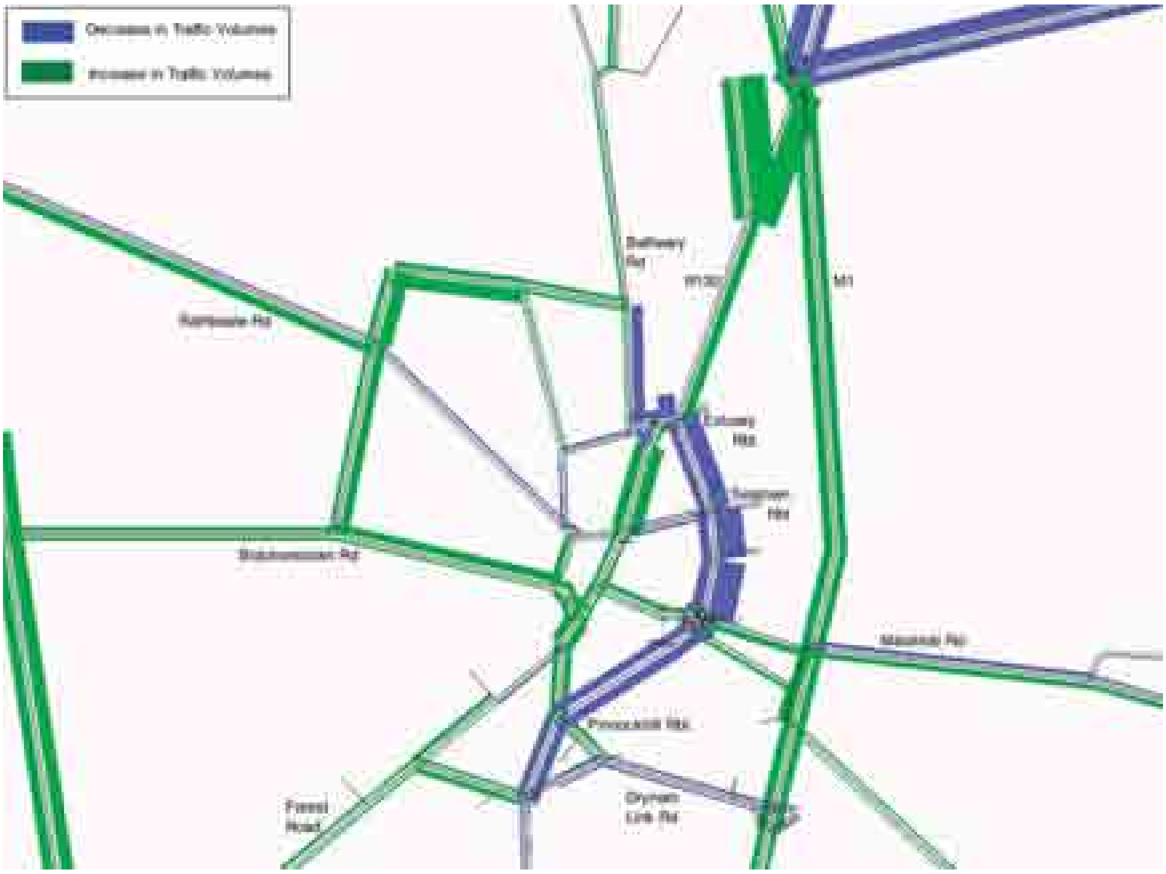


Figure 7.3
Traffic flow changes – do-minimum vs. do-something 2011 (Swords area)

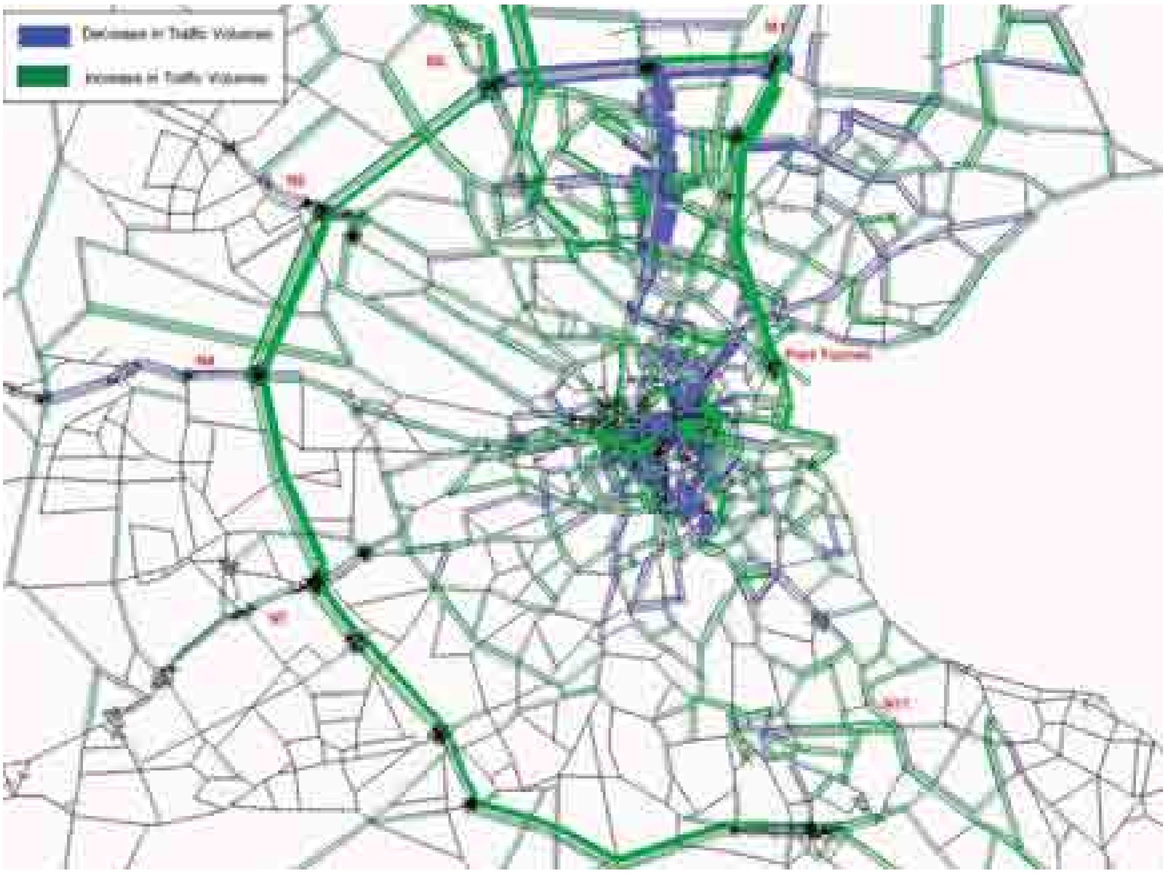


Figure 7.4
Traffic flow changes – do-minimum vs. do-something 2011 (city wide area)

Figure 7.5
Traffic flow changes – do-minimum vs. do-something 2011 (Ballymun/ Glasnevin/ Finglas/ Drumcondra areas)

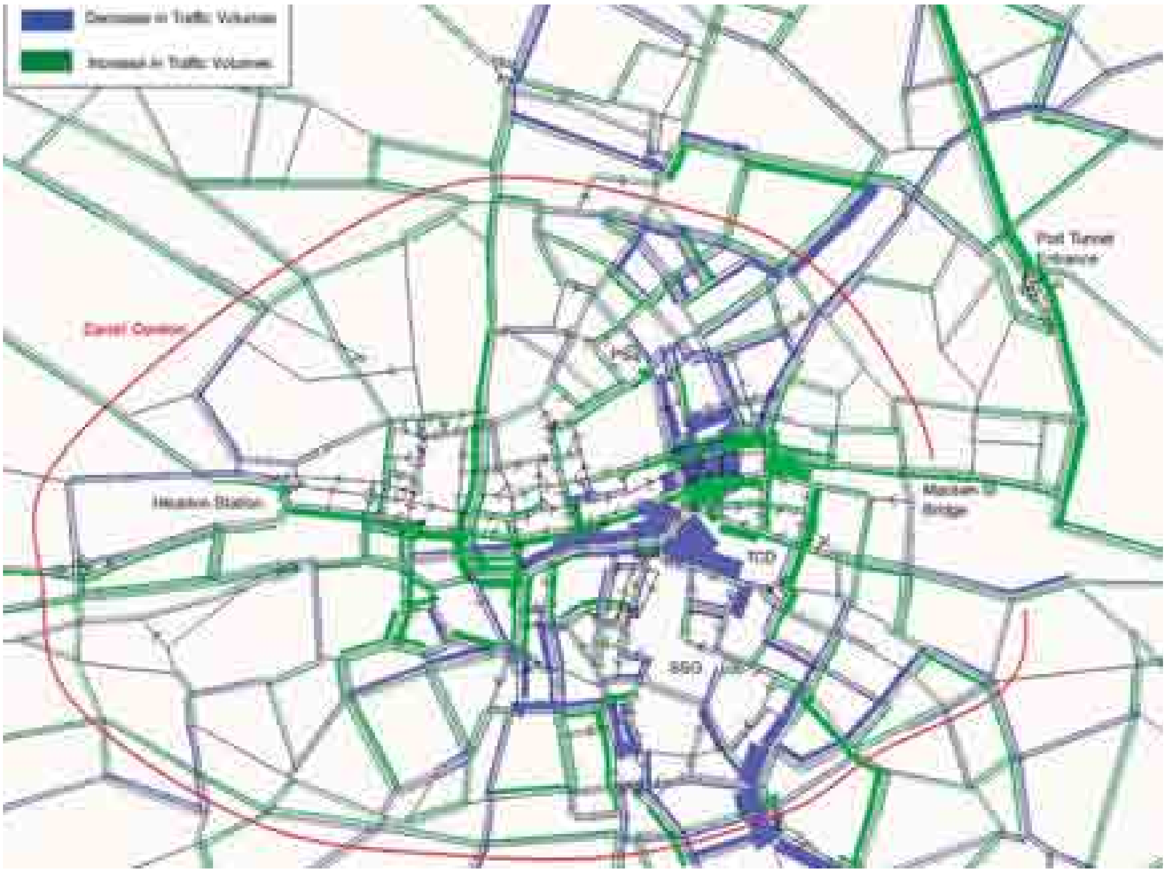


Figure 7.6
Traffic flow changes – do-minimum vs. do-something 2011 (city centre area)

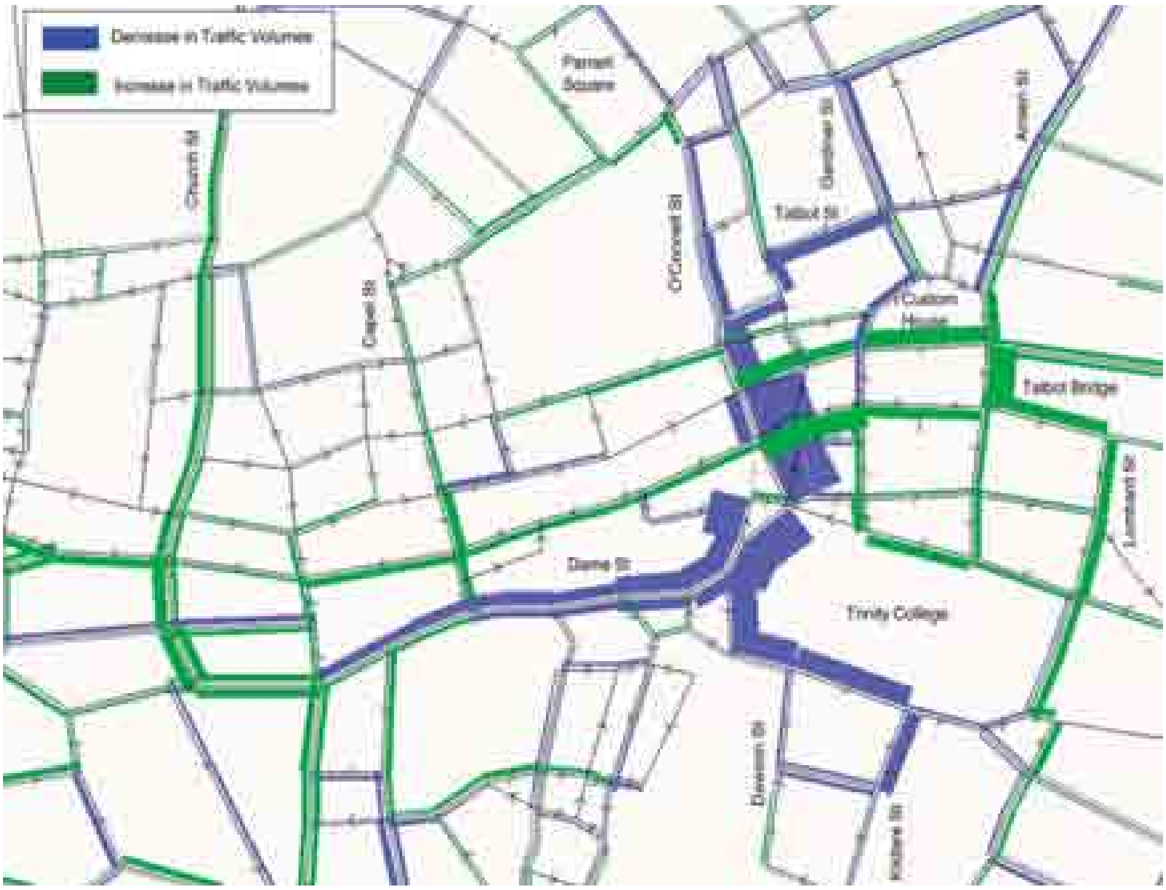


Figure 7.7
Traffic flow changes – do-minimum vs. do-something 2011 (core city area)

Figure 7.8
Traffic flow changes – do-minimum vs. do-something 2014 (Swords area)

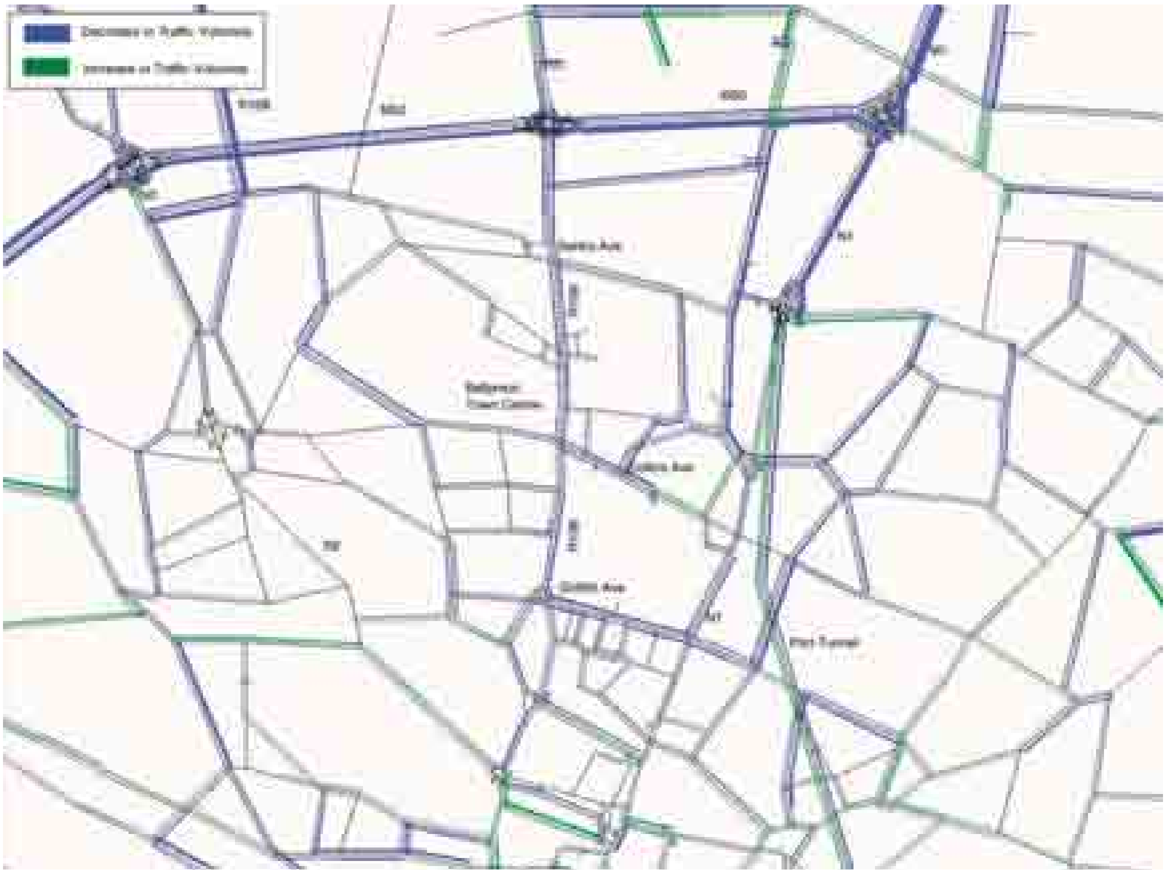


Figure 7.9
Traffic flow changes – do-minimum vs. do-something 2014 (Ballymun/ Glasnevin/ Finglas/ Drumcondra area)

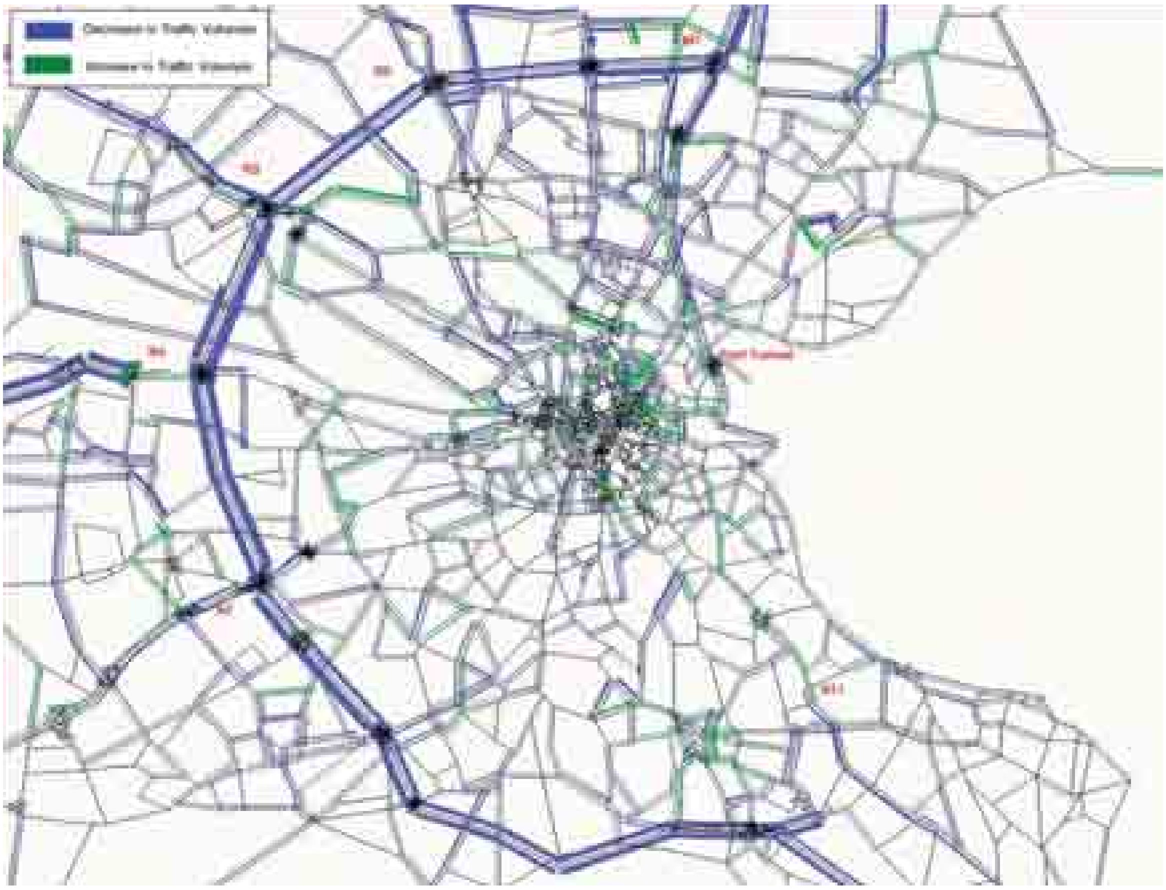


Figure 7.10
Traffic flow changes – do-minimum vs. do-something 2014 (city wide area)

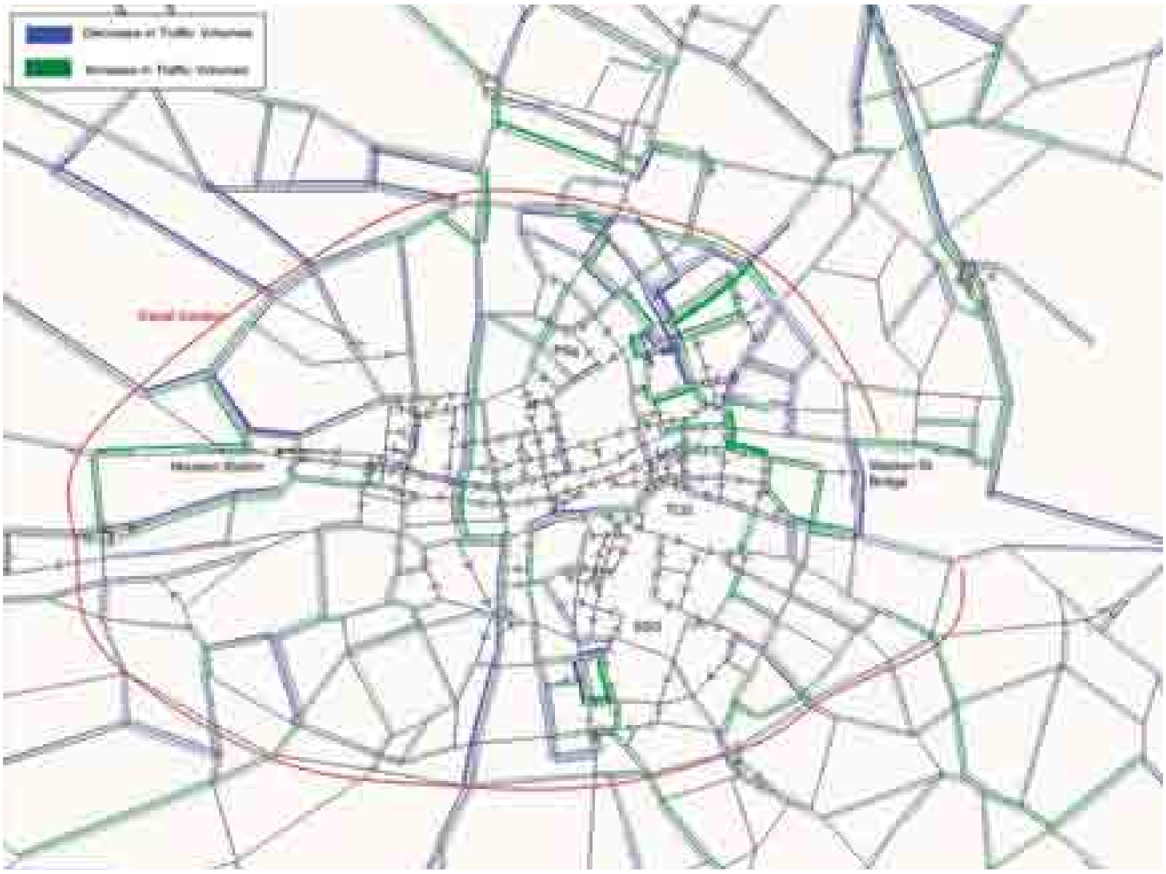


Figure 7.11
Traffic flow changes – do-minimum vs. do-something 2014 (city centre area)

Figure 7.12
Traffic flow changes – do-minimum vs. do-something 2014 (core city area)

Figure 7.13
Traffic flow changes – do-minimum vs. do-something 2029 (Swords area)

Figure 7.14
Traffic flow changes – do-minimum vs. do-something 2029 (Ballymun/ Glasnevin/ Finglas/ Drumcondra area)

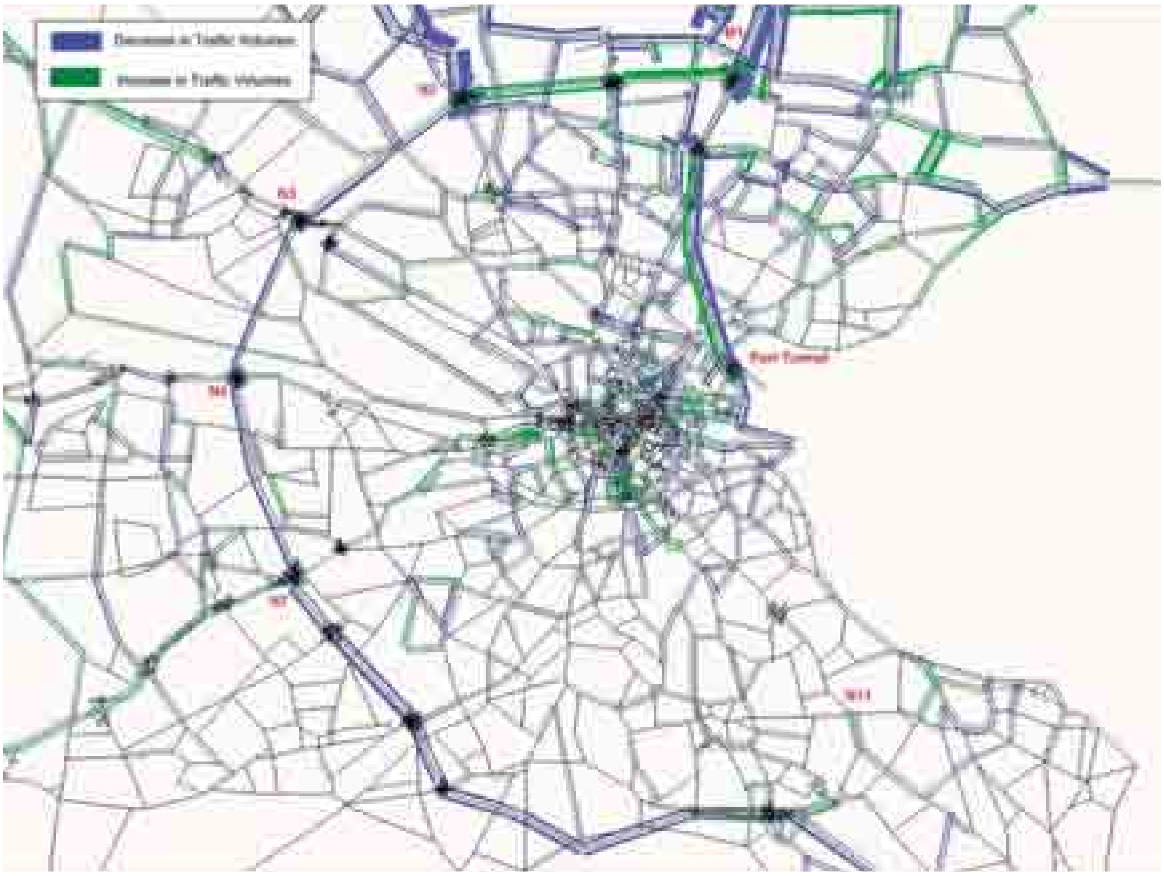


Figure 7.15
Traffic flow changes – do-minimum vs. do-something 2029 (city wide area)

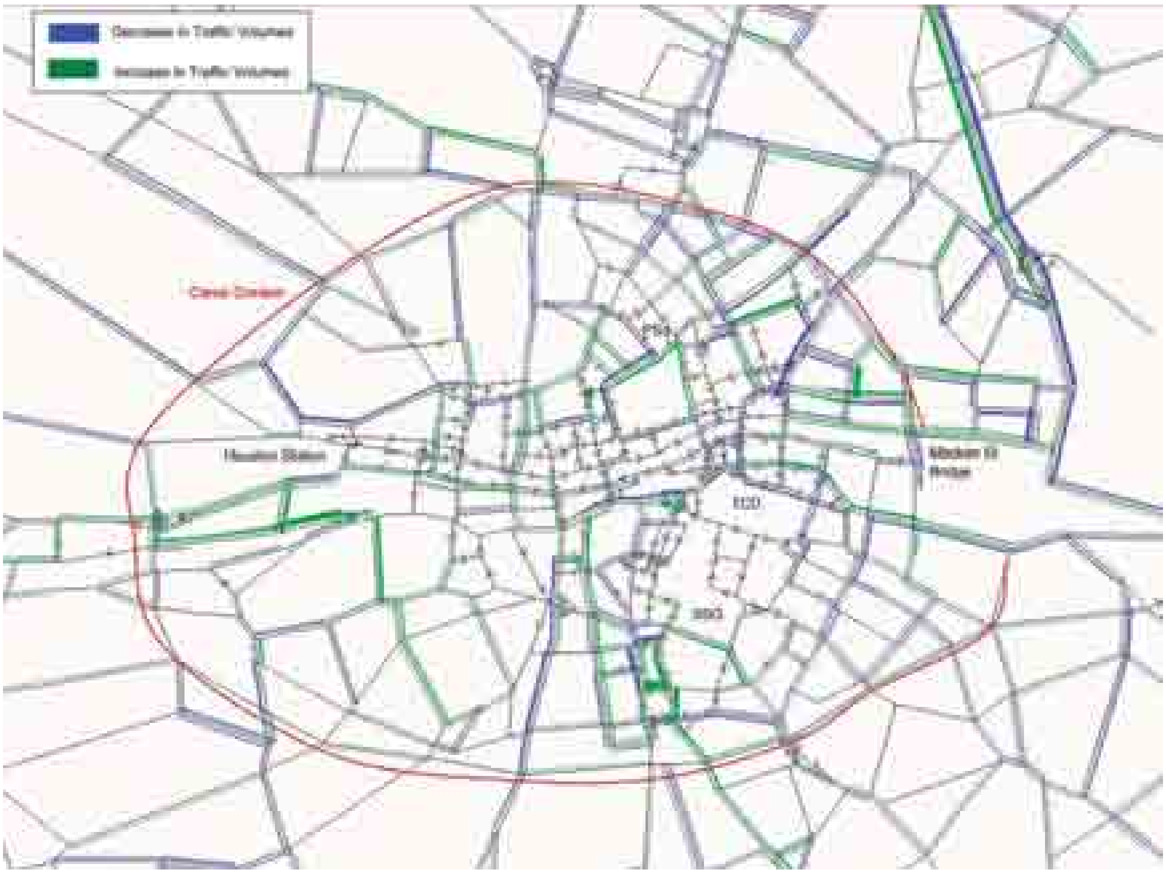


Figure 7.16
Traffic flow changes – do-minimum vs. do-something 2029 (city centre area)

Figure 7.17
Traffic flow changes – do-minimum vs. do-something 2029 (core city area)

7.4.6.3 Journey time and speed changes along key routes

A further method of demonstrating the predicted impact of the proposed scheme is through the assessment of journey times along key radial and orbital routes. Journey time statistics for a number of key radial and orbital routes in the vicinity of the proposed scheme have been extracted from the MNTM traffic model for the do-minimum and do-something scenarios.

Annex I of this EIS (Volume 3, Book 2 of 2) illustrates the routes for which these statistics are presented.

7.4.6.4 Predicted construction impact on traffic flow

Table 7.10 presents and compares the journey time statistics for 2011 for the do-minimum and do-something scenarios. Generally there is an increase in journey times on most of the routes assessed. Without the mitigation measures some routes would experience considerable journey time deterioration, particularly the R132 through Swords, Ballymun Road, N2, Collins Avenue, Church Street and Baggot Street.

Overall the impact on journey time can be classified as Moderate to Severe on the routes assessed in the absence of the proposed mitigation measures.

7.4.6.5 Predicted operational impact on traffic flow

Table 7.11 and Table 7.12 present and compare the journey time statistics for the do-minimum and do-something for 2014 and 2029 respectively. In both operational years there is a general reduction in journey times on most of the routes assessed. Journey time reductions of note include on the R132, Ballymun Road, M1, N2, Collins Avenue and Santry Avenue. The journey time assessment for the operational years illustrates the magnitude of the positive impact that the proposed scheme would have on traffic movement particularly in the vicinity of the alignment.

Table 7.10 Journey times – 2011 do-minimum vs. do-something

Route	2011 AM Peak Do-minimum (Minutes)	2011 AM Peak Do-Something (Minutes)	% Change
R132 Southbound	21m 28s	26m 33s	23.6%
R132 Northbound	35m 15s	45m 09s	28.1%
M1/N1 Southbound	42m 57s	44m 25s	3.4%
M1/N1 Northbound	20m 55s	23m 42s	13.3%
N2 Southbound	25m 39s	27m 19s	6.5%
N2 Northbound	15m 40s	16m 23s	4.6%
Ballymun Road Southbound	34m 07s	34m 22s	0.7%
Ballymun Road Northbound	18m 40s	21m 52s	17.1%
M50 Southbound	26m 01s	26m 53s	3.3%
M50 Northbound	24m 47s	24m 17s	-2.0%
Santry Ave Southbound	23m 55s	23m 14s	-2.8%
Santry Ave Northbound	18m 33s	19m 29s	5.0%
Collins Ave Eastbound	22m 02s	24m 40s	11.9%
Collins Ave Westbound	13m 04s	15m 41s	20.1%
Griffith Ave Eastbound	13m 07s	12m 13s	-6.9%
Griffith Ave Westbound	10m 57s	11m 25s	4.2%
Port Tunnel Southbound	07m 44s	09m 02s	16.8%

Route	2011 AM Peak Do-minimum (Minutes)	2011 AM Peak Do-Something (Minutes)	% Change
Port Tunnel Northbound	09m 11s	08m 29s	-7.7%
Gardiner Street/ Baggott Street Southbound	16m 32s	17m 11s	3.9%
Baggott Street/ Gardiner Street Northbound	34m 04s	40m 54s	20.0%
Church Street/ Clanbrassil Street Southbound	30m 57s	36m 46s	18.8%
Clanbrassil Street/ Church Street Northbound	21m 40s	31m 40s	46.1%
North Quays – Heuston to O'Connell Bridge	15m 33s	17m 02s	9.5%
South Quays - O'Connell Bridge to Heuston	06m 42s	07m 54s	17.9%
South Quays – Georges Quay to O'Connell Bridge	14m 02s	08m 58s	-36.1%
North Quays – Heuston to North Wall Quay	22m 38s	24m 26s	8.0%
South Quays – Georges Quay to Heuston	22m 40s	17m 19s	-23.6%

Table 7.11 Journey times – 2014 do-minimum vs. do-something

Route	2014 AM Peak Do-minimum (Minutes)	2014 AM Peak Do-Something (Minutes)	% Change
R132 Southbound	22m 13s	21m 26s	-3.6%
R132 Northbound	37m 20s	32m 42s	-12.4%
M1/N1 Southbound	53m 13s	41m 34s	-21.9%
M1/N1 Northbound	21m 28s	21m 07s	-1.7%
N2 Southbound	26m 60s	26m 06s	-3.3%
N2 Northbound	14m 52s	15m 06s	1.6%
Ballymun Road Southbound	38m 45s	32m 18s	-16.7%
Ballymun Road Northbound	17m 28s	17m 37s	0.9%
M50 Southbound	27m 49s	26m 29s	-4.8%
M50 Northbound	25m 29s	27m 25s	7.6%
Santry Ave Southbound	14m 42s	13m 32s	-7.9%
Santry Ave Northbound	19m 53s	17m 31s	-11.9%
Collins Ave Eastbound	20m 07s	18m 19s	-9.0%
Collins Ave Westbound	13m 04s	13m 26s	2.9%
Griffith Ave Eastbound	11m 05s	10m 54s	-1.6%
Griffith Ave Westbound	11m 13s	10m 53s	-3.0%
Port Tunnel Southbound	07m 58s	07m 52s	-1.4%
Port Tunnel Northbound	08m 34s	08m 37s	0.6%
Gardiner Street/ Baggott Street Southbound	15m 59s	15m 35s	-2.5%
Baggott Street/ Gardiner Street Northbound	35m 11s	35m 35s	1.1%
Church Street/ Clanbrassil Street Southbound	32m 07s	30m 07s	-6.2%

Route	2014 AM Peak Do-minimum (Minutes)	2014 AM Peak Do-Something (Minutes)	% Change
Clanbrassil Street/ Church Street Northbound	18m 38s	17m 21s	-6.9%
North Quays – Heuston to O'Connell Bridge	18m 04s	17m 07s	-5.2%
South Quays - O'Connell Bridge to Heuston	06m 32s	06m 38s	1.5%
South Quays – Georges Quay to O'Connell Bridge	13m 23s	12m 44s	-4.8%
North Quays – Heuston to North Wall Quay	24m 56s	24m 08s	-3.2%
South Quays – Georges Quay to Heuston	21m 46s	21m 03s	-3.3%

Table 7.12 Journey times – 2029 do-minimum vs. do-something

Route	2029 AM Peak Do-minimum (Minutes)	2029 AM Peak Do-Something (Minutes)	% Change
R132 Southbound	26m 52s	27m 02s	0.6%
R132 Northbound	40m 06s	32m 09s	-19.8%
M1/N1 Southbound	64m 32s	54m 05s	-16.2%
M1/N1 Northbound	24m 56s	24m 38s	-1.2%
N2 Southbound	37m 29s	34m 12s	-8.8%
N2 Northbound	18m 24s	18m 15s	-0.9%
Ballymun Road Southbound	49m 55s	45m 04s	-9.7%
Ballymun Road Northbound	21m 09s	21m 24s	1.2%
M50 Southbound	40m 04s	37m 42s	-5.9%
M50 Northbound	39m 23s	38m 52s	-1.3%
Santry Ave Southbound	17m 01s	16m 11s	-4.9%
Santry Ave Northbound	30m 04s	25m 11s	-16.2%
Collins Ave Eastbound	28m 06s	25m 30s	-9.3%
Collins Ave Westbound	17m 41s	16m 25s	-7.1%
Griffith Ave Eastbound	11m 35s	11m 21s	-1.9%
Griffith Ave Westbound	13m 39s	13m 18s	-2.5%
Port Tunnel Southbound	10m 33s	09m 56s	-5.9%
Port Tunnel Northbound	12m 02s	09m 57s	-17.2%
Gardiner Street/Baggott Street Southbound	17m 04s	16m 05s	-5.7%
Baggott Street/ Gardiner Street Northbound	35m 38s	36m 27s	2.3%
Church Street/ Clanbrassil Street Southbound	35m 06s	35m 45s	1.9%
Clanbrassil Street/ Church Street Northbound	20m 24s	19m 30s	-4.4%
North Quays – Heuston to O'Connell Bridge	16m 58s	18m 28s	8.9%
South Quays - O'Connell Bridge to Heuston	07m 05s	07m 25s	4.9%
South Quays – Georges Quay to O'Connell Bridge	14m 18s	12m 15s	-14.3%
North Quays – Heuston to North Wall Quay	24m 29s	26m 05s	6.5%
South Quays – Georges Quay to Heuston	22m 51s	21m 01s	-8.0%

7.4.7 Conclusions drawn from the strategic predicted impact assessment

The traffic modelling results have shown that the strategic predicted impact of the proposed scheme would be Severe during the construction phase in the absence of further mitigation to offset these predicted impacts. The predicted impact of the operational phase of the proposed scheme on traffic movement is very positive and further mitigation measures are not required.

7.4.7.1 Summary of the predicted construction impact

The assumptions underpinning the traffic modelling undertaken to assess the construction impact of the proposed scheme are very conservative and represent an absolute worst case construction scenario. Limited mitigation measures have been assumed in this assessment. The assessment, therefore, must be viewed in the context of this conservatism in that the modelled impact will be further mitigated to ensure that this impact would not come to fruition. A Scheme Traffic Management Plan which will be developed (see below) will provide further mitigation measures that are required to alleviate the severity of the modelled impact.

Based on the traffic modelling construction assumptions and results, the predicted strategic impact on traffic accruing from construction activities would be Severe without implementing further mitigation measures. Modelling results indicate that traffic speeds across the GDA would decrease by over 11%, a reduction of 3kph. Drivers would travel further distances to avoid construction areas compounding the congestion levels on other parallel routes and affecting the operation of buses through the city. Other traffic modelling statistics such as impact on bus speeds and journey time on key routes further demonstrate the significance of the construction impact in the absence of mitigation measures.

Substantial further traffic management mitigation measures, described below, are required along the full alignment to reduce this impact and to develop intervention policies that will clearly demonstrate how traffic will operate in conjunction with the construction phase.

7.4.7.2 Summary of the predicted operational impact

The strategic impact of the proposed scheme during its operational phases would be very positive. The modal shift from car to the proposed scheme improves the average speed across the GDA by 2kph and 3kph in 2014 and 2029 respectively. Time spent queuing decreases, distance travelled decreases and also time spent travelling decreases. There are also improvements to bus speeds across the GDA. Journey time assessments on key routes further demonstrate the positive nature of the impact as the majority in both 2014 and 2029 show decreases.

7.5 STRATEGIC FURTHER MITIGATION

7.5.1 Introduction

The strategic predicted impact assessment has shown that the city wide construction impact of the proposed scheme, without mitigation measures, would be Severe with average speeds across the city falling 3kph. The following are mitigation measures that are required to reduce the severity of the construction impact.

7.5.2 Scheme Traffic Management Plan

Measures necessary to mitigate the negative effects of construction of the proposed scheme will be developed as the proposed scheme evolves to construction in consultation with key stakeholders such as the relevant roads authorities. These will be detailed in a Scheme Traffic Management Plan. This plan will prioritise pedestrian, cyclist, public transport and local access needs (for example, multi storey car parks, residential and commercial properties). Such an approach will minimise the impact of the construction phase on transport and business activities. To facilitate this, it will be important for the plan to divert through traffic away from key construction areas.

This plan is a framework document within which the necessary mitigation measures will be developed through the various stages of design and construction. This will detail the proposed programme of works, how appropriate access can be retained throughout the works and how the potential negative traffic impacts (including pedestrian and cyclist impacts) associated with operating a number of urban construction sites concurrently can be managed. Initially, this plan will be developed by RPA in consultation with the roads authority and other key stakeholders until the PPP contractor is appointed. Then the PPP contractor will continue to develop and implement the strategy throughout the construction phase. This plan will be reviewed on a regular basis during its implementation for its relevance and effectiveness.

The MNTM traffic model has been used to assess the impact of Dublin City Council's SCATS system. Within the MNTM there is a facility to optimise signal green times for the whole Dublin region. This signal optimisation programme was run through the MNTM for 2011 with scheme construction assumed. The results of this test are shown below in Table 7.13 and Table 7.14 compared to the do-minimum and do-something scenarios. The results indicate that by reconfiguring the signal green time within the city there will be potential to minimise the traffic disruption generated by the construction activities to achieve congestion levels and network speeds that exist in the do-minimum scenario.

Table 7.13 Strategic construction impact 2011 (AM Peak Hour) – general traffic

Criteria	Do-Minimum	Do-Something	Do-Something with Signal Optimisation
Queuing Statistic (pcu hours)	21,000	25,700	19,400
Travel Time (pcu hrs)	86,700	100,200	87,000
Travel Distance (pcu kilometres)	2,190,000	2,250,000	2,220,300
Average Speed (kph)	25	22	25

Table 7.14 Strategic construction impact 2011 (AM peak hour) – bus only

Criteria	Do-Minimum	Do-Something	Do-Something with Signal Optimisation
Bus Speed (kph)	19	15	19
Bus kilometres lost to queuing per hour	1,900	4,800	2,100

7.5.3 Public transport operations

The Scheme Traffic Management Plan will consider public transport operating needs along the alignment of the proposed scheme. Discussions will be held with relevant public transport operators, and roads and planning authorities to mitigate the proposed scheme's impacts.

7.5.4 Corridor management strategies

The Scheme Traffic Management Plan will include corridor management strategies as required for areas and roads directly affected by construction activities. These strategies are required for routes that without mitigation measures would experience substantial increases in traffic flow from displaced vehicle trips avoiding construction areas. The corridor management strategies will take the form of additional signal priority for certain movements, reconfiguration of key junctions, re-signing of routes (including utilisation of VMS).

7.5.5 Pedestrian management strategies

The Scheme Traffic Management Plan will include pedestrian management strategies around each work site to ensure that pedestrian circulation and safety requirements take priority in all instances where construction works interface with pedestrians. This is critical in the context of the large number of construction phases envisaged at and between discrete site locations. Furthermore, the city centre stops are located in very sensitive urban areas with high pedestrian volumes and substantial volumes of general traffic. The additional construction activity (site areas and construction vehicles) in these areas will impede pedestrian circulation and access unless properly managed.

7.6 PREDICTED LOCAL CONSTRUCTION IMPACT - AREA MN103

The construction phase will include utilities diversions and enabling works, which, by their nature are of short duration and will have localised impacts which will be mitigated. This phase also includes the main construction works for the proposed scheme, which are of longer duration and which have a potentially greater impact along the full length of the scheme. The following assessment therefore considers the main construction works. The combined impact of both HGV and general traffic has been assessed in the preceding Strategic Impact Assessment section.

7.6.1 Construction impact area

The proposed scheme alignment through Area MN103, extends south from the Naul Road to Collinstown Lane and will be predominantly in tunnel. The main tunnelling worksite will be located in the Dardistown area on the south side of the airport within Area MN104.

One stop is to be located within Area MN103, at Dublin Airport. This stop will be an underground stop. The stop will be constructed from ground level and excavated to facilitate the construction of the station platform, concourse, access and ventilation shafts and other components.

There will be no alterations to the general road network within Area MN103 as a result of the construction of the proposed scheme. The internal road network within the Airport will be subject to minor modifications to allow for the construction of the Airport Stop.

The Airport Stop will be located east of the existing terminal building and the adjacent multi-storey car-park. The construction of the stop will be entirely within the Airport lands, and will not encroach on the public road network.

7.6.2 Construction traffic and background HGV traffic flows

To provide the most robust assessment of the impacts on all road users, the modelled scenario is based on a worst case assumption of excavation and concreting operations taking place simultaneously at every work site throughout the scheme. In practice, due to constraints on vehicle/ plant/ staff resources the full impacts predicted below are very unlikely to materialise, in particular on routes serving multiple sites such as the M1 and R132.

Table 7.15 details the predicted construction traffic volumes within Area MN103 based on the combined impact of the construction of each critical stage along the proposed scheme alignment. In addition, the traffic modelled results allow for the impact of the redistribution of background HGV traffic.

Table 7.15 Comparison of 2011 modelled heavy goods vehicle and construction vehicle traffic flows with and without the construction of the proposed scheme (AM peak hour flows 08:00 to 09:00)

Link	Direction	2011 Do-Minimum	2011 Do-Something	% Change
R132, north of Airport Roundabout	Northbound	80	75	-6%
	Southbound	30	30	0%
Corballis Road North	Eastbound	50	50	0%
	Westbound	40	40	0%
M1 Link Road to Airport Interchange	Eastbound	30	60	100%
	Westbound	90	130	44%
R132, between Airport Roundabout and Corballis Road South	Northbound	30	50	67%
	Southbound	50	80	60%
Corballis Road South	Eastbound	5	5	0%
	Westbound	35	35	0%
R132, between Corballis Road South and Collinstown Cross	Northbound	90	100	11%
	Southbound	70	100	43%
M1, between Drynam and Airport Interchanges	Northbound	320	510	59%
	Southbound	370	540	46%
M1, between Airport and M50 Interchanges	Northbound	390	550	41%
	Southbound	380	515	36%

Table 7.15 illustrates that there will be more than a 50% increase in HGV and construction vehicle traffic on the M1 between the Drynam and Airport Interchanges. This equates to approximately 200 additional vehicle movements per hour. Without mitigation the impact of the construction of the proposed scheme on the M1 within Area MN103 will be severe as a result of additional construction vehicle traffic. The modelled results comprise peak construction vehicle movements and this high level of construction related traffic will be mitigated to ensure that this impact would not come to fruition, particularly on routes serving multiple sites such as the M1.

7.6.3 Construction phase impact on general traffic

Table 7.16 illustrates the modelled traffic flows within Area MN103 for the construction year 2011.

Table 7.16 Comparison of 2011 modelled car and light goods vehicle traffic flows with and without the construction of the proposed scheme (AM peak hour flows 08:00 to 09:00)

Link	Direction	2011 Do-Minimum	2011 Do-Something	% Change
R132, north of Airport Roundabout	Northbound	1,140	1,270	11%
	Southbound	1,200	1,290	8%
Corballis Road North	Eastbound	1,600	1,600	0%
	Westbound	1,700	1,700	0%
M1 Link Road to Airport Interchange	Eastbound	710	820	15%
	Westbound	2,100	2,230	6%
R132, between Airport Roundabout and Corballis Rd South	Northbound	130	100	-23%
	Southbound	1,570	1,530	-3%
Corballis Road South	Eastbound	60	60	0%
	Westbound	1,160	1,130	-3%
R132, between Corballis Road South and Collinstown Cross	Northbound	910	900	-1%
	Southbound	1,130	1,100	-3%
M1, between Drynam and Airport Interchanges	Northbound	2,380	2,050	-14%
	Southbound	4,280	3,990	-7%
M1, between Airport and M50 Interchanges	Northbound	3,470	3,070	-12%
	Southbound	4,050	3,660	-10%

There will not be a significant adverse impact on general traffic volumes within Area MN103.

There have been a significant number of road traffic accidents in and around the Airport. The road network in the vicinity of the Airport is classed as sensitive as a result of the high number of accidents. The construction of the proposed scheme will not have a significant impact on these roads. However, traffic conditions will be monitored during the construction phase to ensure that there is not an adverse impact on the rate of accidents.

Overall car speeds within Area MN103 will decrease from 33.5kph in the do-minimum scenario to 30.2kph during the construction of the proposed scheme. This represents a 10% decrease in car traffic speeds during the AM peak hour period and a relative change of 3.3kph. The predicted speeds are relatively similar in the do-minimum and construction scenarios. Overall an average speed of 30kph is reasonably high for the AM period and the impact on traffic conditions will be slight.

During the off-peak hour average car speeds within Area MN103 will decrease from 42.1kph to 41.2kph. This equates to a negligible decrease in car traffic speeds during the representative off-peak hour (14:00 to 15:00).

Overall, the impact on general traffic of the construction of the proposed scheme within Area MN103 will be slight.

7.6.4 Construction phase impact on public transport

Bus and taxis are the main form of public transport currently serving the airport within Area MN103. The construction activity within Area MN103 will not impact on the movement of buses or taxis and therefore the impact will be slight.

7.6.5 Construction phase impact on pedestrians and cyclists

Pedestrian and cyclist volumes in and around the general road network are very low within Area MN103. The construction of the proposed scheme will not have a significant impact on these road users within the area as a whole.

There are a considerable number of pedestrian movements internally within the Airport. However, the vast majority of these will not be affected by the proposed scheme.

Overall the impact on pedestrians and cyclists will be slight within Area MN103.

7.7 PREDICTED LOCAL OPERATIONAL IMPACT - AREA MN103

7.7.1 Operational phase impact on general traffic

Table 7.17 presents the traffic flows extracted from the MNTM traffic model for cars and light goods vehicles during the operational phase of the proposed scheme for 2014 and 2029. Dublin Airport is a major trip attractor in North Co. Dublin and, as a result is a significant contributor to traffic flows on roads in its vicinity. In the do-something scenario there will be a general decrease in traffic volumes throughout Area MN103. This is a result of the modal shift from car to the proposed scheme as a means of accessing the Airport. This is further emphasised by the significant predicted reduction in vehicles exiting the airport eastbound on Corballis Road North. This will have a positive impact on the local road network generally, and the operation of the Airport Roundabout in particular.

There is, however, a predicted percentage increase in traffic on the R132 between Corballis Road South and the Airport Roundabout but the absolute numbers are small and well within the capacity of the road.

The decrease in AM-peak traffic volumes is reflected in the increased average network car speed in Area MN103 in future years. In 2014, the do-minimum average speed in Area MN103 is 36kph, which increases to 45kph with the scheme in place. Similarly, in 2029, the do-minimum speed is 28kph, which increases to 39kph with the scheme in place. This will very positively impact on drivers by reducing AM-peak journey times, thus lessening driver stress on routes through the area.

Comparison between the off-peak do-minimum and do-something scenarios reveals marginal increases in the average network car speed within Area MN103. In 2014, the do-minimum average speed is 55kph, which remains constant at 55kph with the scheme in place. In 2029, the do-minimum speed is 28kph, which increases to 35kph with the scheme. Thus, in comparison to the AM-peak, the presence of the scheme will have a smaller but still positive impact on off-peak journey times. The impact on traffic in the off peak period will always be marginal as congestion is much less than in the AM Peak period.

Table 7.18 presents the traffic flows extracted from the MNTM traffic model for heavy goods vehicles during the operational phase of the proposed scheme for 2014 and 2029. As expected, the volumes of HGV traffic remain relatively constant in Area MN103, with a decrease predicted on Corballis Road within the Airport. It is unlikely that the operation of the proposed scheme will impact on HGV traffic in a substantial way in Area MN103.

Table 7.17 Changes in car and light goods vehicle traffic volumes due to the operation of the proposed scheme, as modelled for the years 2014 and 2029 (AM peak hour flows 08:00 to 09:00)

		2014 Cars and LGVs			2029 Cars and LGVs		
Link	Direction of traffic flow	Do-Minimum	Do-Something	% Change	Do-Minimum	Do-Something	% Change
R132, north of Airport Roundabout	Northbound	860	830	-3%	1,340	900	-33%
	Southbound	1,090	1,000	-8%	1,140	1,000	-12%
Corballis Road North	Eastbound	1,740	1,340	-23%	2,260	1,350	-40%
	Westbound	2,180	1,820	-17%	2,190	1,790	-18%
M1 Link Road to Airport Interchange	Eastbound	780	690	-12%	890	690	-22%
	Westbound	1,870	1,790	-4%	1,850	1,530	-17%
R132, between Airport Roundabout and Corballis Rd South	Northbound	100	160	60%	100	260	160%
	Southbound	1,060	1,020	-4%	1,020	820	-20%
Corballis Road South	Eastbound	50	80	60%	50	70	40%
	Westbound	770	690	-10%	650	480	-26%
R132, between Corballis Road South and Collinstown Cross	Northbound	870	850	-2%	750	740	-1%
	Southbound	980	960	-2%	910	730	-20%
M1, between Drynam and Airport Interchanges.	Northbound	2,160	2,250	4%	1,770	1,760	-1%
	Southbound	4,260	4,350	2%	3,970	3,750	-6%
M1, between Airport and M50 Interchanges.	Northbound	3,010	2,940	-2%	2,700	2,550	-6%
	Southbound	4,300	4,060	-6%	4,120	3,810	-8%

Table 7.18 Changes in heavy goods vehicle traffic volumes due to the operation of the proposed scheme, as modelled for the years 2014 and 2029 (AM peak hour flows 08:00 to 09:00)

		2014 HGVs			2029 HGVs		
Link	Direction of traffic flow	Do-Minimum	Do-Something	% Change	Do-Minimum	Do-Something	% Change
R132, north of Airport Roundabout	Northbound	45	50	11%	75	75	0%
	Southbound	30	30	0%	70	65	-7%
Corballis Road North	Eastbound	40	35	-13%	70	60	-14%
	Westbound	25	25	0%	45	45	0%
M1 Link Road to Airport Interchange	Eastbound	25	25	0%	65	55	-15%
	Westbound	45	50	11%	75	85	13%
R132, between Airport Roundabout and Corballis Rd South	Northbound	30	35	17%	35	45	29%
	Southbound	40	45	13%	55	75	36%
Corballis Road South	Eastbound	0	5	N/A	0	5	N/A
	Westbound	15	15	0%	20	10	-50%
R132, between Corballis Road South and Collinstown Cross	Northbound	60	65	8%	70	70	0%
	Southbound	65	70	8%	90	100	11%
M1, between Drynam and Airport Interchanges.	Northbound	325	335	3%	365	375	3%
	Southbound	370	380	3%	445	465	4%
M1, between Airport and M50 Interchanges.	Northbound	360	370	3%	405	425	5%
	Southbound	405	400	-1%	505	510	1%

7.7.2 Operational phase impact on public transport

The proposed scheme has no impact on the level of bus priority in Area MN103, where buses benefit from long sections of bus priority along the R132.

7.7.3 Operational phase impact on pedestrians and cyclists

The Dublin Airport Authority has plans to provide comprehensive pedestrian and cyclist facilities in conjunction with the proposed scheme and in compliance with the DETR Guidelines and the Disability Act, 2005.

The predicted impact of the operation of the scheme on pedestrians and cyclists within Area MN103 is assumed to be neutral.

7.8 RESIDUAL LOCAL IMPACT – AREA MN103

The predicted local impact of the proposed scheme during both the construction and operational phases is detailed in the previous sections. Where these impacts are severe they will be mitigated by introducing further mitigation measures at the local level, as detailed in Table 7.19. The residual local impacts which remain after the introduction of these measures are also shown.

7.8.1 Further local construction mitigation measures

7.8.1.1 General traffic mitigation measures

Where appropriate, construction work requiring short term disruption and road closures, will be carried out when traffic volumes are lower, such as:

- At night;
- At weekends;
- During school holidays.

On contract award the contractor will further develop construction vehicle routing arrangements in line with project programme and the evolving construction methodology. The Scheme Traffic Management Plan will be updated to reflect this.

7.8.2 Residual local construction impact

The localised impacts resulting from the proposed scheme construction in Area MN103 have been described in detail above. By applying the further local mitigation measures the severity of these impacts will be reduced, as outlined in the Table 7.19 below.

Table 7.19 Construction impact, further mitigation and residual local impacts

Impact ID	Location	Source of impact	Description of local impact	Strategic mitigation measures	Possible further local mitigation	Residual local impact
MN103/ T01	M1	Additional HGV traffic generated by construction vehicle movements	The volume of HGV traffic on the R132 within Area MN103 will increase on the M1 as a result of the construction of the proposed scheme. There will be more than a 50% increase in HGV and construction vehicle traffic on the M1 between the Drynam and Airport Interchanges. This equates to approximately 200 additional vehicle movements per hour.	Phasing and sequencing of construction works	The Scheme Traffic Management Plan will address or identify an appropriate phasing schedule for construction vehicle activities and construction works areas.	The residual impact will be moderate post introduction of mitigation.

7.8.3 Residual local operational impact

The proposed scheme has been designed to minimise the impact on all road users in its vicinity. During the operational phase of the proposed scheme there will be on-going liaison between the operator and the road authority to ensure the safe and efficient operation of the system and that any residual impacts are minimised.

08 FLORA AND FAUNA

This chapter of the EIS describes the potential impacts on flora and fauna, which may arise due to activities associated with the construction and operation of the proposed scheme in Area MN103.

8.1 INTRODUCTION

This chapter of the EIS describes the potential impacts on flora and fauna, which may arise due to activities associated with the construction and operation of the proposed scheme in Area MN103.

8.2 STUDY AREA

The study area comprises any area within 500m of the centre line of the proposed alignment. This study area extends to up to 1km from the proposed alignment if species or habitats of particular interest are found to occur. The study area for designated sites comprises all areas within 10km of the centre line of the proposed alignment. Within this study area, a number of individual detailed faunal surveys have been carried out and the extent of the study area for each of these detailed species surveys is primarily influenced by species mobility. The study area for individual aspects of this environmental topic as set out in Table 8.1.

Table 8.1 Study area

Environmental aspect	Habitats to be surveyed	Width of study area (on both sides of the alignment)
Designated Sites*	Special Areas of Conservation (SAC), Special Protection Areas (SPA), Natural Heritage Areas (NHA), Nature Reserves, Ramsar Sites, National Parks, Refuge for Fauna	10km
Badger	Woodland habitats and hedgerows	500m
Otter	Rivers and streams in the area of above ground sections of the alignment	500m
Bats	Man-made structures (buildings, bridges and culverts) and aquatic habitats including rivers, streams and still water habitats associated with hedgerows, scrub woodlands etc.	500m
Birds	Suitable habitats for birds as identified during the Phase 1 Habitat Survey. Specific survey to record flight heights of wintering birds in the area of the Broad Meadow Swords SPA	500m
Amphibians	Specific aquatic habitats identified during the Phase I Habitat Survey as having a high potential to provide amphibian habitat e.g. lakes, ponds, rivers	500m
Habitats Phase I	All accessible habitats	500m

* Designated sites comprise those designated under national legislation, EU directives and other international conventions.

The habitat complexes in Area MN103 are dominated by Dublin Airport, which comprises large areas of buildings and hardstanding. The habitats are predominantly managed grasslands of low local functional value. At the extreme northern end of Area MN103 lies the Sluice River, which is a salmonid river and flows into the Baldoyle Bay SPA. This river is of higher nature conservation value.

8.3 IMPACT ASSESSMENT METHODOLOGY

The impact assessment methodology is described in Section 8.3 and the potential impacts are described in Section 8.4.1. Mitigation measures to be implemented are listed in Section 8.4.2. These measures are designed to reduce the adverse impacts that are deemed to be significant at a given geographical level. The residual impacts are reported in Section 8.4.3.

The potential for ecological and nature conservation impacts has been assessed in light of the habitats and species that are likely to be affected by the proposed scheme taking into account the latest 'Guidelines for Ecological Impact Assessment in the United Kingdom' published by the Institute of Ecology and Environmental Management (IEEM, 2006), the 'Guidelines for the Assessment of Ecological Impacts of National Road Schemes' (National Roads Authority, 2006) and the relevant EPA guidance with respect to EISs (EPA, 2002, 2003).

As part of the assessment the significance of potential ecological impacts has been evaluated taking into account the following factors:

- The magnitude of both positive and negative effects, as determined by intensity, frequency and by the effect extent in space and time;
- The vulnerability of the habitat or species to the changes likely to arise from the proposed scheme;
- The ability of the habitat, species or ecosystem to recover, considering both fragility and resilience;
- The viability of component ecological elements and the integrity of ecosystem function, processes and favourable condition;
- Value within a defined geographic frame of reference (national, regional or district);
- The biodiversity value of affected species, populations, communities, habitats and ecosystems, considering aspects such as rarity, distinct sub-populations of a species, habitat diversity and connectivity, species-rich assemblages, and species distribution and extent;
- Designated site and protected species status, and Priority Biodiversity Action Plan (BAP) or Habitat Action Plan (HAP) status.

Significance is determined through consideration of these criteria. The value of the affected feature is used to determine the geographical scale at which the impact is significant (e.g. international, national, regional and local levels). The determination of significance is based on whether the impact will affect the integrity or conservation status of the species, habitat, site or ecosystem within a given geographical frame of reference. Residual impacts are considered to be either significant or insignificant (and negative or positive), after taking into account the zone of influence, mitigation measures and the confidence in predictions associated with the assessment.

8.4 IMPACT ASSESSMENT

8.4.1 Impact identification

Potential sources and types of impact are set out in Table 8.2.

Table 8.2 Sources and types of impact

Impact source	Impact type
Construction phase	
Temporary land-take - Construction compounds - Working areas along track bed - Cut and cover tunnels	- Permanent loss of habitat or species - Temporary loss of habitats or species - Fragmentation of habitat or severance of wildlife corridors between isolated habitats of ecological importance - Creation of barriers to the movements of animals, especially mammals, amphibians and plants with limited powers of dispersal - Impacts on designated sites
Construction activities (e.g. runoff and other pollution, increase of suspended solids, alteration of hydraulic conditions, noise and dust emissions, lighting, movement of LMVs, presence of construction personnel)	- Damage or alteration to adjacent habitats - Disturbance to species in the vicinity of the proposed scheme - Impacts on designated sites - Introduction of invasive species
Operational phase	
Permanent land-take (e.g. stops, track bed, substations, ventilation shafts, ancillary roads, tunnel portals, watercourse crossings (bridges and culverts), overhead wires, catenary system and supporting structures and elevated structures)	- Permanent loss of habitat or species - Permanent alterations to existing habitats - Fragmentation of habitat or severance of wildlife corridors between isolated habitats of ecological importance - Creation of barriers to the movements of animals, especially mammals, amphibians and plants with limited powers of dispersal - Impacts on designated sites - Creation of new habitats as a result of reinstatement works, habitat enhancement proposals and landscaping
Operation of rolling stock and maintenance of the track (e.g. runoff and other pollution, increase of suspended solids, noise and dust emissions, lighting, movement of LMVs, presence of maintenance personnel)	- Disturbance to species in the vicinity of the proposed scheme - Animal collisions - Impacts to designated sites

8.4.2 Mitigation measures

The mitigation measures necessary to avoid or reduce the significance of any adverse impacts on flora and fauna are outlined in this section. Detailed information regarding mitigation measures specific to this area are outlined in Section 8.4.2. These measures are over and above those already incorporated into the scheme design, which has for example sought to avoid sensitive habitats by using existing bridges over watercourses (e.g. across the Broad Meadow River).

- Habitat loss will be limited to the minimum needed for safe implementation of the works. Implementation of best practices will ensure that the risk of disturbance or damage to adjacent habitats is minimised;
- The 'Guidelines for the Protection and Preservation of Trees, Hedgerows and Scrub prior to, during and post Construction of National Road Schemes' (NRA) will be followed in areas where these habitats will be impacted upon or are in close proximity to the proposed scheme. Where possible, linear habitats such as hedgerows and tree lines will be crossed at right angles, utilising any existing gaps, to reduce the extent of habitat loss;
- Where new access roads are required, they will be situated in a position that utilises existing gaps in hedgerows/trees wherever possible to minimise tree loss and hedgerow removal;
- Where ditches are to be affected by works, measures will be implemented to ensure a regular water flow is maintained;
- Prior to excavation work, topsoil will be stripped and stored separately from subsoil and reinstated in the same order on completion of the works. Topsoil from any habitats of nature conservation value will be stored separately from topsoil removed from other areas;
- Stockpiled sand, gravel and soil will be placed in areas of low conservation value, kept to minimum size, situated well away from all watercourses and covered or seeded where appropriate;
- Sustainable Urban Drainage Solutions (SUDs) are to be incorporated into the design of all storm control areas, using best practice standards as detailed in the Surface Water chapters of the EIS (see Volume 2, Chapter 11);
- Best site management practices will be adopted during construction to minimise the risk of secondary impacts on adjacent habitats. Such practices include fencing to clearly mark boundaries and prevent accidental entrance into adjacent habitats, drainage systems designed to prevent water pollution and dust suppression to avoid dust dispersion. Further information is provided in the Surface Water and Air and Climatic Factors chapters of this EIS (Volume 2, Chapters 11 and 12 respectively);
- Measures will be put in place to avoid the pollution of waters during the construction and operation of the scheme, including following CIRIA guidance (Masters et al., 2001) on the control of water pollution from construction sites as described in the Surface Water chapter of this EIS (Volume 2, Chapter 11);
- Measures will be taken to avoid the spread of invasive species (including Japanese knotweed *(Fallopia japonica)*, and giant hogweed *(Heracleum mantegazzianum)* during construction work (e.g. using appropriate control methods if species are noted), managing plant movement (e.g. wheel washing) and managing the use of imported soil (e.g. not using soil from areas where invasive species known |to be present);
- Where habitats are directly lost as a result of the proposed scheme, new alternative habitats will be created where feasible. Temporary works areas will be restored as soon as is reasonably practicable. Progressive restoration will occur along the route. Where areas of land become isolated due to severance and fragmentation, opportunities will be taken to create new habitat as part of the landscape strategy;
- Mitigation planting will be undertaken using predominantly native species typical of the area, obtained from local sources wherever possible and planted in order to emulate the surrounding natural vegetation. The details of tree planting, species mixes and habitat creation will be established by a professional landscape architect with the project ecologist at the detailed design stage of the project, in consultation with National Parks and Wildlife Services (NPWS);
- Tree loss during construction and operation of the proposed scheme will be compensated for by tree planting along the alignment as described in the Landscape and Visual chapter of this EIS (Volume 2, Chapter 13);
- Where attenuation ponds are created, their restoration upon completion of the construction works will include features to enhance biodiversity in the longer term (e.g. scalloped edges, variation in water depths, marginal habitats and aquatic plant species);
- Mitigation which will be implemented will take account of relevant guidance including for badgers (NRA, 2006), bats (NRA, 2006) and otters (NRA, 2006) and will be agreed with NPWS It will ensure that appropriate pre-construction surveys are undertaken for protected species, that works are undertaken at appropriate times of the year, pathways and foraging routes are maintained including through the sue of tall trees for bats, breeding sites protected and animals are not disturbed or excluded/translocated (unless under licence). Alternative breeding sites (e.g. bat boxes, bird boxes) will be provided in areas where nest and roost sites are lost;

- Vegetation clearance will take place outside the breeding bird season (1 March to 31 August inclusive) in order to avoid the risk of disturbing breeding birds (which is an offence under the Wildlife Act, 1976 (as amended)). If work has to be undertaken within the breeding bird season, buildings and trees, scrub and other vegetation will be checked for nesting birds before removal using methods agreed with NPWS;
- Measures will be taken to ensure that all construction areas are made safe and do not pose a threat to mobile and inquisitive species such as otters and badgers (e.g. planks will be placed across any identified pathways in excavated areas and in trenches to allow escape for any animals which may fall in, and exposed pipe systems will be covered);
- The contractor will develop best practice construction procedures and method statements in consultation with the Eastern Regional Fisheries Board (ERFB) prior to the commencement of in-stream construction activities. In-stream works will be undertaken in accordance with the advice set out in the guidelines of the NRA, ERFB and/or Department of Communications, Marine and Natural Resources. No works will be undertaken in salmonid rivers during the annual closed season of 1st October to 30th April inclusive or where amphibians are present in waterbodies during their breeding season. Any requirements specified by the Office of Public Works (OPW), ERFB or NPWS will be adhered to by the contractor;
- Culverts will be designed to allow the safe passage of wildlife, including fish and otter, in accordance with the NRA and ERFB best practice guidance referenced previously;
- Construction/security/scheme lighting will be kept to a minimum and directed away from sensitive receptors (e.g. badger setts, otter holts, bat foraging habitats). All light will be directed downwards and the height of the light columns will be as low as possible, taking safety and visibility requirements into account. Low pressure sodium lighting will be used where possible as these lights have been shown to attract the lowest numbers of prey insects which attract feeding bats. Construction compounds will not be illuminated at night when working has ceased to avoid impacts to bats;
- Night time lighting at construction compounds will be restricted to the minimum necessary for safety purposes, to reduce the risk of disturbance impacts on bats and otters;
- 'Safe hop-over' features will be incorporated into the design of new bridges where flight paths of important bird species could potentially be affected. Tall trees will also be included in the landscaping planting to encourage important bird species to fly over the LMVs;
- Works associated with the strengthening of the existing bridges and the construction of new bridges will commence after sunrise and finish before sunset in order to avoid disturbance impacts on otters;
- The methods used for applying herbicides to control plant growth on the tracks will ensure that it does not result in adverse impacts on adjacent habitats. The type of herbicides used will also be ones which do not have adverse effects on wildlife in the surrounding areas. The types and methods of application will be agreed with OPW, NPWS and ERFB;
- Best construction practices will be implemented to ensure that noise and air pollution (such as dust) is kept to a minimum to reduce impacts on adjacent flora and fauna. Further information in this regard is provided in the Noise and Air and Climatic Factors chapters oft his EIS (Volume 2, Chapters 4 and 12 respectively);
- Monitoring will be undertaken to confirm the effectiveness of mitigation measures during construction;
- Trees that are lost will be replaced where possible using a mixture of native species, of local provenance and typical of the local area and ornamental species;
- Construction activities at the bridge crossings will be avoided during night time wherever possible to avoid disturbance impacts to otters.

8.4.3 Assessment of residual impacts

The majority of this section of the route is in tunnel and hence there will be no ecological effects. The proposed Airport Stop is entirely located on artificial surfaces and no impact occurs within this section. The main ecological impacts are associated with the proposed scheme crossing the Sluice River and its northern tributary, and the portal, which affects areas of semi-natural grassland to the north of the airport.

8.4.3.1 Project scenario: construction phase

Construction impacts on designated sites
The proposed Natural Heritage Area 'Feltrim Hill' is located 2km to the east of the proposed scheme. This site will not be impacted by the proposed scheme as the ecological resources of the site will not be affected.

Construction impacts on habitats
Construction impacts will affect the following habitats:

- Watercourses (Eroding upland river – FW1);
- Scrub (WS1);
- Semi-natural grassland (GS2 - Dry meadows and grassy verges);
- Built land (BL3 – Buildings and artificial surfaces).

Watercourses
A range of measures will be implemented during the construction works on the Sluice River to avoid impacts on adjacent stretches of the river beyond the box culvert section. These measures are described in Section 8.4.2 and include control of sediment generation and dispersion, avoidance of pollution and measures to ensure that water flow is maintained.

Woodland
The construction of the bridge crossing Sluice River will result in a temporary loss of semi-mature scrub along the watercourse. This habitat will be partly be reinstated after the construction phase has been completed. The bankside vegetation in the area of the proposed crossing is species poor and dominated by bramble *(Rubus fruticosus agg.)*, which reaches far into adjacent grassland habitat. Mature examples of elder *(Sambuccus nigra)* to the west of the crossing point will be retained. Mitigation measures are described in Section 8.4.2. The construction works will be fenced off to avoid any effects on mature trees within this habitat. The landscape design for this area will include replacement planting and enhancement of woodland strips to the north and south of the river using species typical for this habitat which will increase the biodiversity value of the water course. Significant impacts on the favourable conservation status and abundance of this habitat type are not predicted.

Grassland
The construction of the at grade section of the alignment in Habitat Complex 09, as well as the portal and associated Construction Compound 7 (North Portal Airport Tunnel) will result in temporary loss of semi-natural grassland (GS2). The North Portal of the Airport Tunnel is the location at which the TBM that bores the tunnel under Dublin Airport is to be extracted. This site may act as a spoil storage area. The site will be used for a period of approximately four years. The topsoil from those areas that are temporarily affected will be stripped and stored separately so that it can be used during re-instatement of the areas once the construction works are complete. Hence in the long-term this habitat will be restored and significant impacts are not predicted. Measures will be implemented to ensure that the surrounding areas of semi-improved grassland are not affected. These measures are described in Section 8.4.2 and include the use of fencing to prevent incursions and storage of materials away from the grassland. Semi-natural grassland within the area impacted upon is species poor and characterised by common species such as *Holcus lanatus* which is widespread and common throughout the local area and Ireland. Only small areas will be lost during the construction phase of the proposed scheme and significant impacts on the favourable conservation status and abundance of this habitat type are not predicted.

Construction impacts on species

Bats
The construction of the proposed scheme in Area MN103 does not entail the demolition of buildings or removal of mature trees (see Landscape Insertion Plans provided in Volume 2, Chapter 13) potentially supporting roosting bats. Common bat species such as Leisler's bats (Nyctalus leisleri) are known to occur within the area of Dublin Airport. Considerable areas of foraging habitat remain and the temporary loss of a small area of habitat from along the Sluice River corridor in Area MN103 is not predicted to be significant. Measures will be implemented to reduce the risk of disturbance to bats during construction including the use of appropriate lighting which is directed away from foraging habitats.

Leisler's bats are widespread and common in Ireland and the impacts does not affect the favourable conservation status of this species. Additional commuting routes will be incorporated into the proposed landscape design to either side of the at-grade section of the proposed scheme in Habitat Complex 09.

Badgers
Surveys in June 2008 recorded badger activity at a sett in the northern part of Area MN103. This sett is approximately 300m from the alignment and will not be affected by disturbance. Pre-construction badger surveys will also be carried out prior to the commencement of any construction works to confirm the status of this species.

The construction works may affect the movement of badgers along the Sluice River corridor, and also result in the temporary loss of some foraging areas. Measures will be implemented to ensure that the passage of badgers along this corridor is maintained and that they are not at risk due to the presence of the construction compound (see Section 8.4.2). Large areas of foraging habitat for badgers will remain in the surrounding areas and significant impacts on foraging are not predicted.

Otters
Otters are not known to occur along this section of the Sluice River. Pre-construction surveys will be undertaken prior to works commencing to confirm the status of this species. Mammal ledges will be incorporated into the proposed bridge structure at the Sluice River in order to allow species movement throughout this area and good practice measures will be implemented to reduce the risks to highly mobile species (see Section 8.4.2).

Birds
Increased noise levels over the predicted construction period of approximately four years may cause some disturbance to a range of bird species in the immediate vicinity of the works, especially during the initial use of the Tunnel Boring Machine (TBM) in construction compound 7. Grassland habitats and scrub alongside the river banks support reed buntings, starlings, house sparrow and pheasant. These birds are common and widespread throughout the local area and Ireland.

Yellowhammer, a bird of Conservation Concern in Ireland was also recorded here. However, given the location of the Sluice River close to a major road and the airport, species in this area are likely to be accustomed to a degree of disturbance from noise, aircraft vehicles and people. Significant impacts are not predicted.

Bird nest boxes where required will be erected in surrounding trees which will remain prior to the commencement of construction activity in liaison with the NPWS, BirdWatch Ireland and Dublin Airport Authority. Construction activities in these areas are short-term and only small proportions of suitable breeding habitat will be lost. Therefore significant impacts on common bird species and local yellowhammer populations are not predicted to occur. Vegetation clearance along the watercourse will take place outside the breeding bird season (1st March – 31st August inclusive).

Aquatic fauna
The Sluice River will be temporarily realigned in order to allow the construction of a box-culvert and the bridge. Method statements will be defined and will include measures agreed with OPW, ERFB and NPWS to reduce the risk of secondary effects. These include minimising the generation and dispersal of suspended solids and maintaining water flows over the period of the works. The timings of the works will be agreed to reduce the risks of impacts to salmon, trout and other aquatic fauna (see Section 8.4.2). The measures will ensure that the proposed Natural Heritage Area 'Sluice River Marsh' which lies approximately 5.2km downstream and to the east of the cross-section will not be affected. Significant impacts from construction on aquatic fauna are, therefore, not predicted.

8.4.3.2 Project scenario: operational phase

Operational impacts on designated sites
The proposed NHA 'Feltrim Hill' is located approximately 2km to the east of the proposed scheme. This site is a geological site and will not be impacted upon by the proposed scheme as the ecological resources of the site will not be affected.

Operational impacts on habitats
The operating scheme will affect the following habitats:

- Watercourses (Eroding upland river – FW1);
- Woodland (WS1 – Scrub);
- Semi-natural grassland (Dry meadows and grassy verges – GS2);
- Built land (BL3 – Buildings and artificial surfaces).

Watercourses
The Sluice River, which supports salmonid species and feeds into the Sluice River Marsh pNHA will be culverted over a length of 40m. The watercourse is a steep sided river running through grassland fields with a strip of scrub running along the top of the bank.

The proposed design includes a box culvert and incorporates mammal passage facilities. The proposed scheme crosses the river at a point which avoids effects on mature trees and scrubs which occur further upstream and there is little marginal vegetation in this area. The water flow will be maintained in the long-term. Although the works affect a relatively long stretch of the river, the loss of habitat is small. The habitat that is lost is species poor and the impact affects plant species which are widespread and common along the watercourses in the local area. Significant impacts are not predicted.

Woodland
The proposed bridge crossing the Sluice River will result in a loss of a strip of species poor scrub (WS1) which runs along the top of the river banks. This scrub comprises species such as bramble *(Rubus fruticosus agg.)*, hawthorn *(Crataegus monogyna)* and elder *(Sambucus nigra)*. A substantial number of mature trees and scrub which occur further west will remain. The proposed landscape design for includes the enhancement and replacement of riparian habitat along the embankment. This minor loss of habitat will have little effect on the long-term distribution and abundance of this habitat type in the local area and is regarded as not significant.

Grassland
The portal located at Construction Compound 7 and the above ground structure of the proposed scheme will cause the permanent loss of 1.3ha semi-natural grassland in Habitat Complex 09 and 11. This habitat is species poor, dominated by common grassland species and located within an extensive area of semi-natural grassland to the north of Dublin Airport. It is noted that other areas are also being affected by the construction of a new runway north of Dublin Airport.

Areas of semi-natural grassland in Ireland have been improved and hence this habitat type is now nationally rare (Fossit, 2000). However, this habitat type was recorded in a number of locations predominantly north of Dublin City within the study area. The loss of 1.3ha of this habitat type is a small fraction of that which is present in the local area. Semi-natural grassland habitat of higher biodiversity value characterised by species rich floral assemblages to the east of the proposed scheme will remain unaffected. Where practical, the proposed embankments will be seeded from the seedbank of the areas lost for the portal and other above ground structures. Hence the loss will have little effect on the overall distribution and abundance of this habitat type and significant impacts are not predicted.

Operational impacts on species

Bats
While no bat roosts were recorded within Area MN103, riparian habitat associated with Sluice River has the potential for supporting foraging and/or commuting bat species such as Leisler's bats *(Nyctalus leisleri)*.

It is likely that a number of common species such as common and soprano pipistrelle (*Pipistrellus pipistrellus* and *P. pygmaeus)* which occur throughout the study area may forage along the Sluice River. This linear woodland will be severed over a length of 40m. However, the landscape design for the embankments of the proposed scheme in Habitat Complex 09 will include planting of native trees providing additional corridor habitat for commuting bats. These species are one of Ireland's most common species and feed along linear habitats such as watercourses and hedgerows. Given the extent of foraging and commuting areas which remain and the creation of new corridors, the severance of the Sluice River corridor is not predicted to be significant.

Stop lighting will be kept to a minimum in accordance with the mitigation measures outlined in Section 8.4.2.

Badgers

An active badger sett was recorded to the west of the proposed scheme along the banks of the River Sluice. The proposed culvert may intersect with foraging routes of the species along the watercourse.

The area to the east of the proposed scheme is highly disturbed by human activity. Lands to the west of the proposed scheme support areas of higher value for foraging and breeding badgers. The level of disturbance is lower in this area and suitable habitat for foraging and breeding badgers is present. It is therefore likely that badger movements along the watercourse are predominantly directed towards the western edge of the study area. The incorporation of mammal ledges into the proposed culvert design will ensure that potential badger movements will not be severed in the event that they forage in the affected area.

The proposed scheme may increase noise levels in the vicinity of the alignment. Disturbance impacts are unlikely to have a significant impact on badger species because of the distance between the active sett and the proposed scheme.

The proposed scheme is unlikely to affect the distribution or abundance of badgers or their favourable conservation status, and hence significant impacts on badger populations are not predicted.

Otters

Otters are not known to occur along this section of the Sluice River. However, mammal ledges will be included in the culvert design to ensure that mammal movements including any future otter movements along the watercourse will not be impeded. The proposed scheme is unlikely to affect the distribution or abundance of otters or their favourable conservation status, and hence significant impacts on otter populations are not predicted.

Birds

The permanent land-take will result in the loss of habitat for a range of common bird species, typical of agricultural and river corridor habitats, especially in the areas immediately north of the airport. Significant impacts on local populations of yellowhammer are not predicted to occur as only minor proportions of suitable nesting and foraging habitat will be permanently lost. Effects on the long-term distribution and abundance of bird species is unlikely and no significant impacts are predicted.

The LMVs may cause some localised disturbance of bird species. However, significant impacts are not predicted to occur given the location close to the airport, as birds are already accustomed to a degree of disturbance due to noise from planes, other vehicles and human activity.

Aquatic fauna

The Sluice River is a known salmonid river. The mitigation measures outlined in Section 8.4.2 will be agreed with OPW, NPWS and ERFB to ensure that the loss of habitat will not affect the abundance and distribution of salmonid species. Effects on the long-term distribution and abundance of aquatic species are unlikely and no significant impacts are predicted.

8.5 OVERVIEW OF LAND-TAKE IMPACTS

Table 8.3 shows the permanent and temporary land-take within the different habitat types within Area MN103 in comparison to the total area of those habitat types within the study area of the proposed scheme.

Table 8.3 Permanent/temporary habitat loss in Area MN103

Habitat Type	Area of habitat lost in Area MN103 [ha]	Total existing area of habitat within Area MN103 [ha]	Total area of habitat in study area [ha]
Temporary land-take			
BL3	0.5	121.7	1,054.6
ED3	0.1	0.8	17.0
GS2	0.4	28.9	80.6
Permanent land-take			
GS2	1.3	28.9	80.6
WS1	0.1	1.1	10.8

09 SOIL AND GEOLOGY

This chapter of the EIS describes the potential impacts on soils and geology, which may arise due to activities associated with the construction and operation of the proposed scheme in Area MN103.

9.1 INTRODUCTION

This chapter of the EIS describes the potential impacts on soils and geology, which may arise due to activities associated with the construction and operation of the proposed scheme in Area MN103. In addition this chapter also considers the impact of ground movements generated by construction of the bored and mined tunnels and Airport Stop cut and cover structure on overlying and adjacent property.

9.2 STUDY AREA

The study area for this assessment is set out in Table 9.1. The assessment area has been defined with reference to the potential for impact from the proposed scheme and the availability of relevant information.

Table 9.1 Study area

Criteria	Width of study area (on both sides of the alignment)
Geology	50m
Landuse	50m
Subsoils	50m
Ecology	50m
Preliminary Ground Investigation	1km approx.
Construction compounds	All areas within 50m of construction site boundary
Construction generated ground movements	Tunnels - The greater of 30m from the tunnel centreline or the position of the predicted 2mm settlement contour line. Stop boxes – The greater of the distance equating to the depth of the excavation measured from the face of the cut and cover excavation, or the position of the predicted 2mm settlement contour line.

9.3 IMPACT ASSESSMENT METHODOLOGY

The source and type of all potential impacts is described in Section 9.4.1. Mitigation measures to be put in place are defined in Section 9.4.2. Mitigation measures are defined for any adverse impacts that are deemed to be of Medium or greater significance prior to mitigation, or are undertaken to manage ground movements generated by tunnelling and cut and cover construction.

The extent to which mitigation is needed increases as the significance of the impact increases.

Mitigation measures are also undertaken to manage ground movements generated by tunnelling and cut and cover construction.

The residual impact of each impact is then evaluated in Section 9.4.3 in terms of magnitude and significance.

9.3.1 Magnitude

The criteria used to assess the different impacts associated with the proposed scheme with the exception of those associated with ground movements are shown in Table 9.2.

Table 9.2 Criteria for assessment of impact magnitude

Criteria	Impact magnitude
- Creation of impermeable areas that do not allow the percolation of water through soils e.g. paving, construction of impermeable tunnels through areas of soil - Creation of areas with very high levels of contamination	very high
- Permanent substantial impacts to soils including compaction, excavation and contamination - Temporary major impacts to soils during construction e.g. temporary creation of impermeable areas - Creation of areas with high levels of contamination	high
- Temporary moderate impacts to soils including compaction and excavation. - Creation of areas with medium levels of contamination	medium
- Permanent low magnitude impacts such as implementation of drainage schemes, landscaping and maintenance work - Creation of areas with low levels of contamination	low
- Temporary immaterial impacts such as minor ground disturbance or use of unpaved, non-compacted areas for and impacts associated with activities such as track cleaning etc. - Creation of areas with very low levels of contamination	very low

The method of assessing the impact of ground movements and in particular the response of buildings and infrastructure to excavation induced ground movements is based on a progressive approach, where successive assessment and elimination allows concentration of property considered to be at potential risk. For the proposed scheme a 4 stage assessment process has been adopted, as summarised below. At each stage a review of the proposed construction methods is carried out, and where appropriate the construction methods are amended to reduce the risk of potential damage.

Stage 1 Preliminary 'Greenfield' Settlement Analysis

This stage involves the prediction of ground movements generated by underground excavation and construction of TBM bored tunnels, cut and cover tunnels, retained cuttings, mined tunnels, shafts, stop (station) boxes and portal structures and the identification of property at potential risk of damage.

Settlement predictions take account of likely construction methods, ground conditions and comparable projects (in terms of ground conditions and construction methods). The predictions have been undertaken using empirical, finite element and discrete element computer analysis and validated against case studies.

The settlement predictions are translated into settlement contours that are then used to identify property at potential risk. For the proposed scheme any building where the predicted settlement is less than 10mm and the predicted slope is less than 1/500 shall not be subject to further assessment in accordance with the guidance provided by CIRIA Project Report 30 'Prediction and effects of ground movements caused beneath urban areas'. Settlement and slope in excess of these values will be progressed to the next assessment stage.

In addition buildings and structures identified from site inspection that are deemed to be particularly susceptible to ground movements, or are of significant public interest shall also be progressed to the next assessment stage for further study. Typically these include:

- Complex structures;
- High value structures;
- Prestigious property;
- Prominent structures;
- Structures of cultural or historical value;
- Structures in poor condition;
- Structures known or suspected to contain equipment sensitive to ground movements e.g. hospitals, recording studios, aircraft instrumentation.

In addition to buildings there will be items of infrastructure that will be affected by the underground construction of the proposed scheme, including:

- Highways;
- Luas;
- Railways;
- Embankments;
- Bridges;
- Electricity substations;
- Canals;
- Airport infrastructure;
- Monuments;
- Hospitals.

For the Stage 1 assessment any item of infrastructure that falls within the predicted 2mm contour line will be selected for further assessment at Stage 2A.

At this stage consideration is also given to alignment adjustment to minimise the amount of damage, reduce the number of buildings affected, or to avoid particularly sensitive property.

Stage 2A Initial Response Assessment
This stage involves the assessment of the response of buildings and infrastructure (identified during Stage 1) to predicted ground movements, and where appropriate the consideration of possible mitigation measures.

All buildings carried through from the Stage 1 Assessment are individually assessed using a limiting tensile strain approach. Buildings are modelled and assumed to follow the greenfield settlement profile of the ground. This approach is conservative since it neglects any interaction between the stiffness of the buildings and the ground.

The maximum tensile strains resulting from differential settlement and/or rotations of the foundations are calculated and together with the ground surface settlement predictions the corresponding levels of risk are determined in accordance with Table 9.3. The impact of ground movements on piled buildings has been assessed in accordance with methodology proposed by Kaalberg and guidance from Professor John Burland.

Buildings identified as being in the negligible, very slight or slight damage risk category will not be assessed further. Where buildings or structures are classified as being at moderate damage or above risk levels, then a review of the construction methods proposed is undertaken and if appropriate amended and the building(s) reanalysed. Where ground movements still generate an unacceptable level of risk to buildings they are passed to Stage 3 for detailed assessment. In addition buildings that are deemed to be complex structures in terms of their response to ground movements, or where the application of the Stage 2A building response assessment methodology is considered inappropriate are also progressed to the Stage 3 detailed assessment.

As noted earlier, the above approach for deriving categories of damage is likely to be conservative in its estimation. In the majority of cases the likely actual damage will be less than the assessed category since the calculation of tensile strain assumes that the building in question has no inherent stiffness, and that it deforms to the greenfield settlement profile. In reality the stiffness of the building will interact with the supporting ground, and therefore tend to reduce the deflection ratio and horizontal strains. More robust buildings such as framed buildings will offer greater restraint and therefore ground slope may overestimate likely damage.

The Stage 2A assessment of infrastructure involves an assessment of the impact of predicted ground movements against specified limiting criteria set down by standards or infrastructure owner's guidance documents. In the absence of documents defining limiting criteria, assessments are undertaken to demonstrate the predicted ground movements do not cause unacceptable damage. Where infrastructure is adjudged to be at potential risk, then the assessment is progressed in a manner similar to that described for buildings above.

The impact of long term consolidation settlements resulting from groundwater drawdown is also considered at Stage 2A.

Stage 2B Review of 2A Initial Response Assessment
Stage 2B provides for a review and update of the Stage 1 and 2A assessments taking account of the detailed design and actual construction methods to be used.

Stage 3 Detailed Response Assessment
This stage involves a detailed assessment of all buildings, utilities and infrastructure carried over from Stage 2B, and the design and implementation of protection measures as appropriate.

All buildings that fall into the moderate, severe and very severe categories will be assessed in detail taking account of information collected from detailed structure and sub-structure surveys. The method, extent and detail of the analysis will be determined on a case by case basis, however factors that would be taken account of include, three dimensional effects, construction and excavation methods and sequencing, structural continuity of the building, foundation and structural details, building condition, orientation of the building, soil / structure interaction, settlement predictions at depth and previous movements. Reflecting the conservative assumptions of the previous assessments, the detailed evaluation will usually result in a reduction in the possible degree of damage. If any buildings fall into the 'at risk' category after the Stage 3 Assessment then further amendments to construction proposals will be considered as will possible protective works. The assessment is then repeated to ensure that the measures taken remove the property from the 'at risk' category.

Prior to the Railway Order Planning Application, Stages 1 and 2A have been undertaken by RPA. The remaining stages of the process shall be undertaken by the Contractor taking account of its detailed design and construction proposals.

The criteria used to assess the impact of construction generated ground movements on overlying and adjacent buildings are in accordance with the building damage classification system set out by the Building Research Establishment 251 (1990) using a limiting tensile strain approach (see Table 9.3).

The calculated damage category forms the basis for determining the need for ground movement mitigation measures for each of the buildings assessed. It is generally considered that where the degree of damage predicted is "negligible", "very slight" or "slight" that these categories fall under the aesthetic damage category and that protective measures are not required.

The basis for not providing protective measures for the slight damage category or below is that small deformations that cause cracking with a very low risk of structural damage may generally be more easily and cost effectively repaired than the measures required to prevent them. Any potential protective measures are likely to result in considerable disruption to the function and occupiers of the buildings, and may themselves cause some degree of cracking or damage during their installation. Therefore it is preferable to monitor the buildings, with final crack repairs, re-plastering and finishing being carried out after the cessation of ground movements.

Table 9.3 Building Damage Classification System

Category of damage	Normal degree of severity	Limiting Tensile Strain (%)	Description of typical damage
0	Negligible	0 – 0.05	Hairline cracks less than about 0.1mm
1	Very Slight	0.05 – 0.075	Fine cracks not greater than 1mm which are easily treated during normal decoration.
2	Slight	0.075 – 0.15	Cracks less than 5mm. Cracks filled. Re-decoration probably required. Recurrent cracks can be masked by suitable linings.
3	Moderate	0.15 – 0.30	Cracks 5-15mm, or number of cracks >3mm. The cracks require some opening up and can be patched by a mason. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.
4	Severe	>0.3	Cracks 15-25mm. Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.
5	Very Severe	>0.3	Cracks >25mm. This requires a major repair job involving partial or complete rebuilding.

For buildings where the degree of severity of ground movement damage is "moderate" or above, protective measures will be considered with the aim to restrict damage to the "slight" category or below. However it is recognised that the degree of importance attached to cracks less than 5mm can be subjective, and there may be situations where such damage would be unacceptable. For example where a building has been identified as having historical or other significance and the development of such cracking may be unacceptable, then the limit before mitigation or protection measures are considered is reduced to "very slight".

9.3.2 Significance

The significance of all impacts is assessed in consideration of the magnitude of the impact and the functional value of the area upon which the impact has an effect.

9.4 IMPACT ASSESSMENT

9.4.1 Impact identification

The following components of the proposed scheme may cause impacts on soils and geology.

- All areas where elements of the proposed scheme intersect soils or geology e.g. stops, track, substations, ventilation shafts, landscaping bunds, ancillary roads and access ways and tunnel portals;
- Earthworks, cuttings and embankments;
- Spoil storage areas and disposal sites;
- Construction compounds;
- Track maintenance and drainage operations which may lead to contamination of soil.

In addition ground movements generated by the excavation and construction of the following has the potential to impact on property overlying or adjacent to sites where such works are being undertaken:

- TBM bored tunnels;
- Cut and cover tunnels;
- Retained cuttings;
- Mined tunnels;
- Shafts;
- Stop (station) boxes;
- Portal structures.

Two types of impact are recognised to occur: temporary and permanent.

9.4.1.1 Temporary impacts

Temporary impacts are typically associated with the construction phase of the proposed scheme. These impacts are typically short-term in nature and are required to facilitate the construction of the proposed scheme. The impacts will not continue after the construction phase has been completed. Impacts of this type include those associated with activities such as the movement, excavation and disposal of soils, contaminated materials and bedrock, temporary paving or compaction of soils, temporary construction of roads, traffic management procedures and dewatering works.

In some cases, only minor disturbance of soils occurs. An example of this is areas on construction compounds used for temporary administration structures or ground disturbed during construction but not subject to compaction.

9.4.1.2 Permanent impacts

Permanent impacts are longer term impacts which are expected to persist for the lifetime of the proposed scheme and its operation. Permanent structural impacts occur where the soil or geology has been permanently altered to allow for the construction of the parts of the proposed scheme e.g. sealing of surfaces by paving and also impacts associated with the installation of the railway, new traffic systems or roadways, drainage and conduit channels, car park facilities, ancillary buildings and ground movement and / or settlement.

Permanent operational impacts occur where the general day to day operation of the proposed scheme impacts on soil and geology. Potential impacts of this type arise due to activities such as maintenance works (including track cleaning) and activities which could potentially lead to contamination.

To assess the impact of ground movements in Area MN103, a Stage 1 Preliminary Ground Movement Assessment and Stage 2A Preliminary Building Response Assessment have been undertaken. For items of airport infrastructure, this assessment has been based on information provided by Dublin Airport Authority (DAA), Irish Aviation Authority (IAA) and Air BP. From these assessments the following impacts have been determined:

Highways
The assessment of highways has been undertaken in two stages:

1. An assessment of the impact of ground movements on serviceability criteria, measured in terms of poor performance due to excessive change in gradient, cross fall and / or road drainage inefficiency. These criteria are more critical and onerous in determining the performance of a highway than risk of structural damage.

2. For highways identified as exceeding serviceability limiting criteria, or highways deemed to be particularly sensitive to ground movements, a risk based approach has then been adopted to consider particular features of the highway such as surfacing material, condition and traffic levels / usage. The risk assessment has been completed considering likelihood of 'ponding' occurring, and requirement for temporary and permanent repair. An assessment of the temporary and permanent situations has also been undertaken for walkways.

The roads identified within Area MN103 are predicted to settle up to a maximum of 15mm. Based on experience of highway maintenance, settlements of up to 50mm are considered permissible for carriageways and can be managed for temporary situations provided ground slope is not greater than 1:500 which is the case for Area MN103. Resurfacing may be required on the cessation of ground movements over short lengths of road.

Buildings
Existing building facilities including, storage facilities, hanger 5, APU Engine Test Cell buildings, terminal building pier C, proposed terminal building Pier E and the proposed hotel and multi-storey car development are predicted by the Stage 2A assessment to be exposed to a predicted settlement of 11mm or less, and a slope not greater than 1:2250, resulting in a predicted damage categorisation of 0 in accordance with Table 9.3.

Airport Hardstandings
The bored tunnel passes beneath the north and south aprons and taxiway TWYB1 on the south side of the airport.

The proposed south apron is predicted to settle a maximum of 15mm, reducing to 0mm over the length/width of 6 bays, hence each slab bay is expected to be subject to approximately 2mm settlement. Applying the principles specified ASTM (American Society for Testing of Materials) D 5340, Standard Test Method for Airport Pavement Condition Index Surveys these aprons and taxiway have been classified as being in the low risk severity category and any potential damage is likely to be remedied by planned maintenance activities.

The main concern where settlement occurs under pavement slabs is loss of support, particularly differential settlement, which might cause the slabs to 'rock' inducing 'pumping' in the subgrade and cracking/damage to the slabs. If the settlement leaves an unacceptable degree of deformation in the pavement surface, grouting can be undertaken to stabilise the ground and re-level the slabs. Tunnelling generated ground movements are not expected to compromise airport operations. Where remedial measures are required, these can be undertaken during non-operational hours.

The impact of ground movements on pavement levels has also been reviewed to assess the impact on the drainage system. The assessment shows that the performance of the drainage system is not reduced as a result of a slight reduction in drainage falls due to settlement.

Fuel hydrants and associated pipework
The south apron structure incorporates the fuel hydrant pipework and hydrant pit boxes. The hydrant pits have been assessed as being capable of accommodating the 15mm settlement predicted. The fuel main would be constructed of welded steel pipe which should be capable of accommodating any minor deflection caused by the predicted ground settlement but this would need to be confirmed by Air BP at detail design.

Airport instrumentation
Localiser 16 Antenna Array is predicted to settle up to 10mm. Structurally the foundation is not considered to be at risk of damage. However there is the possibility of:

- Possible damage to antennae array, cables and associated units;
- Misalignment of antennae array resulting in a system shutdown or system operating out of tolerance and requiring re-commissioning;
- Damage to lightning protection.

9.4.2 Mitigation measures

Paving
Paving of areas will be avoided where possible. Paved areas that are not required after the construction of the proposed scheme will be removed and reinstated with landscaping to compliment the surrounding landuse. The areas that are to be reinstated are illustrated on the Landscape Insertion Plans in the Landscape and Visual chapter of this EIS (Volume 2, Chapter 13).

Compaction
Compaction of areas will be avoided where possible. Hoarding and signposting will be used in this regard to clearly demarcate haulage routes and other areas being used during construction. Landscaping and restoration will be undertaken with areas reinstated to their original condition, where possible. The areas that are to be reinstated are illustrated on the Landscape Insertion Plans in the Landscape and Visual chapter of this EIS (Volume 2, Chapter 13).

Excavation
Excavation of areas will be avoided where possible. Areas of potential contamination may be encountered during the construction phase. Uncontaminated spoil will be reused where possible within the proposed scheme to construct areas such as the depot, embankments, bunds and landscaping structures.

Uncontaminated spoil will be loaded directly onto trucks so that intermediate storage will not usually be required. Any contaminated spoil will be treated in accordance with all relevant legislation and best practice guidelines at the point of origin or at an alternative suitable site prior to disposal. Spoil will be dewatered, as part of treatment, if required, in order to reduce the volume of spoil generated.

Once the spoil has been loaded onto the trucks, the trucks will then travel directly to the area in which the spoil is to be reused, recycled or disposed. All trucks will be covered during transport. Spoil that cannot be reused or recycled will be disposed of in a manner that is in accordance with all relevant legislation and best practice guidelines.

Any mitigation measures associated with potential human health impacts are addressed in the Human Health chapter of this EIS (Volume 1, Chapter 8). Measures taken to reduce the potential for environmental pollution and dispersion of contaminated soil comprise capping of contaminated areas and dust suppression if necessary. The disturbance of contaminated soils will be minimised and an appropriate risk assessment will be undertaken to mitigate against environmental risks.

Waste, spoil and contamination
A waste management plan is to be developed in accordance with the Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects (DoEHLG, 2006) as part of the construction environmental management plan to ensure that all construction waste is stored, managed, moved, reused or disposed of in an appropriate manner by appropriate contractors in accordance with all relevant waste legislation. A spoil strategy is to be developed as part of the Waste Management Plan to ensure that spoil and any potential contamination is dealt with in an appropriate manner in accordance with all relevant legislation.

Maintenance of the Light Metro Vehicles (LMVs) will only occur in hardstanding areas of the depot. All maintenance/repair work of LMVs or track will be undertaken using non-polluting substances where possible. Any hazardous materials required for the proposed scheme's maintenance will be stored in bunded areas.

Ground gases including radon
It is noted the Radiological Protection Institute of Ireland (RPII) assessment does not take into consideration exposure pathways that may be created due to any underground works such as the construction of tunnels or underpasses. In recognition of this fact, an occupational monitoring programme will be implemented to ensure that no adverse impacts occur as a result of the tunnel construction process due to the migration of ground gases (including carbon dioxide, methane and radon) which may be mobilised due to the tunnel construction technique or associated dewatering activities.

The RPII has issued separate guidance in respect underground working entitled 'Radon in Underground Workplaces - Guidance Notes for Employers' (2007) and in this guidance an occupational exposure standard of 400 Bq/m³ has been set. If radon levels in the underground sections of the proposed scheme exceed this threshold during construction, appropriate remedial measures (as prescribed by the RPII) will be undertaken to ensure that no negative impact on the surrounding environmental occurs.

Settlement
The mitigation and protection measures for Area MN103 have, or are expected to take the form of the following:

(a) Ground investigation
To enable the adequate design of ground support measures to control and manage ground movements resulting from tunnels and stop box construction and the accurate prediction of ground movements. For the proposed scheme this has been achieved by undertaking a review of historical site investigation data available from Geological Survey Ireland, the Metro North Preliminary Ground Investigation, the Metro North Main Ground Investigation and a desk study review of historical maps. Further ground investigation will be carried out as required for the detail design and construction phase of the proposed scheme.

(b) Sub-structure surveys and building records
The collection of sub-structure survey data, building condition data and as-constructed records to enable the impact of ground movements to be accurately determined, and appropriate mitigation and / or protection measures to be designed where required.

(c) Alignment design
The tunnel horizontal alignment has been set with a tunnel separation of two tunnel diameters to minimise settlement effects and impacts.

This separation may however be reduced during detailed design but only should there be the assurance that the anticipated settlement effects and impacts are substantially unchanged.

The tunnel vertical alignment between the portals and the Airport Stop has been designed with a low point to maintain the tunnels at depth so far as possible to minimise the peak settlement generated at ground level.

The tunnel vertical alignment at the portals has been set with rail level approximately 14m below ground level (subject to the limits of deviation) to minimise impact on the roads located close to the TBM launch and reception sites.

Cross passages have been located wherever possible beneath greenfield sites to minimise settlement impact on airport infrastructure. Relocation of cross passages and sumps depending on location of geological discontinuities encountered during running tunnel construction shall be also undertaken if required.

(d) Internal measures
The running tunnels will be constructed using a TBM with the capability to pressurise and support the tunnel face to minimise ground losses. Probing ahead of the tunnel face to determine problematic ground conditions in advance will also be undertaken as necessary. The installation of a segmental tunnel lining with the annulus (the void between the back of the tunnel lining and the excavated profile of the ground) grouted immediately after erection and installation of the tunnel lining will further reduce the opportunity for the ground to relax and generate surface settlement.

At the interface of the tunnel with the Airport Stop box, the ground immediately outside the box may be treated to prevent excessive ground movements at the surface being generated. In addition the presence of a backfilled quarry at the northern end of the Airport Stop will potentially result in increased sensitivity to settlement and may therefore require ground treatment as the TBM enters / exits this portion of ground. This backfilled quarry may also require treatment to assist with the management of ground movements during the construction of the Airport Stop.

The cross passages will be constructed using sequential excavation measures (SEM). Excavation in parts, sequencing of excavation, reducing excavation lengths and installing pre-support as required will be employed to maintain tunnel stability and manage ground movements at the surface. Where cross passages are constructed in the glacial till ground treatment may be undertaken to stabilise sand and gravel lenses, while in the limestone fissure grouting to prevent excessive water inflows, or stabilisation of solution features may be employed.

For the Stop box, structural measures comprising stiffness of the vertical support, propping arrangements and excavation phasing will be employed to maintain ground movements within manageable limits. Ground treatment may also be employed to manage ground water inflows at the interface between rock and the softer overlying ground.

In the permanent condition the tunnels and Airport Stop are designed as undrained structures thereby preventing ground water drawdown and the potential for long-term consolidation settlement. For the SEM tunnels this will be achieved by placing an insitu concrete lining with a waterproof membrane, while the TBM constructed tunnel will have a single segmental tunnel lining that will be watertight.

(e) Instrumentation and Monitoring
A comprehensive instrumentation and monitoring regime will be implemented to monitor ground displacements and the deformation of structures. Measurements can be taken at the surface or indirectly from sub-surface installations. Instrumentation that may be employed includes:

- Optical/electronic surveying methods;
- Portable displacement gauges;
- Single point monuments;
- Vertical pipe settlement gauges;
- Remote settlement gauges;
- Heave gauges;
- Inclinometers and electrolevels;
- Borehole extensometers;
- Soil strain gauges;
- Tunnel convergence;
- Piezometers;
- Load cells and strain gauges.

For the monitoring of structures, greenfield sites and the hardstanding areas airside, remote monitoring systems will be required, most likely comprising total stations and prismatic targets with the ability to remotely relay monitoring readings back to a central data base for review, interpretation and assessment.

Instrumentation will be installed to enable baseline monitoring to be undertaken 6 to 12 months prior to construction to identify ambient background levels, operator variations, reading errors, instrument error, survey and seasonal variations.

During construction, verification of the predicted settlement and building damage assessment results will be carried out using actual monitoring data measured on site. The results of the verification re-analysis shall be communicated back to the design and site teams so that modifications to the construction methods and/or the protection and mitigation measures can be made if appropriate. Additionally instrumentation and monitoring arrays will be installed to greenfield site areas encountered early on in the tunnel drive to enable the predicted settlements and impacts to be validated against actual settlement before tunnel construction proceeds beneath the taxiways and airport aprons.

(f) Action and contingency plans
A pre-determined plan of action in response to recorded readings to ensure that action is taken before damage is incurred to buildings, structures, utilities and infrastructure or the stability of the works are placed at risk. The action and contingency plans shall be integrated with monitoring and construction plans.

(g) Particular mitigation and protection measures

(i) Highways

Resurfacing of highways to restore highways to their original condition prior to the proposed scheme construction may be required.

(ii) Airport hardstandings

If due to settlement, loss of support occurs beneath the pavement slabs, grouting of the void to stabilise the slab can be undertaken to stabilise the ground and re-level the slabs.

(iii) Airport instrumentation

Localiser 16 Antenna Array is located within the predicted settlement zone with a potential predicted settlement of up to 10mm. Possible Mitigation Measures which could be undertaken during tunnelling works comprise:

- System withdrawn from service during the period of works (Subject to Operational Air Traffic Control and DAA Approval).
- Use of subsidence monitors on the foundation remotely monitored ideally at the IAA's Dublin Technical Control Desk, which is manned 24Hrs.
- The system is remotely monitored for shutdown from the Technical Control Desk within the control tower.

(h) Property Protection Scheme
A Property Protection Scheme will be implemented covering properties within 30m of the tunnel centreline or the face of a cut and cover structure. If damage occurs as a result of the underground works below a ceiling of €30,000, as certified by an independent firm of building surveyors, arrangements will be made for prompt rectification involving as little disruption to the property owner as possible. The Property Protection Scheme is in addition to and does not impede people's normal legal rights.

9.4.3 Assessment of residual impacts

9.4.3.1 Project scenario: construction phase

Paving
A number of paved areas will be constructed in Area MN103. These paved areas will include parts of the track, tunnel portal, the tunnel and the Airport Stop. The magnitude of the impact associated with paving of any area is considered to be very high because the soil cannot continue to perform its natural functions. The paved areas at the tunnel portal are located predominantly in areas of high functional value so the magnitude and significance of this impact is High. When the mitigation measures are taken into consideration, the magnitude and significance of this impact remains the same but the footprint of the area impacted upon decreases.

There are also areas of natural soil, made-ground and paved areas such as areas to the north of the tunnel portal and at the halting site in this area. These have lower functional value and the significance of impact Medium, Low and Very low respectively.

The locations of paved illustrated on the Landscape Insertion Plans in the Landscape and Visual chapter of this EIS (Volume 2, Chapter 13).

Compaction
Compacted areas will occur during the construction phase in Area MN103. These will include parts of the track, the tunnel portal, the tunnel and the Airport Stop. The magnitude of the impact associated with compaction of an area during construction is high as the soil is compressed and disturbed and this has a detrimental effect on its ability to perform its natural functions. The compacted areas at the tunnel portal will be constructed predominantly in areas of high functional value so the magnitude and significance of this impact is High. When the mitigation measures are taken into consideration, the magnitude and significance of this impact remains the same but the footprint of the area impacted upon decreases.

There are also areas of natural soil, made-ground and paved areas such as areas to the north of the tunnel portal and at the halting site. These have lower functional value and the significance of impacts in these areas decreases to Medium, Low and Very low respectively.

The locations of paved areas are illustrated on the Landscape Insertion Plans in the Landscape and Visual chapter of this EIS (Volume 2, Chapter 13).

Excavation
Excavation of soil will occur at the tunnel portal and the Airport Stop. The magnitude of impact associated with this excavation activity is high as the soil has been disturbed. Excavation associated with the tunnel portal is to occur in areas of high functional value so the impact is of High significance.

There are also areas of made-ground and paved areas such as the halting site in this area. These areas are of lower functional value with respect to soil and the impact is of Low to Very low significance.

Excavation associated with the Airport Stop occurs in an area of very low functional value, so the impact is of Very low significance.

The locations of paved areas are illustrated on the Landscape Insertion Plans in the Landscape and Visual chapter of this EIS (Volume 2, Chapter 13).

Waste, spoil and contamination
Soil from a number of sampling locations along the route has been sampled and tested for contamination. In all cases, the current information indicates that there will not be any impact on commercial landuses in which the samples all occur because contamination levels are all below the screening criteria for a commercial end landuse.

However, soil sampling was undertaken at discrete representative locations based on historical activities and an assessment of the potential for contamination to be encountered. Areas of soil contamination could potentially be encountered in other areas outside the areas where analysis was undertaken.

If contamination is encountered in other areas during construction, the magnitude of this impact will range from low to high depending on the type and amount of contamination encountered. Areas of contamination may be encountered in Area MN103 in areas of Medium functional value so the impacts would be of medium significance if mitigation measures were not put in place. The mitigation measures to be put in place are specified in Section 9.4.2. When these mitigation measures are taken into consideration, the magnitude of the impact will be reduced to low or very low.

A total of approximately 2.9 million cubic metres of spoil is to be generated across the proposed scheme. Approximately 2.0 million cubic metres of this spoil is to be reused in the proposed scheme for a number of purposes such as construction of embankments, levelling of topography, landscaping and other mitigation measures. Where reuse is not possible, spoil will be recycled and where this is not possible, spoil will be disposed of in a manner that is in accordance with all relevant legislation. Impacts associated with the transport of spoil are assessed in the Traffic chapter of this EIS (Volume 2, Chapter 7). A waste management plan is to be developed as part of the construction environmental management plan to ensure that all construction waste is managed, stored and disposed of in an appropriate manner by appropriate contractors in accordance with all relevant waste legislation.

Ground gases including radon
Radon gas comes from the radioactive decay of minute quantities of uranium present in all rocks and soils. The RPII has produced a 'Radon Map of County Dublin' which was compiled based on monitoring results from a number of sample houses within the county. The map illustrates 10km grid squares within the county and provides an estimate of the percentage of dwellings within each 10km area which are predicted to exceed the domestic radon standard of 200 Bq/m^3 of radiation.

The geology of the study area is described in the Soil and Geology chapter of this EIS (Volume 1, Chapter 17). As detailed in this chapter, the study area is dominated by limestones and shales which would allow the transmission of radon to occur if a significant source of radon existed.

However, the RPII database indicates that within the study area, the percentage of dwellings predicted to exceed the domestic radon standard is low (1- 5%) and the area is not defined as a 'high radon area'. This provides an indication that the area as a whole is not likely to be associated with a significant radon problem.

It is noted that the RPII assessment does not take into consideration exposure pathways that may be created due to any underground works such as the construction of tunnels or underpasses. In recognition of this fact, the mitigation measures detailed in Section 9.4.2 are to be put in place to ensure that no significant adverse impact occurs.

Settlement
For Area MN103 the residual impact is a maximum predicted settlement of 15mm. The significance of the impact is Very low.

9.4.3.2 Project scenario: operational phase

Scheme maintenance
Maintenance work is likely to be undertaken along the track within the tunnel section. As a result, the potential for contaminating materials (such as oils and lubricants) to impact on the soil outside of paved areas is Very low. The magnitude of impact associated with a spill of hazardous materials during maintenance/repair work is high because of the potential for soil contamination to occur. However areas around the track are typically of low to very low functional value and when the mitigation measures set out in Section 9.4.2 are taken into account, the significance of an impact is Very low.

During the operational phase Metro North infrastructure will not generate further ground movement. The underground structures are designed as undrained (watertight) and therefore long-term ground movements beyond the construction phase are not expected to occur.

9.4.3 Summary of residual impacts

A summary of the residual impacts associated with the scheme and affecting this area is provided in Table 9.4.

Table 9.4 Summary of residual impacts

Location	Area of land-take (m^2)	Type of impact	Significance of Impact
MN103	52,000	Paved	Predominantly Low to Very low. Medium to High in the area of the Northern Airport Tunnel Portal
MN103	12,000	Potentially Disturbed Ground	Predominantly Low to Very low. Medium to High in the area of the Northern Airport Tunnel Portal

10 GROUNDWATER

This chapter of the EIS describes the potential impacts on groundwater, which may arise due to activities associated with the construction and operation of the proposed scheme in Area MN103.

10.1 INTRODUCTION

This chapter of the EIS describes the potential impacts on groundwater, which may arise due to activities associated with the construction and operation of the proposed scheme in Area MN103.

10.2 STUDY AREA

The study area for this assessment is set out in Table 10.1.

Table 10.1 Study area

Criteria	Width of study area (on both sides of the alignment)
Groundwater	500m

10.3 IMPACT ASSESSMENT METHODOLOGY

The source and type of all potential impacts is described in Section 10.4.1. Mitigation measures to be put in place are defined in Section 10.4.2. Mitigation measures are defined for any adverse impacts that are deemed to be of Medium or greater significance prior to mitigation. The extent to which mitigation is needed increases as the significance of the impact increases. The residual effect of each impact is then evaluated in Section 10.4.3 in terms of magnitude and significance.

10.3.1 Magnitude

The criteria used to assess the different impacts associated with the proposed scheme are shown in Table 10.2. The criteria have been defined in consideration of the 'Guidelines on Information to be Contained in Environmental Impact Statements' (EPA, 2002).

Table 10.2 Criteria for assessment of impact magnitude

Criteria	Impact magnitude
- Permanent impact relating to the alteration of the direction of groundwater flow - Long-term impact relating to the depletion of groundwater sources due to dewatering activities - Long-term impact relating to the deterioration of groundwater quality (if left untreated) - Permanent impact relating to the recharge of the underlying groundwater sources	very high
- Long-term impact relating to the alteration of the direction of groundwater flow - Medium-term impact relating to the depletion of groundwater sources due to dewatering activities - Medium-term impact relating to the deterioration of groundwater quality (if left untreated) - Long-term impact relating to the recharge of the underlying groundwater sources	high
- Medium-term impact relating to the alteration of the direction of groundwater flow - Medium-term impact relating to the depletion of groundwater sources due to dewatering activities - Medium-term impact relating to the deterioration of groundwater quality (if left untreated) - Medium-term impact relating to the recharge of the underlying groundwater sources	medium
- Short-term impact relating to the alteration of the direction of groundwater flow - Short-term impact relating to the depletion of groundwater sources due to dewatering activities - Short-term impact relating to the deterioration of groundwater quality (if left untreated) - Short-term impact relating to the recharge of the underlying groundwater sources	low
- Temporary impact relating to the alteration of the direction of groundwater flow - Temporary impact relating to the depletion of groundwater sources due to dewatering activities - Temporary impact relating to the deterioration of groundwater quality (if left untreated) - Temporary impact relating to the recharge of the underlying groundwater sources	very low

The duration of impacts (as detailed in Table 10.2) are defined as shown in Table 10.3 as per EPA Guidance (EPA, 2002).

Table 10.3 Definition of duration criteria

Impact Description	Definition
Permanent impact	Impact lasting over sixty years
Long-term impact	Impact lasting fifteen to sixty years
Medium-term impact	Impact lasting seven to fifteen years
Short-term impact	Impact lasting one to seven years
Temporary impact	Impact lasting for one year or less

10.3.2 Significance

The significance of all impacts is assessed in consideration of the magnitude of the impact and the functional value of the area upon which the impact has an effect. The functional value of all groundwater resources is set out in the baseline Groundwater chapter of this EIS (Volume 1, Chapter 18).

10.4 IMPACT ASSESSMENT

10.4.1 Impact identification

Various elements of both the construction and operational phases have the potential to impact on the groundwater environment.

10.4.1.1 Construction phase impacts

During the construction phase, certain activities have the potential to impact on the hydrogeological environment within the study area. Potential impacts can include localised alteration of the direction of groundwater flow due to tunneling operations and the installation of piles for the construction of bridges. Developments that extend into underlying aquifers, for example during tunneling, can potentially cause temporary lowering of the water table. This can result in the depletion of groundwater in supply wells (where present) in the surrounding area.

There is the potential that the underlying groundwater quality may be impacted during the construction phase due to leakage of fuel from construction vehicles, oil spillages during refueling or vehicle maintenance operations, leakage from chemical storage areas and inappropriate disposal of chemicals (paints, oils, glues etc.). Surface contaminants can migrate towards underlying groundwater sources. Contaminants arising from similar activities during subsurface operations can be released directly into the surrounding aquifer. It should be noted that the construction of the proposed scheme may result in a localised improvement in groundwater quality along some sections of the route due to the removal of overlying contaminated material.

10.4.1.2 Operational phase impacts

Potential impacts on the groundwater environment during the operational phase would be expected to include localised alteration of the groundwater flow along sections of the proposed route where tunnels exist. The replacement of greenfield areas along sections of the route with areas of hardstanding areas (stops, rail depots, in addition to Park & Ride facilities) can reduce to some extent the recharge rate into the underlying aquifer. The construction of a tunnel within an aquifer can result in a localised depression of the water table due to the construction of sumps within the tunnel.

During the operational phase of the proposed scheme, there is the potential for the migration of surface contaminants (arising from the leakage of oils from LMVs, chemical storage areas at depots, wastewater discharge and runoff from car parks, for example) towards the underlying groundwater sources. Due to the fact that the tunneled sections of the route will comprise sealed structures and all underground pipework will include appropriate containment measures, the potential for contamination from underground sections of the route is considered to be low.

10.4.2 Mitigation measures

10.4.2.1 Construction phase

All of the impacts identified for the construction phase of the proposed scheme for this section of the route were found to be of Low significance. The following good housekeeping practices will be implemented in order to ensure protection of the surrounding groundwater sources.

Where possible groundwater will be recharged to the groundwater aquifer. Potentially contaminated groundwater generated by construction activities and firewater (in the event of a fire in the tunnel) will be removed from the tunnel by a sump and pump arrangement to a foul water sewer at the surface in accordance with the conditions set in the Trade Effluent Discharge License from the relevant Local Authority. Where required by the Local Authority, the treatment of groundwater will be carried out prior to discharge to the foul sewer in order to comply with the requirements of the discharge licence, which may contain limits for such parameters as, inter alia, pH, heavy metals, hydrocarbons, suspended solids and BOD. In the event that sufficient capacity is not available in the local foul sewer, the groundwater will be treated in accordance with the conditions in the Effluent Discharge License from the relevant Local Authority prior to discharge to a nearby surface water body. The treatment of groundwater will include as a minimum the use of silt/sediment traps and oil interceptors prior to the release to surface water bodies, surface water drains or foul sewers. The discharge of firewater to surface water bodies or surface water drains will not take place.

Surface water and groundwater, which is generated during the construction phase, will be collected on-site and tested prior to discharge to the surface water drain or foul sewer, in order to ensure any related adverse impacts are minimised. The treatment of surface water runoff and groundwater will include as a minimum the use of silt/sediment traps and oil interceptors prior to the release to surface water bodies, surface water drains or foul sewers.

Foul water generated by the welfare facilities at the construction compounds will collected in portaloo facilities. At the larger compounds semi-permanent welfare facilities may be provided and the foul water generated will be treated at a local package treatment plant and the effluent will be discharged to local foul sewers.

Groundwater pollution will be minimised by the implementation of good construction practices as contained in the publication by the Construction Industry Research and Information Association (CIRIA) 'Control of Water Pollution from Construction Sites, Guidance from Consultants and Contractors' (Master, Williams et al. 2001). An emergency response protocol for pollution incidents will be established by the contractor and regularly updated. This protocol will include containment measures, a list of appropriate clean up materials and equipment, details on staff responsibilities and trained personnel and contact details for pollution clean up companies and relevant Local Authorities and emergency services..

In order to minimise any impact on the underlying subsurface strata and groundwater from material spillages, all oils, solvents and paints used during construction will be stored within labelled, sealed containers in specially constructed dedicated, temporary, bunded areas or suitable bunded lockable storage containers within buildings or enclosures (hardstanding) in the construction compounds or TBM (Tunnel Boring Machine) launch site. The storage of small quantities of oils, lubricants and conditioning agents for the TBM in the tunnel will follow similar containment procedures. A strict protocol will be followed for the movement of any oils, chemical substances or other potentially hazardous construction materials from the TBM launch site or stop box compounds down into the tunnel.

Taking into account the 'Guidance Note for the Control of Pollution (Oil Storage) (England) Regulation 2001' (Department of Environment, Food and Rural Affairs in the UK (DEFRA), 2001), oil and fuel storage tanks shall be stored in designated bunded areas within the surface construction compounds and TBM launch site. These areas shall be either double skinned or shall be bunded to a volume of 110% of the capacity of the largest tank/container present or 25% of the total tank capacity within the bund (plus an allowance of 30mm for rainwater ingress). Filling and draw-off points will be located entirely within the bunded area(s). Drainage from the bunded area(s) shall be diverted for collection and safe disposal off site by an appropriately licensed contractor. All storage tanks will have primary, secondary and tertiary containment. Their integrity will be regularly checked and maintained. Tank level gauges will be checked regularly in order to detect leakage at an early stage.

Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles, will take place in a designated area of the surface stop box compound or TBM launch site. The refuelling area will not be situated close to any surface water body or surface water drain. If it is not possible to bring a machine to the refuelling point, fuel will be delivered in a double skinned mobile fuel bowser. A drip tray will be used beneath the fill point during refuelling operations in order to further contain any spillages that may occur. Spill-kits and hydrocarbon adsorbent packs will be stored in this area and operators will be fully trained in the use of this equipment. Spill-kits and drip trays will be used to contain any spillages, which may occur.

Where concrete mixing is required this will only take place at a designated area at the construction compound, which will not be located next to a surface water drain or stream. The washing of concrete mixing vehicles will take place in a hardstanding bunded designated area. An emergency response protocol will be implemented in the event of concrete spillages during pouring operations.

All associated hazardous waste residuals, such as oil, solvent, material used in oil spill clean ups, glue and solvent based paint containers will be stored within appropriately covered skips at the TBM launch site or stop box compounds prior to removal by a suitable Local Authority or EPA licensed waste management contractor for off-site treatment/ recycling/disposal. Any other construction waste will be disposed of to on-site skips for removal by a duly approved waste management contractor.

Stockpiles of spoil from tunnelling operations will be covered (to minimise the generation of runoff) and temporarily stored at the TBM site in a bunded area of hardstanding prior to collection by a suitably licensed waste contractor on a regular basis for off-site disposal.

10.4.2.2 Operational phase

All of the impacts identified for the operational phase of the proposed scheme for this section of the route were found to be of Low significance. The following good housekeeping practices will be implemented in order to ensure protection of the surrounding groundwater sources.

Substations located at each stop will be regularly checked and maintained to minimise the potential for leakage of oil from them. The substations will be located on areas of hardstanding and bunded.

In accordance with the Waste Management Act 1996 (as amended) and associated regulations, waste material generated at the stops along this section of the route should be stored in a suitably designed waste storage area and transferred to the surface for collection on a regular basis by a suitably licensed waste collection contractor for disposal at an appropriately licensed waste facility. The waste storage area should be regularly and appropriately maintained.

Foul effluent generated at the Airport Stop along this section of the route will be discharged to the foul water sewer at the surface by means of a sump, pump and rising main arrangement under the approval of the relevant Local Authority. This will ensure that untreated foul water is not released into the surrounding groundmass, thus towards the underlying groundwater sources. A similar arrangement will apply for the discharge of firewater from the tunnel in the event of a fire.

The integrity of surface and foul sewers will be regularly checked and they will be appropriately maintained.

10.4.3 Assessment of residual impacts

10.4.3.1 Project scenario: construction phase

During the construction phase of this section of the route, there is the minor potential for localized alteration of groundwater flow around the tunnel. Provided that the mitigation measures detailed in Section 10.4.2 are put in place, the magnitude of this impact is low and the impact affects an area of low functional value. Therefore, the impact is considered to be of Low significance.

The Groundwater Baseline Assessment indicates that the levels of a range of contaminants in groundwater are either non-detectable or present at low concentrations along this section of the route with the exception of the pesticide Malathion, which exceeded the criteria contained in Table 3.1 (Interim Guideline Values for Characterisation of List of Parameters (IGV)) in the document 'Towards Setting Guideline Values for the Protection of Groundwater in Ireland, Interim Report by the EPA' (EPA, 2003). In general, the concentration of the contaminants in the groundwater along this section of the route is below the surface water quality criteria in the EPA publication 'Parameters of Water Quality, Interpretation and Standards' (EPA, 2001). Therefore, there is the possibility that groundwater generated from construction along this section of the route could be discharged into a surface water body/drain but this would be subject to approval by the relevant Local Authority. Construction of the bored sections of the tunnel will not require continuous significant dewatering operations but will require the removal of groundwater seepage into the tunnel by means of a sump, pump and rising main arrangement. Dewatering is likely to be required at the cut and cover sections for the construction of the Airport Stop.

There is the potential that the groundwater quality may be impacted during tunnelling operations due to the leakage of fuel/lubricants/conditioning agents from the TBM and associated equipment underground. Waste spoil generated by boring operations and waste construction materials will be transported to the TBM launch site for removal and disposal off-site. Water may be generated in the tunnel in the event of a fire and could impact the surrounding groundwater quality if not appropriately contained and managed. The hydrostatic pressure at the depth of the tunnel would be expected to minimise the potential for the release of contaminants from the tunnel into the surrounding aquifer. Provided that the mitigation measures detailed in Section 10.4.2 are put in place, the magnitude of this impact is low and the impact affects an area of low functional value. Therefore, the impact is considered to be of Low significance.

The construction phase for this section of the route will also involve activities at the surface stop box compound with the potential to adversely impact the underlying groundwater quality as follows:

- leakage of fuel/lubricants from the construction vehicles and associated equipment;
- oil spillages during refuelling or vehicle maintenance operations;
- leakage from chemical storage areas (including storage tanks) at the compounds and inappropriate disposal of chemicals (paints, oils, glues etc);
- the generation of leachate/runoff from inappropriately managed waste storage areas at the construction compound;
- Spillage and/or inappropriate disposal of raw or uncured concrete or grout;
- The generation of potentially contaminated leachate from storage areas for construction materials at the construction compounds;
- Inappropriate disposal of domestic effluent from welfare facilities at the construction compound;
- Spillage and/or leakage of bitumen or sealants for waterproofing surfaces.

Surface contaminants could migrate towards underlying groundwater sources. Provided that the mitigation measures detailed in Section 10.4.2 are put in place, the magnitude of this impact is low and the impact affects an area of low functional value. Therefore, the impact is considered to be of Low significance.

There is the potential for cumulative adverse impacts on groundwater quality along this section of the route during construction work at the surface for Dublin Airport Terminal 2. However, the implementation of the mitigation measures recommended in Chapter 11 (Soils, Geology and Groundwater) of the EIS for Dublin Airport – Terminal 2 (Ove Arup and Partners International Ltd., 2006) for the Dublin Airport Authority will ensure that such impacts are of Low significance.

Tunnel boring operations will result in the generation of spoil that has the potential to be contaminated with oil, lubricants or conditioning agents used. In addition, cut and cover operations will result in the excavation of made ground that has the potential to be contaminated. The storage of stockpiles of potentially contaminated spoil from boring and cut and cover operations could result in the generation of contaminated leachate, if suitable mitigation measures (such as the immediate removal of spoil) are not implemented. Provided that the mitigation measures detailed in Section 10.4.2 are put in place, the magnitude of this impact is low and the impact affects an area of low functional value. Therefore, the impact is considered to be of Low significance.

According to the Groundwater Baseline Assessment, groundwater has been encountered within 1.34m below ground level (bgl) along this section of the route. Therefore, the tunnel, which extends to depths in the range of 40m bgl will be located within the underlying aquifer. The approximate depth of 40m bgl is based is based on information from Appendix H (Exploratory Hole Location Plan and Inferred Geological Section Sheet 6 and 7 of 14) of the Dublin Metro North M7084 - Outline Method Construction (Jacobs Engineering, 2008). As previously mentioned, tunnelling operations are not expected to result in dewatering of significant volumes of groundwater. However, dewatering operations are likely to be required for the cut and cover sections of the route. Unless they are suitably controlled, dewatering activities have the potential to temporarily lower the water table to the extent that the water supply in nearby wells is affected. No significant long term lowering of the water is expected as a consequence of building the Dublin Metro North. Lowering of the water table will be limited to 1m. Provided that the mitigation measures detailed in Section 10.4.2 are put in place, the magnitude of this impact is low and the impact affects an area of low functional value. Therefore, the impact is considered to be of Low significance.

There is the potential for cumulative adverse impacts on groundwater along this section of the route during dewatering activities that may be required during the construction of Dublin Airport Terminal 2. However, the implementation of the mitigation measures recommended in Chapter 11 (Soils, Geology and Groundwater) of the EIS for Dublin Airport – Terminal 2 (Ove Arup and Partners International Ltd., 2006) for the Dublin Airport Authority will help ensure that such impacts are of Low significance.

10.4.3.2 Project scenario: operational phase

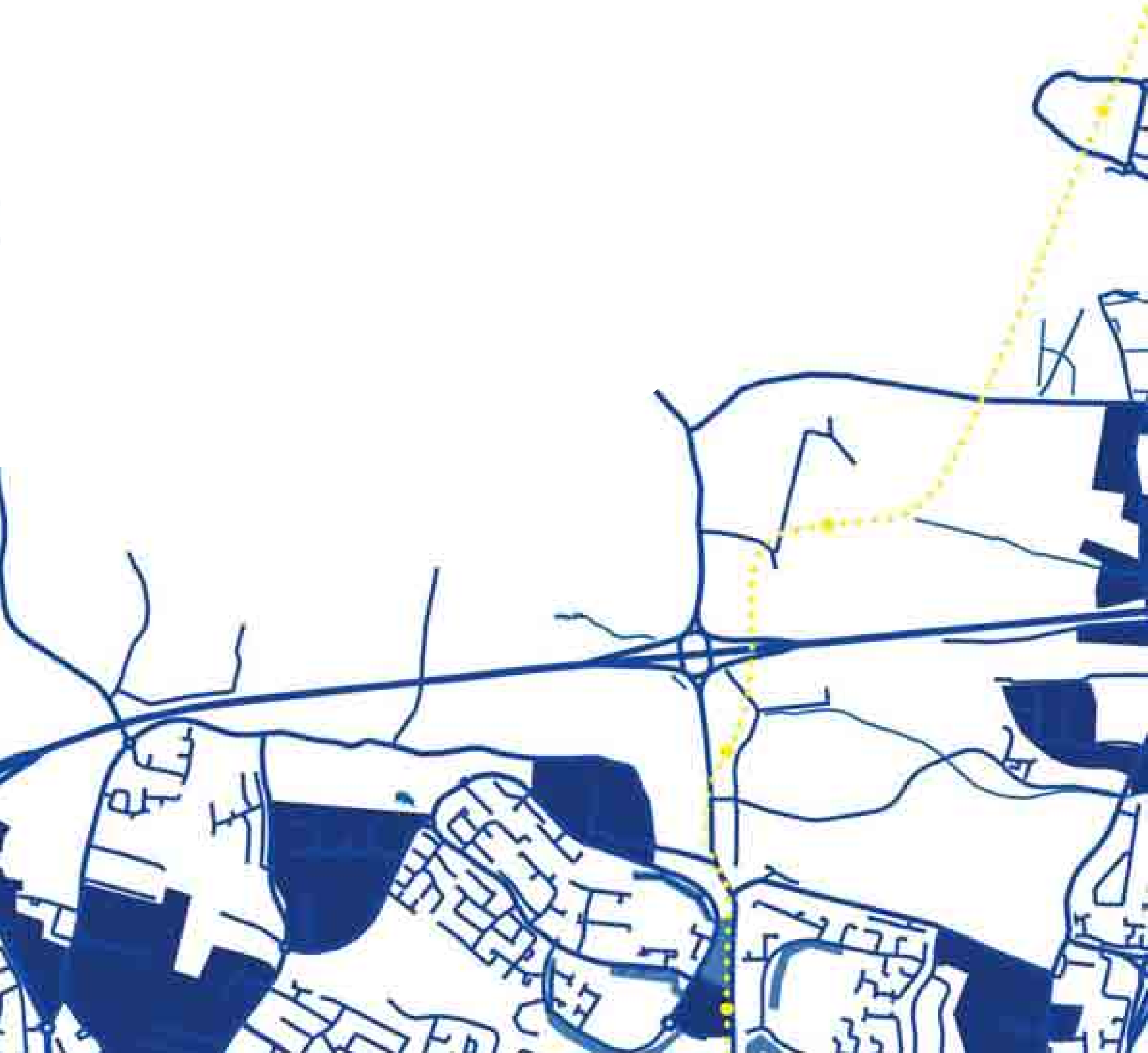
During the operational phase of this section of the route, there is potential for localized alteration of groundwater flow around the tunnel. Provided that the mitigation measures detailed in Section 10.4.2 are put in place, the magnitude of this impact is low and the impact affects an area of low functional value. Therefore, the impact is considered to be of Low significance.

Infiltration into the bored tunnel sections of the route will be collected at the Airport Stop and filtered and recharged into the water table during the operational phase. If the quality of this drainage water is not controlled, it could impact the quality of the surrounding aquifer. Provided that the mitigation measures detailed in Section 10.4.2 are put in place, the magnitude of this impact is low and the impact affects an area of low functional value. Therefore, the impact is considered to be of Low significance.

Potential sources of groundwater contamination within the tunnel during the operational phase would be expected to include inappropriate disposal of domestic effluent from the Airport Stop and fire water from the tunnel. In addition, there is the potential for leakage from oils used in substations at the Airport Stop, in addition to storage areas for waste, cleaning agents and chemicals (oils, lubricants and solvents for example) required for stop equipment. The tunnel will be a sealed structure and the potential for the release of contaminants into the surrounding groundwater would be considered to be low. The hydrostatic pressure at the depth of the tunnel would be expected to minimise the potential for the release of contaminants from the tunnel into the surrounding aquifer. Provided that the mitigation measures detailed in Section 10.4.2 are put in place, the magnitude of this impact is low and the impact affects an area of low functional value. Therefore, the impact is considered to be of Low significance.

There is the potential for cumulative adverse impacts on groundwater quality along this section of the route if wastewater and surface water runoff (with the potential to be contaminated) generated at Dublin Airport Terminal 2 is not managed and disposed of appropriately. However, the implementation of the mitigation measures recommended in Chapter 11 (Soils, Geology and Groundwater) of the EIS for Dublin Airport – Terminal 2 (Ove Arup and Partners International Ltd., 2006) for the Dublin Airport Authority will ensure that such impacts are of Low significance.

11 SURFACE WATER



This chapter of the EIS evaluates the potential impacts on surface water, which may arise due to activities associated with the construction and operation of the proposed scheme in Area MN103.

11.1 INTRODUCTION

This chapter of the EIS evaluates the potential impacts on surface water, which may arise due to activities associated with the construction and operation of the proposed scheme in Area MN103.

11.2 STUDY AREA

The study area for this assessment is set out in Table 11.1.

Table 11.1 Study area

Criteria	Width of study area (on both sides of the alignment)
Surface water quality and hydrodynamics (including flooding)	500m

11.3 IMPACT ASSESSMENT METHODOLOGY

The source and type of all potential impacts is described in Section 11.4.1. Mitigation measures to be put in place are defined in Section 11.4.2. Mitigation measures are defined for any adverse impacts that are deemed to be of Medium or greater significance prior to mitigation. The extent to which mitigation is needed increases as the significance of the impact increases. The residual impact of each impact is then evaluated in Section 11.4.3 in terms of magnitude and significance.

11.3.1 Magnitude

The criteria used to assess the different impacts associated with this scheme are shown in Table 11.2. The criteria have been defined in consideration the 'Guidelines on Information to be Contained in Environmental Impact Statements' (EPA, 2002).

Table 11.2 Criteria for assessment of impact magnitude

Criteria	Impact magnitude
- Long-term to permanent change to a designated conservation site or designated salmonid river - Medium-term to permanent contamination of surface water over entire surface water catchment - Medium-term to permanent potential changes in drainage patterns over entire catchment	very high
- Medium term change to a designated conservation site or a designated salmonid river - Temporary to short-term contamination of surface water over entire surface water catchment - Temporary to short-term potential changes in drainage patterns over entire catchment	high
- Temporary to short-term change to a designated conservation site or a designated salmonid river - Medium to long-term contamination of local surface water - Medium to long-term potential changes in local drainage patterns	medium
- Short-term contamination of local surface water - Short term potential changes in local drainage patterns	low
- Temporary contamination of local surface water - Temporary potential changes in local drainage patterns	very low

The duration of impacts (as detailed in Table 11.2) are defined as shown in Table 11.3 as per EPA Guidance (EPA, 2002).

Table 11.3 Definition of duration criteria

Impact Description	Definition
Permanent impact	Impact lasting over sixty years
Long-term impact	Impact lasting fifteen to sixty years
Medium-term impact	Impact lasting seven to fifteen years
Short-term impact	Impact lasting one to seven years
Temporary impact	Impact lasting for one year or less

11.3.2 Significance

The significance of all impacts is determined in consideration of the magnitude of the impact and the functional value of the surface water resource.

11.4 IMPACT ASSESSMENT

11.4.1 Impact identification

Various elements of both the construction and operational phases have the potential to impact on surface water.

During the construction phase, various activities have the potential to result in increased surface water runoff which could potentially impact local drainage. These include the discharge of dewatering liquids from tunnel excavations, construction of watercourse crossing points, installation of drainage discharge points to watercourses and surface water or foul drains, installation of hard standing for temporary construction compounds and access roads and construction of surface and elevated structures on existing greenfield sites. During the operational phase, surface water runoff will arise from drainage of the metro tracks and surface and elevated structures. Dewatering of groundwater from tunneled sections may also be necessary during the operational phase which may require to be discharged to surface water bodies.

During construction, potentially contaminated runoff may arise in parking and turning areas, fuel off-load and distribution areas, materials storage areas, skip and waste compactor areas and from on-site trade effluent and sewage treatment plants.

During the construction phase, there is the potential for surface water runoff (rainfall directly falling on open surfaces in excavation and rainfall migrating by overland flow to the excavation) to infiltrate open excavations of the route along this area. In areas where soil may be compacted due to construction works, or where impermeable soils are encountered, it will be necessary to collect this run-off in sumps at low points along the track alignment. From sumps it will be pumped into the nearby storm water drainage system or treated and discharged to surface water bodies (if available). If contaminated, this has the potential to pollute receiving surface water bodies.

Furthermore, dewatering of groundwater from sub-surface track and structures that are below the local groundwater table level has the potential to pollute surface water bodies if subsequently discharged to them untreated.

Works involving the diversion of ditches and the construction of bridges have the potential to impact flow regimes in existing watercourses and to lead to flooding of adjacent lands. If significant this may have the following impacts:

- Increased flood levels upstream of the culvert due to the creation of a restriction in the watercourse;
- Erosion of the watercourse and/or floodplain being initiated or accelerated due to the restriction increasing flow velocities and turbulence;
- Deposition of material in the watercourse or on the flood plain due to a change in flow velocities and turbulence;
- Interference with the passage or movement of fish.

11.4.2 Mitigation measures

All waters collected in sumps in open excavations during the construction phase will be treated in silt traps and hydrocarbon interceptors prior to discharge. These measures are subject to agreement with Fingal County Council and if necessary to obtaining an appropriate discharge licence.

All discharge points will be fitted with oil separators which will comply with current European Standard EN 858. The oil separators will have silt chambers for the removal of silts and other settleable solids. Each separator will be fitted with an automatic alarm system which will relay information to a control unit to indicate the condition of the separator. The alarm probes will be set to coincide with the maximum oil storage volume for each separator. All full retention separators will be fitted with automatic closure devices which will be set to operate when the separated light liquid storage capacity reaches a volume equal to ten times the nominal size of the separator. By-pass separators will not be fitted with automatic closure devices.

Any discharges arising from the construction or operational phases in Area MN103 and entering the sewer network will be in accordance with the requirements of a discharge licence granted by Fingal County Council. Similarly, any water discharged to surface water bodies will be treated in advance and also in accordance with the requirements of a discharge licence granted by Fingal County Council.

Treatment of water produced during the construction phase will involve silt removal using a silt trap and hydrocarbon removal using a hydrocarbon interceptor. Contaminated groundwater, if encountered, may require treatment using more specialised treatment equipment including chemical treatment, activated carbon or other absorbent systems.

Regular monitoring of water will be conducted prior to discharge to ensure all relevant water quality parameters are within criteria specified by the Fingal County Council.

Re-fuelling of construction equipment and the addition of hydraulic oil or lubricants to vehicles/equipment will take place in designated areas within the construction compounds, away from surface water gullies or drains. The vehicles and equipment will not be left unattended during refuelling. Spill kits and hydrocarbon adsorbent packs will be stored in this area and operators will be fully trained in the use of this equipment. As a precaution, a spill kit will also be stored in cab of each vehicle in case of localised hydrocarbon loss of containment incidents, such as a machine ‘blowing’ a hydraulic hose.

Any hazardous waste residuals or potentially contaminated sludge from spill clean-up will be stored within appropriate metal or plastic containers in temporary bunded storage areas in the construction compounds prior to removal by an appropriate Local Authority or EPA approved waste management contractor for off-site treatment/recycling/disposal.

Silt fences will be used during construction of the culvert on the Sluice River tributary (north of Naul Road) to prevent contamination of the stream with sediment. Washing of concrete trucks in the vicinity of the Stream will be prohibited and concrete contractors will be required to make provision for removal of any concrete washwaters, no such washwaters will be permitted to be discharged to the stream under any circumstances.

The guidelines provided by the Department of the Marine and Natural Resources (1997) and guidelines provided by CIRIA (2001) and the ERFB (2006) on the prevention of water pollution from construction sites will be adhered to, in order to ensure that the impact on the water environment during the construction phase of the proposed scheme is minimised. The ERFB document in particular provides must useful information about minimising the environmental risks associated with construction works, and will be referred to in the planning of any construction works in the vicinity of watercourses.

In relation to above ground track drainage within Area MN103, all filter drains will be designed to a 30 year return period of with a 10% climate change factor.

In relation to culverting the Sluice River tributary (north of Naul Road), the design will be in accordance with the requirements of the Office of Public Works (OPW) and Section 50 of the Arterial Drainage Act, 1945. The culvert will be capable of passing a fluvial flood flow with a 1% annual exceedance probability or 1 in 100 year flow without significantly changing the hydraulic characteristic s of the watercourse. In addition, cognisance will be taken of the National Roads Authority (NRA) Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes.

Herbicides used during operation will be applied sparingly and in compliance with suppliers' guidance, and will be suitable for use in an environment in which receiving watercourses are present.

11.4.3 Assessment of residual impacts

11.4.3.1 Project scenario: construction phase

Area MN103 extends from the greenfield area in Cloghran, north of the Naul Road to the Southern Perimeter Road of Dublin Airport. A ventilation building (North Tunnel Ventilation Building) will be constructed just north of the Naul Road. The scheme is overground as far as the airport north ventilation building. It is underground for the remainder of this area and will be constructed using tunnel boring techniques.

There is one underground stop along the route at Dublin Airport which will be constructed using open cut techniques. A stream at Forrest Little, which becomes the Sluice River and the Cuckoo Stream, a tributary of the River Mayne are the main surface water features within Area MN103. It is proposed to culvert the stream at Forrest Little (which becomes the Sluice River) to the north of Naul Road where it intersects the overground track.

One construction compound will be installed within this area at the North Tunnel Ventilation Building located immediately north of the Naul Road which will include offices and welfare facilities. Temporary portaloo facilities will be used and foul water generated will be removed and treated off-site by an appropriately licensed contractor.

Within the area the groundwater table will be intercepted when tunnelling under the airport and it will be necessary to dewater any groundwater arising from the construction of the tunnels. The baseline groundwater study indicated that the groundwater levels measured in the vicinity of Dublin Airport ranged from 3.3m below ground level (bgl) to 11.10m bgl. (Note that the limitations of the use of groundwater strike information are discussed in the baseline groundwater report.) The maximum depth of the tunnels in this area is approximately 15m bgl.

Where possible groundwater will be recharged to the groundwater aquifer. If this is not feasible, dewatered groundwater will be discharged to foul or storm water sewers. If insufficient capacity is available, it will be discharged to a receiving surface water body. Discharges to surface water bodies will receive prior treatment. All measures are subject to agreement with Fingal County Council and to obtaining an appropriate discharge licence, if required.

The impacts associated with recharging groundwater (arising from tunnel boring) to the underlying groundwater aquifer are addressed in the Groundwater chapters of this EIS (Volume 2, Chapter 10).

Surface water runoff from the works will be collected and drained to the nearby storm water drainage system or treated and discharged to surface water bodies (if available). All waters collected in this manner will be treated in silt traps and hydrocarbon interceptors prior to discharge. These measures are subject to agreement with Fingal County Council and if necessary to obtaining an appropriate discharge licence.

Surface water runoff (rainfall directly falling on open surfaces in excavation and rainfall migrating by overland flow to the excavation) collected in open excavations in areas where soil may be compacted due to construction works, or where impermeable soils are encountered will be collected in sumps at low points along the track alignment. From sumps it will be pumped into the nearby storm water drainage system or treated and discharged to surface water bodies (if available). If contaminated, this has the potential to pollute receiving surface water bodies. The magnitude of this impact is assessed as low and the significance depends on the sensitivity of receiving water bodies. All waters collected in sumps in open excavations will be treated in silt traps and hydrocarbon interceptors prior to discharge. These measures are subject to agreement with Fingal County Council and if necessary to obtaining an appropriate discharge licence.

Discharge of surface water runoff to storm water sewers or receiving surface water bodies could potentially impact the quality of receiving water bodies if the runoff does not receive adequate treatment in advance. The degree of contamination of the receiving water body depends on the volume and composition of the discharge. A pollution incident (for example a fuel spill) could potentially contaminate a receiving water body for a duration of up to 1 year.

The magnitude of this potential impact is assessed as low. The significance of the impact depends on the impact magnitude and the sensitivity of the receiving water body. Surface water courses within this area were identified as having a medium functional value in the baseline study. Therefore the significance of this impact is assessed as Low.

Construction of the culvert on the Sluice River tributary will involve carrying out works to the stream bed and banks. There is the potential for sediment and pollutants to contaminate the stream which could have a duration of impact of up to 1 year. The magnitude of this potential impact is assessed as low. The baseline functional value assigned to the Sluice River is low. Therefore the significance of this impact is assessed as Low.

Provided that the mitigation measures specified in Section 11.4.2 are implemented for the construction phase, the magnitude of the impact of discharging treated effluent to receiving waters is assessed as Low. The significance depends on the magnitude of the impact and the sensitivity of the receiving water body. Surface water courses within this area were identified as having a medium functional value in the baseline study. Therefore the significance of this impact is assessed as Low.

The magnitude of the impact of culverting the stream at Forrest Little (which becomes the Sluice River) is assessed as low. The baseline study identified the functional value of the Sluice River as medium; therefore the significance is assessed as Low.

11.4.3.2 Project scenario: operational phase

As outlined in Section 11.3.1 above, the area of the scheme includes mostly underground works, with a short overground section of track. The North Tunnel Ventilation Building will be constructed within this area.

Discharge of surface water runoff can potentially impact the quality of receiving water bodies however, the likelihood of contamination from surface water run off from a light rail system is considered low as the system is electrically powered, and while it uses hydrocarbon lubricants within the LMVs, the lubricants are contained within sealed units, and the risk of leaks is therefore low. Herbicides may be used occasionally to control weed growth, but the quantities involved will be small and the herbicides used will comply with all applicable environmental codes.

As described for the construction stage, it may be necessary to dewater groundwater from the tunnelled sections during the operational phase.

Where possible groundwater will be recharged to the groundwater aquifer. If this is not feasible, groundwater will be discharged to foul or storm water sewers. If insufficient capacity is available, it will be discharged to a receiving surface water body. Discharges to surface water bodies will receive prior treatment. All measures are subject to agreement with Fingal County Council and to obtaining an appropriate discharge licence, if required.

The impacts associated with recharging groundwater (arising from tunnel boring) to the underlying groundwater aquifer are addressed in the Groundwater chapters of this EIS (Volume 2, Chapter 10).

All information regarding drainage strategies described below was obtained from the Drainage Reference Design for the scheme (Working Paper 45, February 2008).

The drainage strategy for open cut sections during the operational phase involves the provision of cut-off drains at the top of cut sections to intercept runoff flowing towards the cut slope. Filter drains will be provided at the toe of the cut to collect runoff from the track as well as runoff from the cut slope. Runoff collected in filter drains will be discharged to watercourses by a gravity outfall. Where this cannot be achieved filter drains will be connected to the sump at the adjoining underground section from where runoff will be pumped up into a nearby surface drainage system.

Discharge of surface water runoff to storm water sewers or receiving surface water bodies could potentially impact the quality of receiving water bodies if the runoff does not receive adequate treatment in advance. The degree of contamination of the receiving water body depends on the volume and composition of the discharge. A pollution incident (for example a fuel spill) could potentially contaminate a receiving water body for a duration of up to 1 year. The magnitude of this potential impact is assessed as low and the significance depends on the impact magnitude and the sensitivity of the receiving water body. Surface water courses within this area were identified as having a medium functional value in the baseline study. Therefore the significance of this impact is assessed as Low.

During the operational phase, the stream at Forrest Little north of the Naul Road (which becomes the Sluice River) will be culverted. Culverting has the potential to alter the hydraulic characteristics of the stream. Increased flood levels upstream of the culvert may occur due to the creation of a restriction in the watercourse

All bridge and culvert design for the scheme will be in accordance with the requirements of the Office of Public Works (OPW) and Section 50 of the Arterial Drainage Act, 1945 (OPW, 1945). As such, approval will be sought from the OPW for construction of the culvert, and the OPW's hydraulic design standards will be adhered to. The contractor will also adhere to the requirements of the ERFB (2006) when selecting a culvert design, to ensure minimum negative impact on fish life. Therefore, the magnitude of the impact on the Forrest Little Stream (tributary of the Sluice River) is assessed as very low. The baseline functional value assigned to the Sluice River is medium. Therefore the significance of this impact is assessed as Low.

Provided that the mitigation measures specified in Section 11.4.2 are implemented for the operational phase, the magnitude of the impact of discharging treated effluent to receiving waters and of culverting the Sluice River tributary is assessed as low and the significance is assessed as Low.

Cumulative Impacts

Cumulative impacts on surface water could potentially occur due to the development of the Dublin Airport Terminal 2 and the scheme within the same timeframe. The Environmental Impact Statement (EIS) for Dublin Airport Terminal 2 indicates that the stream at Forrest Little (upstream of the Sluice River) drains the northern area taxiway and runways. The Wad Stream drains the North Apron. Kealy's Stream drains the internal road network and car parks in the airport complex on landside and the Eastland's Carpark. These three streams join downstream of the Dublin Airport boundary, forming part of the Sluice River catchment. The majority of additional surface water run-off generated by Terminal 2 will drain to the Cuckoo Stream, a tributary of the Mayne River with the remainder draining to Kealy's Stream. In relation to Kealy's Stream, the EIS indicates that any increase in the impermeable area is likely to have a negligible increase in the volume of runoff due to mitigation measures included in the design of Terminal 2.

During the construction and operational phases, potential for cumulative impacts to occur depends on nature and quantity of effluent/runoff discharged to surface water bodies. This information is not available for the Dublin Airport scheme. However, the surface water impacts of the Metro North scheme in this area have been assessed as being of low magnitude and significance and therefore cumulative impacts are also assessed as being of Low significance.

12 AIR AND CLIMATIC FACTORS

This chapter of the EIS evaluates the potential air and climatic impacts arising from the construction and operation of the proposed scheme in Area MN103.

12.1 INTRODUCTION

This chapter of the EIS evaluates the potential air quality and climatic impacts arising from the construction and operation of the proposed scheme in Area MN103.

12.2 STUDY AREA

The study area for this assessment comprises all areas within 175m of the central alignment or construction compounds and areas within 200m of road links where changes in air quality are predicted to occur.

12.3 IMPACT ASSESSMENT METHODOLOGY

12.3.1 Introduction

The source and type of all potential impacts is described in Section 12.4.1. Mitigation measures to be put in place are defined in Section 12.4.2. Mitigation measures are defined for any adverse impacts that are deemed to be of medium or greater significance prior to mitigation. The extent to which mitigation is needed increases as the significance of the impact increases. The residual effect of each impact is then evaluated in Section 12.4.3 in terms of magnitude and significance.

The impact that the scheme will have on air quality is assessed after the first year of construction 2011. The impact that the scheme will have on air quality during operation is assessed for 2029. Predicted changes in traffic flows for the do minimum and do metro years of 2011 and 2029 are described in the Traffic chapters of this EIS (Volume 1, Chapter 15 and Volume 2, Chapter 7).

12.3.2 Assessment methodology for dust

For the purposes of this study, dust is taken to mean the particles released that have the capacity to cause annoyance to neighbours, through soiling of surfaces, such as windows and cars. There are no legal standards relating to acceptable levels of deposited dust, although monthly mean deposition rates in excess of 200mg m^{-2} day^{-1} are considered likely to cause a nuisance (Schofield and Shillito, 1990). A risk-based approach has been developed for the purpose of the Environmental Impact Assessment (EIA) to identify significant potential impacts. This risk evaluation matrix has been devised and is presented in Table 12.1. The criteria detailed in the table have been devised in consideration of studies by the Building Research Establishment (BRE) which suggests that nuisance is unlikely to occur at distances greater than 50m from a construction site boundary (BRE, 2003). One particular study (Baughan, 1980) has also shown that at least half the people living within 50m of the site boundary of a road construction scheme were 'seriously bothered' by construction nuisance due to dust, but that beyond 100m less than 20% of the people were 'seriously bothered'.

Construction sites are also temporary in nature and some degree of nuisance is normally tolerable if the activity lasts for no more than a few months.

Table 12.1 Evaluation of Potential Significant Effects of Dust Deposition, with control measures in place

Duration of on-site dust raising activity	Distance from Site Boundary to Sensitive (a) Receptors (m)		
	< 50 m	50 – 100 m	> 100 m
> 12 months	Significant	Significant	Potentially Significant
6 – 12 months	Significant	Potentially Significant	Not Significant
< 6 months	Potentially Significant	Not Significant	Not Significant

(a) Sensitive receptors defined as: residential, commercial office, hospital, surgery etc

12.3.3 Assessment methodology for vehicle emissions

The Transport Analysis Guidance (TAG) of the UK's Department for Transport (2004) and the Design Manual for Roads and Bridges (DMRB) Air Quality Assessment (Highways Agency, 2003) have been used to assess the proposed scheme with respect to the pollutants that relate to road traffic i.e. nitrogen dioxide (NO_2) and particulate matter (PM_{10} or $PM_{2.5}$), and the greenhouse gas, carbon dioxide (CO_2). These tools have been selected because they are the best tools available in terms of allowing the user to assess impacts across many roads in a network, rather than simply considering individual roads in isolation.

In order to protect our health, vegetation and ecosystems, the EU has set down air quality standards in member states for a wide variety of pollutants. On the 14th April 2008 the European Commission adopted the Directive on Ambient Air Quality and Cleaner Air for Europe 2008.

This directive merges four earlier directives and one Council decision into a single directive on air quality, all of which have been transposed into Irish law through the Environmental Protection Agency Act 1992 (Ambient Air Quality Assessment and Management) Regulations (S.I. No. 33 of 1999).

The new directive has not yet been transposed into Irish law, but does not introduce any new air quality limit values, except for the approach to particulate matter. Whereas the previous directive, and Irish law, have a limit value for PM_{10} to be achieved in 2010, the new directive calls for a limit value for $PM_{2.5}$ of 20 μg m^{-3} to be achieved by 2020, with an interim target value of 25 μg m^{-3} by 2015. This limit value will, at some point, be transposed into Irish law and has therefore been adopted as a criterion for this assessment.

A summary of the air quality standards relevant to the Dublin area is shown in Table 12.2.

Table 12.2 Irish Air Quality Standards

Pollutant	Limit Value Objective	Averaging Period	Limit Value (μg m^{-3})	Basis of Application of the Limit Value	Limit Value Attainment Date
NO_2	Protection of Human Health	Calendar year	40	Annual mean	1st January 2010
		1 hour	200	Not to be exceeded more than 18 times in a calendar year	1st January 2010
PM_{10} Stage 1(a)	Protection of Human Health	Calendar year	40	Annual mean	1st January 2005
		24 hours	50	Not to be exceeded more than 35 times in a calendar year	1st January 2005
PM_{10} Stage 2(b)	Protection of Human Health	Calendar year	(20)	Annual mean	1 January 2010
		24 hours	(50)	(Not to be exceeded more than 7 times in a calendar year)	1 January 2010

(a) Stage 1: 1 January 2005 to 1 January 2010

(b) Stage 2: From 1 January 2010 (no longer part of EU legislation)

12.3.4 Assessment methodology for microclimate

The significance of impacts associated with conversion of vegetated to unvegetated surfaces is assessed through consideration of the area of the land experiencing such a change and the area of vegetated land that continues to remain. If the area of land affected is marginal, then the effect on air temperature and microclimate is insignificant. The areas of land-take associated with the proposed scheme have been calculated on the basis of the following assumptions:

- Temporary land-take inside the Compulsory Purchase Order (CPO) line and within the construction compound is assumed to be reinstated back to its original state after construction operation;
- Permanent land-take associated with the proposed scheme is converted to permanent hardstanding concreted areas during operation. This is a worst-case scenario assumption because the some of this land may remain vegetated, depending on the limits of deviation associated with the proposed scheme design.
- Cut and cover areas and embankments are assumed to be reinstated to their original status after construction.
- For the purpose of the calculations, all construction works are assumed to occur in tandem. The actual planned duration of individual construction work tasks is discussed in Section 12.4.3.1.
- Calculated figures are approximate figures with an estimated margin of error of approximately 10%.

All other potential microclimatic impacts are assessed on a case-by-case basis in consideration of the nature of the area affected and the specific design proposed in the area.

12.3.5 Assessment methodology for climate change

The impact of the proposed scheme with respect to climate change is assessed through consideration of the change in CO_2 emissions that will occur due to traffic changes in response to the proposed scheme.

12.3.6 Assessment criteria

The criteria used to assess the different magnitudes of impact associated with the proposed scheme are shown in Table 12.3. In the case of air quality, five classes of impact magnitude are used. In the case of microclimate and climate change, only four classes of magnitude are used because the precision of the assessment is such that only four classes are required.

Table 12.3 Criteria for assessment of impact magnitude

Criteria	Impact magnitude
Air quality - Change of >35 µg m^{-3} in ambient NO_2 concentration - Change of >17.5 µg m^{-3} in ambient PM_{10} concentration - Change of >17.5 µg m^{-3} in ambient $PM_{2.5}$ concentration - Any change with regards to compliance with any regulatory air quality limit specified in relevant legislation - A substantial change in the area of green areas exerting an influence on the surface energy balance.	very high
Air quality - Change of between 25 and 35 µg m^{-3} in ambient NO_2 concentration - Change of between 12.5 and 17.5 µg m^{-3} in ambient PM_{10} concentration - Change of between 12.5 and 17.5 µg m^{-3} in ambient $PM_{2.5}$ concentration - Any change with regards to compliance with any regulatory air quality limit specified in relevant legislation Microclimate - A substantial change in the area of green areas exerting an influence on the surface energy balance. Climate Change - More than 25% change in CO_2 emissions	high

Criteria	Impact magnitude
Air quality - Change of between 5 and 25 µg m^{-3} in ambient NO_2 concentration - Change of between 2.5 and 12.5 µg m^{-3} in ambient PM_{10} concentration - Change of between 2.5 and 12.5 µg m^{-3} in ambient $PM_{2.5}$ concentration **Microclimate** - Permanent structural impacts such as bridges, roadways, embankments, car park facilities and buildings where cold air 'ponding' and shading may take place. - A moderate change in the area of green areas exerting an influence on the surface energy balance **Climate Change** - 15- 25% change in CO_2 emissions	medium
Air quality - Change of between 1 and 5 µg m^{-3} in ambient NO_2 concentration - Change of between 0.5 and 2.5 µg m^{-3} in ambient PM_{10} concentration - Change of between 0.5 and 2.5 µg m^{-3} in ambient $PM_{2.5}$ concentration **Microclimate** - A minor change in the area of green areas exerting an influence on the surface energy balance - Temporary stockpiling of soils during construction that may cause cold air ponding and shading to take place. **Climate Change** - 5- 15% change in CO_2 emissions	low
Air quality - Change of between -1 and 1 µg m^{-3} in ambient NO_2 concentration - Change of between -0.5 and 0.5 µg m^{-3} in ambient PM_{10} concentration **Microclimate** - Permanent non-structural impacts such as minor landscaping and minor drainage. - Air movement generated through movement of the light metro vehicles (LMVs) - Immaterial temporary impacts such as minor ground disturbance or non-compacted areas of construction compounds. - A very minor change in the area of green exerting an influence on the surface energy balance **Climate Change** - 0-5% change in CO_2 emissions	very low

The significance of impacts is assessed in consideration of the magnitude of the impact and the functional value of the receptor or nature of the receiving environment in which the impact has an effect.

12.4 IMPACT ASSESSMENT

12.4.1 Impact identification

12.4.1.1 Dust

Sources of such dust include material stockpiles and other dusty surfaces, which may be disturbed by wind action. Dust of this type may also be thrown up by mechanical action, due to activities such as the movement of tyres on a dusty road, drilling or demolition.

General construction works may cause occasional rather than continuous emissions of dust, as only certain activities (such as grinding and cutting) will result in dust emissions.

Black smoke particles may also occur where hot bitumen is used to carry out tarmac laying. Ventilation shafts can also act as a minor source of dust above ground. Dust is generated underground through the action of LMVs braking and friction wear on the tracks, together with a small biological component from the passengers themselves. Ventilation shafts transfer dust particles from underground tunnels and emit them to the open atmosphere.

The quantity of dust released during construction depends on a number of factors, including:

- the type of construction activities occurring (e.g. crushing and grinding);
- the volume of material being moved;
- the moisture and silt content of the materials;
- the distance travelled on unpaved roads;
- the area of exposed materials;
- the mitigation measures employed.

The effect of dust also depends on the wind direction and the distance between the dust source and receptor. Dust emissions arising from construction activities have the potential to cause nuisance both within the construction site and outside the site boundary. Accumulation and settling of particles on surfaces close to the point of release may occur leading to soiling of property, windows, cars or laundry. Such dust affects amenity, as the particles are mostly of sufficient size that they are visible. In industrial and commercial premises dust can cause soiling of goods, abrasion of moving parts in the plant and clogging of filters, if present in sufficient quantity. The generation of dust can also lead to increases in levels of particulate matter; this may have an impact on human health. It is also important to consider whether the dust has been generated through the disturbance of contaminated ground.

12.4.1.2 Vehicle emissions

Local emissions of NO_2, PM_{10} and $PM_{2.5}$ are typically emitted from vehicle exhausts and therefore are directly associated with the number of vehicles travelling on local road networks. The change in vehicles numbers as a result of the proposed scheme will therefore have an impact on the concentrations of these pollutants in areas where traffic levels change in response to the scheme. The changes in traffic that will occur are described in the Traffic chapters of this EIS (Volume 2, Chapter 7). NO_2, PM_{10} and $PM_{2.5}$ emission can have a potential impact on human health as described in the Human Health chapter of this EIS (Volume 1, Chapter 8).

12.4.1.3 Microclimate

The principal change to microclimate would occur through the replacement of a previously vegetated surface with paved surfaces. If this change occurred over a sufficiently large area, a change in the surface energy balance would occur, as moisture evaporation from the soil beneath the paved surfaces is eliminated and more of the available solar radiation is used to heat air rather than to evaporate water transpired by plants and trees. This could potentially have a discernible effect on air temperature, especially as a cooling effect in summer, and exacerbate the Urban Heat Island (UHI) effect, as described in the baseline Air and Climatic Factors chapter of this EIS (Volume 1, Chapter 20).

During the construction phase, vegetated surfaces may be replaced with compacted or paved surfaces that are not vegetated. Examples include construction compounds, embankments, stockpiles and other temporary features that may lead to the disruption or destruction of existing vegetation. Vegetated surfaces may also be replaced permanently due to the above ground operational structures of the proposed scheme (e.g. track form, Park & Ride facilities, stops)

Alterations of the direction and speed of air flow may occur, due to large structures associated with the proposed scheme. The movement of LMVs on the track can potentially generate localised wind turbulence if the LMVs are moving at significant speeds. The construction of new elevated pedestrian crossings can expose pedestrians to wind turbulence.

Similarly, large structures can also lead to changes in lighting and shade. This impact is usually only significant if the barriers are solid and if sensitive areas are located in close proximity. Cold air can also accumulate behind physical barriers, such as buildings and embankments, thereby blocking nocturnal drainage flows and increasing the potential for incidence of 'frost hollows' and ice. These frost hollows and ice can impact on crops in an agricultural setting or create slip hazards on thoroughfares. These artificial frost hollows only typically occur if relatively solid barriers are created across valleys, where cold surface air would otherwise drain away during the night.

12.4.1.4 Climate change

Greenhouse gases are gases that exist in the earth's atmosphere and that contribute to global temperatures by reducing the loss of heat into space. This 'greenhouse effect' is a natural essential phenomenon in that without it, the planet would be cold and uninhabitable. However, the creation of excess greenhouse gases can lead to adverse impacts associated with excessive increases in global temperature. The major greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_{20}) and fluorinated gases which will not be associated with the proposed scheme.

Traffic emissions are considered to be a significant source of carbon dioxide and this source of impact is considered in this assessment.

12.4.2 Mitigation measures

12.4.2.1 Dust

It is not possible to eliminate completely emissions of dust from construction sites. However, there are a number of good site practices that will be implemented to reduce the risk of dust effects arising during construction:

- All materials with the potential to cause dust will be covered during transport;
- Wheel washing facilities will be installed in all relevant construction sites and will be used by vehicles leaving the site;
- All material stockpiles with the potential to generate dust will be covered or dampened as necessary to minimise the potential for creation of dust. Particular precautionary measures will be undertaken if stockpiles comprise hazardous materials. Such measures will be agreed with the relevant authorities prior to commencement of the activity such that no adverse impact on the environment or human health is allowed to occur at any stage;
- Water suppression or dust extraction will be fitted where possible to construction equipment that has the potential to generate dust e.g. drilling, cutting and grinding equipment;
- On-site vehicle speeds on unhardened roads and surfaces will be limited to less than 15kph;
- Drop heights for material transfer activities such as unloading materials will be minimised;
- Surfaces that are to be excavated or cleared will be dampened prior to clearing or excavation where there is potential for excessive dust to be created;
- Bowsers or similar equipment will be available for use in construction compounds to wash down surfaces and roads, particularly in periods of dry weather.

Tarmac laying and the associated use of hot bitumen can generate significant amounts of black smoke particles. This will be minimised by the application of the following measures suggested by the Building Research Establishment (BRE, 2000):

- bitumen will not be overheated and where possible, bitumen will not be heated with open flame burners;
- pots and tanks containing hot bitumen will be covered to minimise fume production;
- spillages will be minimised.

12.4.2.2 Vehicle emissions

The measures to be taken to minimise the potential for traffic generation and congestion, and associated emissions of PM_{10} and NO_2, are described in the Traffic chapters of this EIS (Volume 2, Chapter 7).

12.4.2.3 Microclimate

A powerful method of off-setting the loss of vegetated surfaces is to plant trees, which have a large leaf area and transpire large quantities of water and thereby exert a significant cooling effect in summer. A summary of the key planting measures to be implemented at numerous locations across the proposed scheme is provided in this chapter. Details regarding the measures to be implemented are detailed further in the Landscape and Visual chapters (and Landscape Insertion Plans) of this EIS (Volume 2, Chapter 13).

- As much existing vegetation as possible is to be retained within and adjacent to the scheme. Trees that are to be retained will be protected in accordance with BS5837;
- Planting and/or hedgerow is to be introduced to compensate for vegetation loss;
- Planting is to be introduced on earthwork embankments and construction compounds to facilitate the reinstatement of these areas.

All bridges have been designed in accordance with appropriate safety design standards.

12.4.2.4 Climate change

The measures to be taken to minimise the potential for traffic generation and congestion, and associated emissions of CO_2, are described in the Traffic chapters of the EIS (Volume 2, Chapter 7).

12.4.3 Assessment of residual impacts

12.4.3.1 Project scenario: construction phase

Dust

Sources

Compound 7 is the only construction compound located in Area MN103 north of Dublin Airport. Compound 7 is a Tunnel Boring Machine (TBM) extraction compound to enable the TBM to be dismantled and extracted for transfer to a new launch site or removal from the site having completed tunnelling operations. Therefore, it is expected that little dust producing activity will occur at this compound.

The track in this area will be constructed in bored tunnels which will travel under Dublin Airport. Fugitive dust will only occur at either end of the tunnel.

Spoil extracted from the tunnelling operations will be inherently damp and should not represent a source of airborne dust prior to its removal. The Airport Stop will be situated under the existing car parking areas at Dublin Airport. Its cut and cover construction method will create the potential for some dust emissions, but there are no receptors in sufficient proximity to experience any impacts.

Sensitive Receptors
Maps (Air and Climatic Factors Baseline and Impact) included in Volume 3, Book 1 of 2 shows the boundaries of Area MN103 with dust buffers around Construction Compound 7 at 50m, 100m and 150m intervals. The construction compound boundaries have been used as the point from which to measure the distance contours because it is not possible at this stage to pinpoint the actual locations of potential dust generating activities within specific construction compounds. In reality the actual project worksites are likely to be much more limited in their spatial extent than the project boundary would indicate.

Maps (Baseline Landuse) included in Volume 3, Book 1 of 2 shows that there are no schools, hospitals or sensitive commercial receptors in Area MN103 around the construction compound and as most of the works will be underground there will be no resulting emissions of dust to ambient air.

There are two unnamed properties within 50m of compound 7. It is thought, however, that there will be little dust producing activity at this compound and therefore impacts will not be significant.

Vehicle emissions

Changes in NO_2 and $PM_{2.5}$ across the proposed scheme in comparison to regulatory limits
Many of the changes described in the previous section do not lead to breaches of any regulatory limits. As described in the baseline Air and Climatic Factors chapter of this EIS (Volume 1, Chapter 20), air quality along 3 road links of the traffic network of the proposed scheme is predicted to breach the NO_2 limit value of 40 µgm^{-3} in 2011 if the proposed scheme is not implemented. If the scheme is implemented during construction, air quality at these 3 road links does not improve and breaches of the limit value persist. The breaches are not attributable to the proposed scheme and therefore are not discussed any further.

The net result of the construction of the proposed scheme in 2011 is that the NO_2 concentration alongside a further 1 road link is predicted to exceed the NO_2 limit value of 40 µg m^{-3}. Table 12.4 shows the street link where a new marginal breach of the NO_2 limit value is predicted to occur in 2011, as a result of the construction phase of the alignment. This street link occurs within Area MN101.

Table 12.4 Street links where a new breach of the NO_2 limit value (40 µg m^{-3}) is predicted to occur in 2011

Road link	Street name	Magnitude of Change (µg m^{-3})	New Concentration (µg m^{-3})	Distance from Alignment
NO_2				
3562_3560	Link road from M1 Northbound to R127 north of Lissenhall	13.53	40.7	Between 500m and 1km

Source: Road names provided by MVA traffic consultants

The magnitude of change in NO_2 concentrations is 13.53 µg m^{-3}. This adverse impact would therefore normally be considered to be of medium magnitude because a change of between 5 and 25 µg m^{-3} in ambient NO_2 concentration occurs. However, this change leads to a breach of the 40 µg m^{-3} NO_2 limit value and therefore the impact is considered to be of high magnitude. As set out in the baseline Air and Climatic Factors chapter of this EIS (Volume 1, Chapter 20), any areas where a potential breach of any regulatory limit may occur are considered to be of very high functional value. This impact is therefore considered to be of High significance.

The proposed scheme does not have any impact in terms of changes in compliance or non-compliance with the limit values for PM_{10} or $PM_{2.5}$ within Area MN103.

Changes in NO_2 and $PM_{2.5}$ across the proposed scheme
Changes in NO_2 and PM_{10}/$PM_{2.5}$ concentration (µg m^{-3}) for 2011 (the first year of construction) are presented in Table 12.5 for two scenarios: if the proposed scheme is not implemented and if it is implemented. The table shows the number of road links that will experience air quality improvements and degradations. The extent of change that will occur has been evaluated using the criteria detailed in Table 12.3 and the links on which changes will occur have been categorised into the relevant magnitude classes. It is assumed that vehicle exhaust is essentially all in the form of $PM_{2.5}$ and therefore may be thought of as contributing to PM_{10} or $PM_{2.5}$ concentrations equally.

Table 12.5 Road links with changes in NO_2 and $PM_{10}/PM_{2.5}$ Concentration (μg m^{-3}) from 2011 Do Minimum to 2011 With Metro

Impact Magnitude	Number of links with: Degradation in Air Quality with respect to NO_2 Concentration (μg m^{-3})	Improvement in Air Quality with respect to NO_2 Concentration (μg m^{-3})	Degradation in Air Quality with respect to $PM_{10}/PM_{2.5}$ Concentration (μg m^{-3}) (a)	Improvement in Air Quality with respect to $PM_{10}/PM_{2.5}$ Concentration (μg m^{-3}) (a)
high	0	0	0/0	0/0
medium	5	7	0/3	0/8
low	108	46	34/77	23/44
very low	12,318 (b)		12,427/12,352 (b)	

(a) Although the magnitude of the $PM_{2.5}$ and PM_{10} concentration changes are equal, the assessment criteria are not and so the impacts are distributed differently across the categories.

(b) This is the total number of changes as defined by a very low impact magnitude for both Degradation and Improvement combined

All of the changes in NO_2 and $PM_{10}/PM_{2.5}$ concentrations are of medium to very low magnitude. These changes are of Low significance.

Microclimate
During the construction phase, existing vegetated areas within Area MN103 will be temporarily converted to unvegetated areas due to the development of construction compounds, embankments and localised movement of plant and construction vehicles. The main sources of land-take are outlined in Table 12.6.

Table 12.6 Significant sources of temporary land-take within Area MN103

Land-take	Approximate area	Approximate duration of land-take
Compound 7 – North Portal Airport Tunnel	12,000m²	4 years
Total	12,000m²	

Area MN103 comprises approximately 2,435,000m² of land. Approximately 47% of this land currently comprises open green areas (1,145,000m²). The use of approximately 12,000 m² of this area for the construction compounds is not considered to be an impact of low magnitude and no significance in light of the fact that the land-take is short in duration (4 years approx.) and extensive green areas exist within the study area and further afield.

Climate change
Predicted CO_2 emissions in the do minimum year of 2011 are detailed in the baseline Air and Climatic Factors chapter of this EIS (Volume 1, Chapter 20). The annual CO_2 emissions from vehicles during construction that will be produced in 2011 if the proposed scheme is implemented are detailed in Table 12.7 along with the percentage change relative to baseline emissions.

Table 12.7 CO_2 Emissions from Network in 2011 (tonnes $annum^{-1}$)

Do Metro 2011 (tonnes $annum^{-1}$)	Change relative to baseline (%)
2, 671,268 (a)	+0.6 %

(a) Estimated using DMRB methodology

The magnitude of change in CO_2 emissions in 2011 during construction if the proposed scheme goes ahead is very low and is, therefore, of no significance. The slight increase arises through a slight reduction in overall vehicle speeds on parts of the network and the additional traffic associated with construction activity.

12.4.3.2 Project scenario: operational phase

Modelling results for 2014, the first operational year of the scheme, showed less of an influence on air quality than for 2029; therefore, these results have not been discussed in detail in this section. They are however presented in the technical report included as Annex G (Volume 3, Book 2 of 2). The 2029 results reflect the worst case scenario and are detailed in the following sections.

Dust

The ventilation shafts located at the stop and portals within this area represent a very minor source of particulate matter emissions. Measurements carried out elsewhere, e.g. on the London Underground, have shown that quantities of PM_{10} emitted underground are not large when compared with road traffic. This is not a significant problem for passengers, as their typical exposure times are small and concentrations are acceptable by reference to occupational exposure levels for workers.

The shaft does not represent a significant source of environmental PM_{10} emissions because it merely transfers PM_{10} at the concentrations found underground and emits them to the open atmosphere, where they immediately become diluted by a factor of a hundred or more, even quite close to the shaft. Ventilation shafts have been the subject of some anxiety by residents in London when the Jubilee line was constructed and during the recent Crossrail application. Monitoring conducted at a shaft on the Jubilee Line and reported as part of the Crossrail application showed conclusively that it did not contribute to local PM_{10} concentrations.

Vehicle emissions

Changes in NO_2 and PM_{10}/$PM_{2.5}$ across the proposed scheme in comparison to regulatory limits

As described in the baseline Air and Climatic Factors chapters in this EIS (Volume 1, Chapter 20), air quality along six road links of the scheme within the 50m band alongside the road are predicted to breach the NO_2 limit value in 2029 if the scheme is not implemented. If the scheme is implemented, air quality at these six road links improves such that breaches of the limit value no longer occur. The six relevant links are shown in Figure 12.1.

The magnitude of improvement in NO_2 concentrations for the majority of the six links shown in Figure 12.1 is between -10 and -20 µg m^{-3}. This positive impact would normally therefore be considered to be of medium magnitude. However, the changes are such that breaches of relevant legislative limits no longer occur. The impacts are therefore considered to be of high magnitude and Medium significance.

Table 12.8 Street links where improvements in NO_2 concentrations result in compliance with the NO_2 limit value (40 µg m^{-3}) in 2029

Road link	Street name	Magnitude of Change (µg m^{-3})	New Concentration (µg m^{-3})	Distance from Alignment
NO_2				
5165_5144 (b)	Taney Road	-18.11	26.28	More than 5km
5014_5011 (b)	N11	-18.47	25.95	Between 3km and 4km
4250_4210 (b)	N7 Eastbound	-12.01	29.19	More than 5km
1833_1832	Oscar Traynor Road	-26.1	27.24	Between 2km and 3km
1415_1408	Berkeley Road	-17.51	24.99	Between 250m and 500m
2013_2012	Junction between College Green, Westmoreland Street and College Street.	-11.32	32.65	Less than 250m

(a) North of the alignment

(b) South of the alignment

Source: Road names provided by MVA traffic consultants

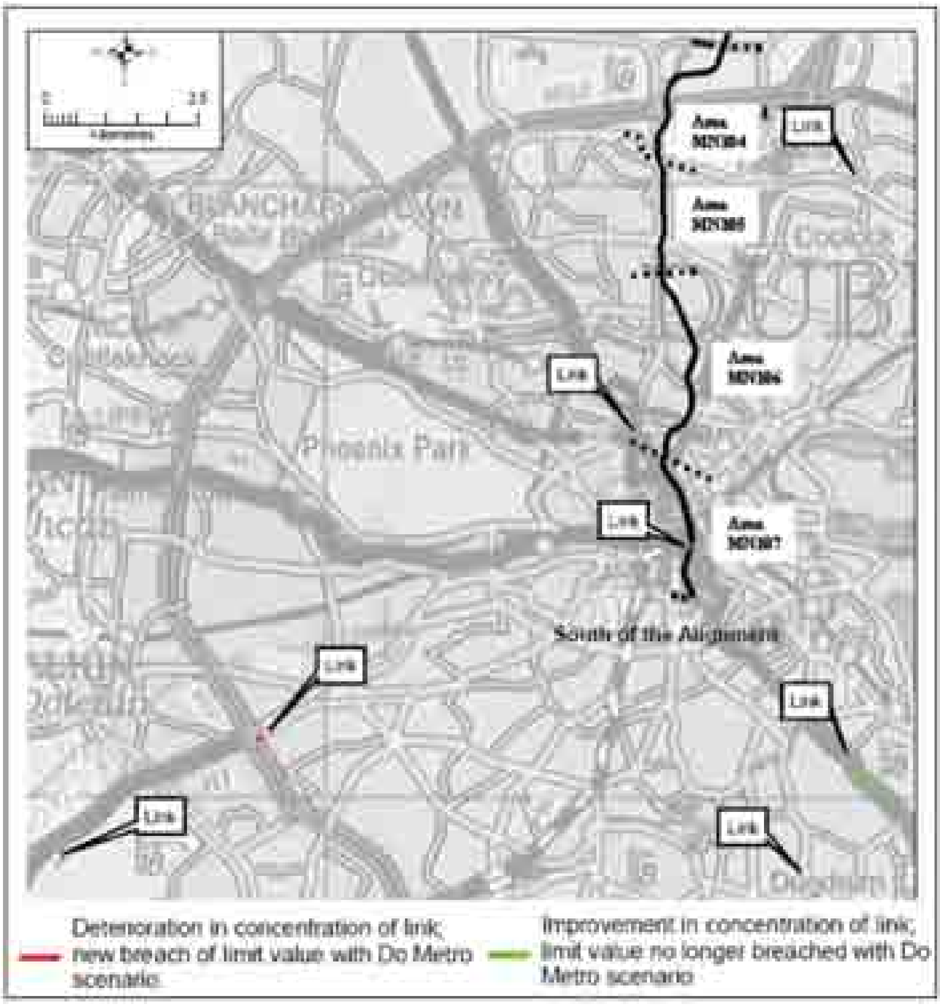
The result of the implementation of proposed scheme in 2029 is that there will only be one road link where NO_2 concentrations are predicted to exceed the NO_2 limit value (this is part of the Red Cow Roundabout). The link is shown in Figure 12.1 and Table 12.9. The magnitude of increase in the annual average NO_2 concentration for this link is approximately 13 µg m^{-3} and causes a marginal breach of the regulatory limit. This negative impact is therefore considered to be of high magnitude and of Medium significance.

Table 12.9 Street link where a new breach of the NO_2 limit value (of 40 µg m^{-3}) is predicted to occur in 2029

Road link	Street name	Magnitude of Change (µg m^{-3})	New Concentration (µg m^{-3})	Distance from Alignment
NO_2				
4221_4220 (b)	Part of the Red Cow Roundabout, going from the East to the West (4221 to 4220), roundabout linking Western Parkway, R110 and Naas Road	12.98	41.41	More than 5km

(b) All links are South of the alignment
Source: Road names provided by MVA traffic consultants

Figure 12.1 Road links where changes in compliance with regulatory NO_2 levels occur



If the proposed scheme is implemented, PM_{10}/$PM_{2.5}$ concentrations will decrease substantially alongside several road links. The proposed scheme does not have any implications in terms of compliance with PM_{10}/$PM_{2.5}$ limit values.

Changes in NO_2 and PM_{10}/$PM_{2.5}$ across the entire scheme

Changes in NO_2 and PM_{10}/$PM_{2.5}$ concentration (µg m^{-3}) for 2029 are presented in Table 12.10 for two scenarios: if the scheme is not implemented and if it is implemented. The table shows the number of road links with air quality improvements or degradation related to the magnitude of concentration changes for both NO_2 and PM_{10}/$PM_{2.5}$.

Table 12.10 Road Links with changes in NO_2 and PM_{10}/$PM_{2.5}$ Concentration (µg m^{-3}) from 2029 Do Minimum to 2029 With Metro

	Change in NO_2 Concentration (µg m^{-3})		Change in PM_{10}/$PM_{2.5}$ Concentration (µg m^{-3})	
Impact Magnitude	Number of links with Degradation in Air Quality	Number of links with Improvement in Air Quality	Number of links with Degradation in Air Quality	Number of links with Improvement in Air Quality
high	0	1	0/0	0/0
medium	47	45	0/7	3/14
low	595	536	68/184	63/198
very low	11,404 (a)		12,225 (a)	

(a) This is the total number of insignificant positive and negative changes as defined by a very low impact magnitude

All of the changes in NO_2 and PM_{10}/$PM_{2.5}$ concentrations are of medium to very low magnitude. These changes are of Low significance

Microclimate

Area MN103 comprises approximately 2,435,000m² of land. Approximately 47% of this land currently comprises open green areas (1,145,000m²). Permanent land-take in this area occurs to facilitate structures such as the northern airport portal (and associated maintenance areas) and the above ground features of the Airport Stop. The land-take for the stop occurs within existing hardstanding areas of Dublin Airport. In light of the large amount of green vegetated areas within Area MN103, the microclimatic impact of land-take is considered to be Low and not significant.

The alignment is primarily underground in this area so significant microclimatic impacts due to LMV movement, cold air pooling, shading, or wind pattern disruption are not expected to occur.

Climate change

Predicted CO_2 emissions in the do minimum year of 2029 are detailed in the baseline Air and Climatic Factors Chapter of this EIS (Volume 1, Chapter 20). The annual CO_2 emissions from vehicle emissions that will be produced in 12.11 if the scheme is implemented are shown in Table 12.11, along with the percentage change relative to baseline emissions.

Table 12.11 CO_2 Emissions from Network in 2029 (tonnes per annum)

Do Metro 2029 (tonnes annum^{-1})	Change relative to baseline (%)
3,096,110 [(a)]	- 0.6 %

(a) Estimated using DMRB methodology

The magnitude of change in CO_2 emissions in 2029 if the proposed scheme goes ahead is low and is, therefore, insignificant. The decrease is a result of a combination of traffic re-routing associated with the direct impacts of the proposed scheme on road capacity and modal shift from car to the rail system. Emission factors are used to predict future emissions; these depend on fuel consumption and the carbon content of fuel. Emission factors decrease in the future as fuel consumption changes with improvements in vehicle efficiency and carbon content from 2008 to 2020 will reflect the introduction of bio-fuels.

Typical Light Metro Vehicle (LMV)