Contents

19 Major Accidents, Inter-Relationships, Interactions and Cumulative Impacts

19.1 Introduction

This chapter of the EIAR presents an assessment of the vulnerability of the proposed road development to risks of major accidents and/or disasters including the methodology used for the assessment (**Section 19.2**). The methodology used to assess interaction/inter-relationship and cumulative impacts is presented in **Section 19.3**, with the assessment of the interaction/inter-relationship of impacts between the various environmental factors as a result of the proposed road development in **Section 19.4** and an assessment of the cumulative impacts of the proposed road development with other projects in **Section 19.5**. Potential transboundary impacts are included in **Section 19.6** and this chapter concludes with references (**Section 19.7**).

19.1.1 Vulnerability of the proposed road development to risks of major accidents and/or disasters

Article 3 of the EIA Directive as amended by Directive 2014/52/EU requires that:

"The effects referred to in paragraph 1 on the factors set out therein shall include the expected effects deriving from ***the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned****".*

Furthermore, Annex IV (8) (*Information Referred to in Article 5(1) (Information for the Environmental Impact Assessment Report*) of the EIA Directive as amended by Directive 2014/52/EU states that the EIAR shall contain:

"A description of the expected significant adverse effects of the project on the environment deriving from the ***vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned****. Relevant information available and obtained through risk assessments pursuant to Union legislation such as Directive 2012/18/EU of the European Parliament and of the Council[1]or Council Directive 2009/71/Euratom[2] or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met.* ***Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies****."*

[1] (*) Directive 2012/18/EU of the European Parliament and the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1).
[2] (**) Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations (OJ L 172, 2.7.2009, p. 18)'.

Section 19.2 of this chapter presents an assessment of the vulnerability of the proposed road development to risks of major accidents and/or disasters which are relevant to the proposed road development.

19.1.2 Interactions and Inter-relationships

Article 3 (1) of the EIA Directive as amended by Directive 2014/52/EU requires that:

"The environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors: (a) population and human health; (b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC; (c) land, soil, water, air and climate; (d) material assets, cultural heritage and the landscape; ***(e) the interaction between the factors referred to in points (a) to (d)****.*

Also, pursuant to section 50(3)(b) of the Roads Act 1993 (as amended) the EIAR (or EIS as then was under the Roads Act) is to contain:

"50(3)(b) a description of the aspects of the environment likely to be significantly affected by the proposed road development, including in particular—

- *human beings, fauna and flora,*
- *soil, water, air, climatic factors and the landscape,*
- *material assets, including the architectural and archaeological heritage, and the cultural heritage,*
- *the inter-relationship between the above factors,*

The interaction of effects within the proposed road development in respect of each of the environmental factors, listed in Article 3(1) of the EIA Directive, have been identified and addressed in detail in the respective chapters in this EIAR. This chapter however, presents a summary of each assessment of the interaction (inter-relationship) of impacts, from the proposed road development, between the various environmental factors.

Section 19.4 of this chapter presents an assessment of the interaction/inter-relationship of impacts between the various environmental factors as a result of the proposed road development.

19.1.3 Cumulative Impacts

Annex IV (5)(e) of the EIA Directive as amended by Directive 2014/52/EU requires that the EIAR shall contain:

"*A description of the likely significant effects of the project on the environment resulting from, inter alia:*

(e) the ***cumulation of effects*** *with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;*

Furthermore, Annex IV (5) states that the EIAR shall contain:

*"The description of the likely significant effects on the factors specified in Article 3(1) should cover the direct effects and any indirect, secondary, **cumulative**, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the project. This description should take into account the environmental protection objectives established at Union or Member State level which are relevant to the project".*

Also, pursuant to section 50(3)(c) of the Roads Act 1993 (as amended) the EIAR (or EIS as then was under the Roads Act) is to contain:

*"(c) a description of the likely significant effects (including direct, indirect, secondary, **cumulative**, short, medium and long-term, permanent and temporary, positive and negative) of the proposed road development on the environment resulting from—*

- *the existence of the proposed road development,*
- *the use of natural resources,*
- *the emission of pollutants, the creation of nuisances and the elimination of waste"*

Section 19.5 of this chapter presents an assessment of the cumulative impacts of the proposed road development with other projects.

19.2 Major Accidents and Disasters

19.2.1 Introduction

This section presents an assessment of the likely significant adverse effects of the proposed road development on the environment arising from the vulnerability of the proposed road development to risks of major accidents and/or disasters that are relevant to the proposed road development.

As mentioned previously, this assessment is necessary following changes to the EU legislation. Article 3 of the EIA Directive as amended by Directive 2014/52/EU states the need to assess "*the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned*".

The underlying objective of the assessment is to ensure that appropriate precautionary actions are taken for those projects which "*because of their vulnerability to major accidents and/or natural disasters, are likely to have significant adverse effects on the environment".*

Based on the requirements of the new EIA Directive, this chapter answers the following questions:

- To what major accidents and/or disasters could the proposed road development be vulnerable?
- Could these major accidents and/or disasters result in likely significant adverse environmental effect(s) and if so what would these be?

- What measures are in place, or need to be in place, to prevent or mitigate the likely significant adverse effects of such events on the environment?

This assessment is set out as follows:

- **Section 19.2.2** sets out the methodology used
- **Section 19.2.3** describes characteristics of the major accidents and/or disasters that may be relevant to the proposed road development
- **Section 19.2.4** details the risk screening process to determine what major accidents and/or disasters to which the proposed road development could be vulnerable
- **Section 19.2.5** provides a summary of the output of the risk screening process
- **Section 19.2.6** details the assessment of the vulnerability of the proposed road development to major accidents and/or disasters identified during the risk screening process
- **Section 19.2.7** describes measures to mitigate the likely significant impacts of such events on the environment
- **Section 19.2.8** describes residual impacts
- **Section 19.2.9** provides a summary

19.2.1.1 Key definitions relevant to this assessment

At the time of undertaking this assessment, there was no clear definition of the term "major accident and/or disaster" in the context of the EIA Directive. Achieving a common terminology is a challenge as various disciplines have developed specific terminology for the assessment of risks and impacts. The following definitions have been adopted for this EIAR following a review of SEC (2010) 1626 – Risk Assessment and Mapping Guidelines for Disaster Management and ISO 31010 – Risk Management.

Hazard is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (*in technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis*).

Natural hazard: Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (*natural hazards are a sub-set of all hazards. The term is used to describe actual hazard events as well as the latent hazard conditions that may give rise to future events. Natural hazard events can be characterised by their magnitude or intensity, speed of onset, duration, and area of extent (UNISDR, 2009)*).

Disaster risk[3] is characterised as a hazard which has potential to incur community losses, encompassing assets, life, health and livelihoods, giving significance to disaster events at a personal and local scale. Disaster risk can also be defined as, hazards which could cause a locality to require assistance from an outside state, which could relate to international aid, or a local authority requiring assistance from another local authority.

A *natural disaster*, in the context of the proposed road development, is a naturally occurring phenomenon such as an extreme weather event (e.g. storm, flood, temperature) or ground-related hazard events (e.g. subsidence, landslide, earthquake) with the potential to cause an event or situation that meets the definition of a major accident as defined above.

Accident is an undesirable event resulting in damage or harm. Natural disaster events refer to natural occurrences, and are not defined to include events caused by humans (however natural events can be exacerbated by human intervention – development exacerbating flooding etc.). This gives reason to the inclusion of both terms 'accident' and 'disaster' within the Directive to ensure there is certainty that both man-made and naturally caused hazards are considered.

Vulnerability is defined as the 'exposure and resilience' of the proposed road development to the risks associated with major accidents and/or disasters. Vulnerability is influenced by sensitivity, adaptive capacity, and magnitude of impact (*the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. (UNISDR, 2009)*).

Low likelihood is defined for the purposes of this assessment, as events that may occur during the lifetime of the proposed road development, so no more than once for the construction phase, and no more than once for the operational phase. The construction period of the proposed road development has been estimated at three years, the minimum operational period can be estimated at 120 years as this is the design life of the structures per DN-STR-03012 (Design For Durability).

The following definition has been derived from *S.I. No. 209/2015 - Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015 (COMAH Regulations 2015)* and the *Framework for Major Emergency Management* prepared by the National Steering Group in Ireland for Major Emergency Management:

A *major accident*, in the context of the proposed road development, is defined as an event that threatens immediate or delayed serious damage to human health, welfare and/or the environment and requires the use of resources beyond those of the road authority or its contractors. Serious damage includes the loss of life or permanent injury and/or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts. The significance of this effect takes into account the extent, severity and duration of harm and the sensitivity of the receptor.

[3] Risk is a combination of the consequences of a hazard (event) and the associated likelihood/probability of its occurrence.

19.2.2 Methodology

19.2.2.1 Introduction

The starting point for the scope and the methodology of this assessment is that the proposed road development is designed and will be built and operated in accordance with best practice. Ensuring that the proposed road development is designed safely and will thus operate safely has been to the forefront of the design process. Additionally, at the forefront of the design process was the need to ensure that the proposed road development is capable of being constructed safely and without risk to health, can be maintained safely, and complies with all relevant health and safety legislation. This approach has allowed all identified risks to be managed such that, where possible, the hazards that result in risks are mitigated (manage hazard source, manage pathway between source and receptor, manage receptor) or eliminated (eliminate source, remove pathway between source and receptor, remove receptor).

The methodology for assessing the vulnerability of the proposed road development to risks associated with major accidents and/or disasters is a risk analysis based approach and is based directly on the requirements of the new EIA Directive (2014/52/EU), the draft 2017 EPA Guidelines on the Information to be contained in Environmental Impact Assessment Reports, Draft, August 2017 and the European Commission (2017) Environmental Impact Assessment of Projects – Guidance on the preparation of the Environmental Impact Assessment Report. (Office for Official Publications of the European Communities 2017).

This risk analysis based approach is derived from documentation prepared by the European Commission such as:

- The Risk Assessment and Mapping Guidelines for Disaster Management[4]
- Directive 2007/60/EC (EU Floods Directive)
- Directive 2008/96/EC (Road Infrastructure Safety Management)
- Directive 2004/54/EC (minimum safety requirements for tunnels in the Trans-European Road Network)
- Directive 91/689/EEC (on hazardous waste)
- Directive 2012/18/EU (control of major-accident hazards involving dangerous substances)
- Directive 2000/60/EC (EU Water Framework Directive)
- Directive 2006/118/EC (Groundwater)

The assessment covers the identification of potential hazards associated with major accidents and/or disasters, their likelihood, and the potential resulting consequences thereof. The assessment has focused on three main areas:

- Consideration of the vulnerability (exposure and resilience) of the proposed road development to risks of major accidents/and or disasters

[4] European Commission, Commission Staff Working Paper, SEC(2010) 1626 final.

- Identification of the types of major accidents and/or disasters that are relevant to the proposed road development and the likelihood of their occurrence
- Description of the expected significant adverse effects of the proposed road development on the environment (environmental factors) arising from the vulnerability of the proposed road development to risks of major accidents and/or disasters

Eliminating, isolating and mitigating identified risks was undertaken during the design and environmental evaluation process for the proposed road development. Design and mitigation measures identified and included to reduce or avoid risks of major accidents and/or disasters are considered to be part of the design, as they reduce the likelihood and consequence of risk events, for the purposes of this assessment. Such measures are detailed within **Section 19.2.4**.

19.2.2.2 Legislation and Guidelines

The following paragraphs set out the requirements of the EIA Directive as amended by Directive 2014/52/EU in relation to major accidents and/or disasters.

Article 3 of the EIA Directive as amended by Directive 2014/52/EU

"The effects referred to in paragraph 1 on the factors set out therein shall include the expected effects deriving from ***the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned****".*

Furthermore, Annex IV (8) (*Information Referred to in Article 5(1) (Information for the Environmental Impact Assessment Report*) of the EIA Directive as amended by Directive 2014/52/EU states that the EIAR shall contain:

"A description of the expected significant adverse effects of the project on the environment deriving from the ***vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned****. Relevant information available and obtained through risk assessments pursuant to Union legislation such as Directive 2012/18/EU of the European Parliament and of the Council[5]or Council Directive 2009/71/Euratom[6] or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met.* ***Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies.****"*

Furthermore, Recital 15 of the EIA Directive as amended by Directive 2014/52/EU states that:

"(15) In order to ensure a high level of protection of the environment, precautionary actions need to be taken for certain projects which, because of their vulnerability to major accidents, and/or natural disasters (such as flooding, sea

[5] (*) Directive 2012/18/EU of the European Parliament and the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1).
[6] (**) Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations (OJ L 172, 2.7.2009, p. 18)'.

level rise, or earthquakes) are likely to have significant adverse effects on the environment. For such projects, it is important to consider ***their vulnerability (exposure and resilience) to major accidents and/or disasters, the risk of those accidents and/or disasters occurring and the implications for the likelihood of significant adverse effects on the environment****. In order to avoid duplications, it should be possible to use any relevant information available and obtained through risk assessments carried out pursuant to Union legislation, such as Directive 2012/18/EU of the European Parliament and the Council[7] and Council Directive 2009/71/Euratom[8], or through relevant assessments carried out pursuant to national legislation provided that the requirements of this Directive are met."*

The requirement to assess the vulnerability of a development to risks associated with major accidents and/or disasters is also referenced in the draft 2017 EPA *Guidelines on the information to be contained in an EIAR* as follows:

"*To address unforeseen or unplanned effects the Directive further requires that the EIAR takes account of the vulnerability of the project to risk of major accidents and /or disasters relevant to the project concerned and that the EIAR therefore explicitly addresses this issue. The extent to which the effects of major accidents and / or disasters are examined in the EIAR* ***should be guided by an assessment of the likelihood of their occurrence (risk). This may be supported by general risk assessment methods or by systematic risk assessments required under other regulations e.g. a COMAH (Control of Major Accident Hazards involving Dangerous Substances) assessment***".

19.2.2.3 Data sources and Consultations

A desktop study of environmental assessments undertaken by each of the specialists who contributed to the preparation of this EIAR was completed. Each environmental specialist considered routine events (those predicted to happen or which are likely to happen) and non-routine events (which 'might' happen) in their assessment of likely significant effects on the environment and provided mitigation measures to eliminate or reduce the risk to the lowest degree possible. The assessment in this chapter makes reference to these assessments where relevant rather than duplicating them. Therefore, this chapter only considers low likelihood but potentially high consequence events. The screening process to determine low likelihood but potentially high consequence events associated with major accidents and/or disasters is set out in **Sections 19.2.2.4** below.

Key to comprehensively understanding the potential consequences of major accidents and disasters in the context of the proposed road development was gaining an understanding of common region-specific accident and/or disasters events. In particular, it was necessary to identify the factors that result in natural disasters. Therefore, emergency service organisations, local authority personnel, and regional authority personnel responsible for responding to and coordinating the response to

[7]Directive 2012/18/EU of the European Parliament and the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1).
[8] Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations (OJ L 172, 2.7.2009, p. 18).

the fallout of major accidents and/or disasters, and indeed for the future planning of responses to such incidents were consulted.

The following emergency service providers and local and regional authorities were consulted:

- Galway City Council
- Galway County Council
- Galway County Council fire department
- An Garda Síochána traffic corps
- An Garda Síochána operations
- Department of Defence
- Health Service Executive – emergency management
- Major Emergency Group West Region

This consultation, as expected, highlighted that weather events are the principal hazards encountered with respect to road operation in the region - be it rainfall, wind, or icy conditions and their potential contribution to natural disasters such as landslides and ground subsidence and major accidents such as vehicular collisions.

In conjunction with local, regional, and emergency organisations, means of enhancing the resilience of the proposed road development to major accident and disaster events were discussed. Such discussions focused on the provision of access to the proposed road development, the provision of warning systems to warn users of incidents in advance of hazards, and the management and operation of the proposed road development.

19.2.2.4 Assessment Methodology

The potential for hazards associated with major accidents and/or disasters to result in a significant adverse environmental effect was assessed. The approach adopted considers hazards that may produce environmental consequences, the likelihood of these consequences occurring, considering planned mitigation, and the acceptability of the subsequent risk to the receiving environment. The process included:

- identifying hazards
- screening these hazards
- defining the impact
- assessing the likelihood of occurrence
- assessing the remaining risks

The assessment was undertaken at a route-wide level but, where relevant, reflects locations that were considered more vulnerable to risks associated with identified potential major accidents and/or disasters.

The key features underlying the assessment of the vulnerability of the proposed road development to major accident and/or disaster risk events are that:

- only risks with a feasible source-pathway-receptor model were considered as part of the appraisal
- tunnels proposed as part of the proposed road development are classified as Category C in accordance with *European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)*. This limits access to the proposed road development to materials of Class C and lesser thus limiting the unrestricted carriage of classes of dangerous goods

In terms of the assessment methodology, the following approach has been adopted:

- no additional risk modelling was undertaken for this assessment. Instead, the risk modelling and the analysis completed as part of the design and environmental evaluation of the proposed road development were utilised
- the assessment was completed via a review of available documentation and legal and regulatory requirements
- where information was not available, reference and regard was had to existing empirical information. For example, regard was had to empirical information regarding collision rates associated with single carriageway and motorway projects. Such information was then utilised to determine safety benefits consequent to the development of the proposed road development

Identification of Environmental Receptors

The assessment considered human beings, population and health, biodiversity, land, soil, water, air quality and climate, noise and vibration, material assets (both agriculture and non-agriculture), archaeology, architecture and cultural heritage, and the landscape, and interactions of these factors as per the requirements of the EIA Directive and the draft 2017 EPA Guidelines. For the purpose of assessment, an environmental receptor was therefore considered to be any of these. Relevant environmental receptors for this assessment therefore included:

- members of the public and local communities
- infrastructure and the built environment (including material assets)
- the natural environment, including ecosystems, land and soil quality, air quality and climate, noise and vibration, surface and groundwater resources, and landscape
- the historic environment, including archaeology and architectural and cultural heritage

Factors considered in determining whether potential adverse effects are significant included:

- the geographic extent of the effects. Effects beyond the extents of the proposed development are considered significant
- the duration of the effects. Effects which are permanent (i.e. irreversible) or long lasting are considered significant

- the severity of the effects in terms of number, degree of harm to those affected and the response effort required. Effects which trigger the mobilisation of substantial civil emergency response effort are considered significant
- the sensitivity of the identified receptors
- the effort required to restore the affected environment. Effects requiring substantial clean-up or restoration efforts are considered significant

For the proposed road development, a significant adverse effect is considered to mean the loss of life or permanent injury, and/or permanent or long-lasting damage to an environmental receptor. The significance of this effect takes into account the extent, severity, duration of harm, and the sensitivity of the receptor.

Identification and Screening of Risks

Risk identification involved collating data from existing sources of information and collating risks identified during design and environmental evaluation process.

To identify whether a risk has the potential for a significant adverse effect on an environmental receptor or for death or permanent injury, three components needed to be present: a source, a pathway (between source and receptor) and a receptor. As such, the assessment uses the following conceptual model:

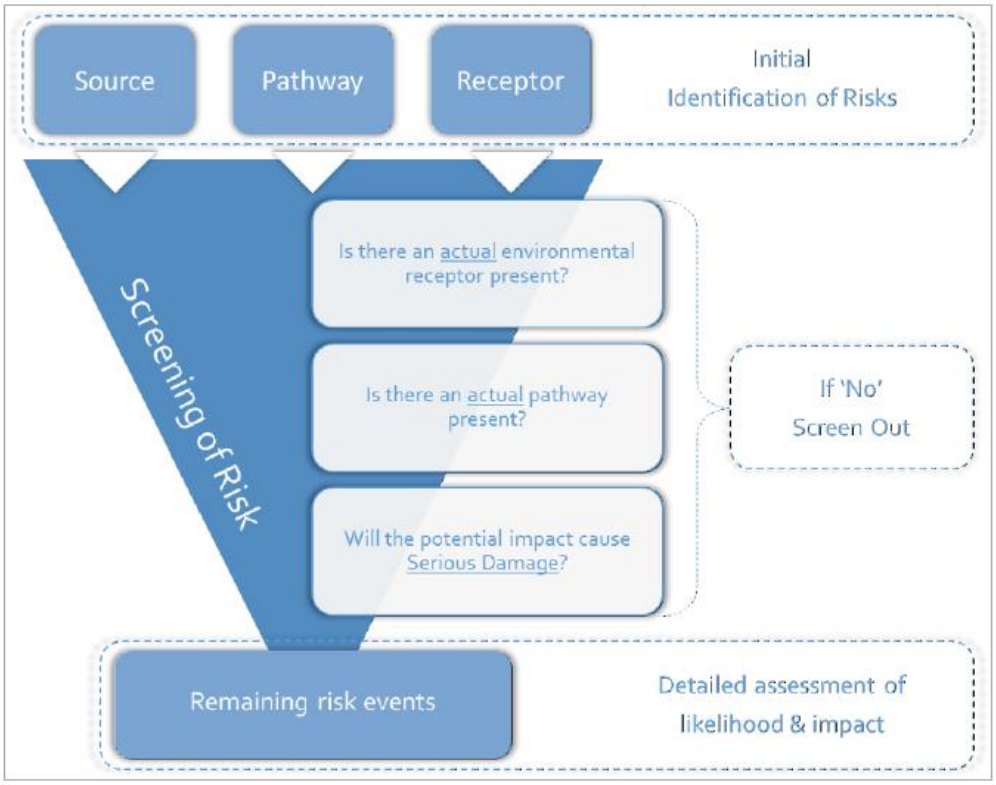
- the source is the original cause of the hazard, which has the potential to cause harm, for example a vehicle travelling on the proposed road development or adverse weather events
- the pathway is the route by which the source can reach the receptor, for example a vehicular accident or flooding
- the receptor which is the specific component of the environment that could be adversely affected if the source reaches it (e.g. environmental habitat damaged via vehicular accident or flooding, loss of life due to vehicular accident or flooding)

Risk events which do not have all three components were screened out from the assessment.

The following screening process was used to identify those risk events requiring further consideration within the assessment (**Plate 19.1**):

- is there a potential source, pathway and receptor? If not, no further assessment required
- is there a relevant environmental receptor present in the locations where the risk event could occur, and a pathway whereby the source of harm can reach the receptor? If not, no further assessment required
- does the potential impact on the environmental receptor meet the definition of a significant adverse effect? If not, no further assessment required

Plate 19.1: Risk Screening Process



For those risk events which were not screened out during this three-step process, the following steps were followed:

- Define impact for each remaining risk event
- Access likelihood of remaining risk events occurring
- Access likely significant impact
- Appraise risk management options

This then formed the basis for recommending additional mitigation measures, if any, as appropriate.

Define impact for each remaining risk event

The worst case impact(s) on environmental receptors was identified for each event which remained, determined where necessary by consultation with relevant environmental specialists to answer the question

> *'could this event constitute a major accident or disaster in terms of the definitions provided?'*

Assess Likelihood of remaining risk events occurring

The likelihood of the reasonable worst case environmental effect(s) occurring was then evaluated taking into account:

- the likelihood of the risk event occurring considering the measures already embedded into the design, proposed mitigation measures and the execution of the proposed road development
- the likelihood that an environmental receptor could be affected by the risk event

Likelihood assessments were not always quantitative. However, all assessments evaluated whether the effect (for example, loss of life) was a possible outcome of the risk event.

This evaluation of the likelihood refers to existing assessments as well as risks identified through consultation with relevant environmental specialists, emergency service providers and local authority personnel responsible for major accident and disaster response, with reference to the definition of low likelihood but high consequence events.

Assess likely significant impact

The events not screened out are assessed in **Section 19.2.6**. The assessment of the events which remained following the screening process is presented in an Environmental Risk Record (**Table 19.1**). This record details the impact (the reasonable worst consequence if the hazard occurred), assesses the likelihood of the hazard occurring, and assesses the consequent risk. As part of this assessment embedded mitigation which reduces the hazard, the likelihood of the hazard, and significance of the potential risk consequent to the hazard is detailed. Ultimately it will be determined whether the risk could constitute a major accident and/or disaster and, if so, whether the risk has been mitigated to the greatest degree possible.

Appraise Risk Management Options

The risks that could not be screened out and reached this final step in the assessment process are low probability but potentially high consequence events. They are events which cannot feasibly be mitigated in the design or eliminated completely. For this reason, they are events for which the feasible method of mitigating against them lies in developing procedures to manage their potential consequences.

The mitigation hierarchy used as part of this assessment is as follows:

- adapt proposed processes such that either the likelihood or the impact of the risk event is reduced
- control the risk, by ensuring that appropriate control measures are in place (e.g. emergency response) so that if a risk event should occur, it can be controlled and managed appropriately

As noted, eliminating, isolating and mitigating identified risks was undertaken during design and environmental evaluation process for the proposed road development. Measures were identified and included to reduce or avoid risks associated with major accidents and/or disasters and included as part of the design considered in this assessment. Risk management measures considered following the

screening process outlined above cannot therefore be classified as embedded, and consequently that is why they are limited to adapting processes to mitigate the consequence of risks and controlling the risks events as best possible.

Plate 19.2 shows the principles of managing risk, where measures to prevent a risk event occurring are barriers or intervention measures, or mitigation measures and putting controls in place should an event occur (for example, firewater containment measures).

Plate 19.2: Principles of Managing Risk

19.2.3 Characteristics of Major Accidents and / or Disasters

The major accidents and disasters considered in this assessment are low likelihood but potentially high consequence events (major accidents and/or disasters).

All low consequence events, whatever their likelihood, do not meet the definition of major accidents and/or disasters. For example, minor spills, silt control, and dust emissions which may occur during construction, but would be limited in area and volume and temporary in nature do not meet the definition of a major accident and/or disaster. Such events have already been considered and mitigated for as part of the design of the proposed road development.

Low likelihood is defined for the purposes of this assessment, as events that may occur during the lifetime of the proposed road development, so no more than once for the construction phase, and no more than once for the operational phase. The construction period of the proposed road development has been estimated at three years, the minimum operational period can be estimated at 120 years as this is the design life of the structures per DN-STR-03012 (Design For Durability). 120 years is not an upper boundary for low likelihood. Very low likelihood events are also included in the assessment, for example flood events which may only occur at most once in every 1,000 years (Flood Risk Assessment). Measures were incorporated into the design to reflect what is reasonable for such events, considering their potential consequence.

19.2.4 Risk Screening Process

This section details the Screening Process and the conclusions of assessments undertaken as part of the design and environmental evaluation process. These earlier assessments took cognisance of the design measures and mitigation measures included to reduce the significance of risks associated with major accidents and/or natural disasters. Risks are screened such that only low likelihood but potentially high consequence events remain. **Section 19.2.5** then details the assessment of these remaining risk events.

Regard has been had to the requirements of the Eurocodes with respect to structural and geotechnical design requirements. Utilisation of the Eurocodes manages the hazards and consequent risks associated with natural disasters (seismic activity, ground related movements). Their utilisation ensures that high quality resilient designs are produced.

Aside from structural and geotechnical design, all other design has been completed in accordance with best practice and national standards (for example, TII Publications). Reference to such standards are provided below as required.

Regard has been had to the requirements of the EIA Directive, the draft 2017 EPA guidelines, and documentation prepared by the European Commission as detailed in **Section 19.2.2**. Documentation prepared by the European Commission, in particular the Directives noted, place an emphasis on ensuring that proposed developments are resilient and safe. Their utilisation ensures that high quality resilient designs are produced thereby ensuring that the vulnerability of the proposed road development to risks associated with major accidents and/or disasters is minimised to the greatest degree possible.

19.2.4.1 Safety

As noted previously, ensuring that the proposed road development is designed safely and will thus operate safely has been to the forefront of design development. To regularise and embed this principle within design development, safety assessments were undertaken for the proposed road development to inform the identification and assessment of hazards and consequent risks. Assessments included health and safety design risk assessments in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013, design reviews, and safety assessments undertaken as part of the transport appraisal. The results of these assessments are enveloped within design of the proposed road development and environmental evaluation as detailed throughout this EIAR.

Regard was had to features external to the proposed road development which could contribute a potential source of hazard to the proposed road development. This information was obtained from a desk based study. Such features include, but are not limited to:

- Presence of Control of Major Accidents and Hazards (COMAH) sites
- Potentially hazardous ground conditions
- Proximity to other infrastructure (road, energy)

COMAH sites, and their associated risks, were scoped out of the assessment due to their distance from the proposed road development[9]. Additionally, the tunnels are proposed as tunnel Category C in accordance with ADR which imposes its own limitations with respect to the carriage of dangerous goods, often associated with COMAH sites, on the proposed road development.

Hazardous ground conditions were assessed as part of the ground conditions assessment above.

Proximity to other infrastructure, especially road infrastructure, was assessed via the preparation of a road safety impact assessment per TII PE-PMG-02001 (Road Safety Impact Assessment). The purpose of Road Safety Impact Assessment (RSIA) is to undertake a strategic comparative analysis of the impact on the safety performance of the road network of different planning alternatives for a new road or a substantial modification to the existing network. The requirements of TII PE-PMG-02001 and the assessments therein are derived from EU Directive 2008/96/EC on Road Infrastructure Safety Management (RISM). Issues highlighted (for example safety of vulnerable road users) as part of the RSIA were targeted for improvement as part of the project objectives.

19.2.4.2 Vehicle Usage

The proposed road development has been designed to accommodate vehicular traffic, thus, there is a consequent potential for vehicular accident events. The likelihood of such events is minimised to the greatest degree possible by designing the geometric layout of the proposed road development in accordance with national requirements (TII Publications) which contain criteria for achieving a desirable level of performance in terms of road safety, operational, economic and environmental effects, and sustainability. The geometric layout has been subjected to safety audits per TII GES-TY-01024 (Road Safety Audit). The purpose of such audits is to ensure that the road safety implications of the proposed road development is fully considered for all users of the road and other users affected by the development. The requirements of TII GES-TY-01024 and the assessments therein are derived from EU Directive 2008/96/EC (Road Infrastructure Safety Management (RISM)).

Vehicular accident events can be exacerbated by interaction with obstacles in the path of errant vehicles, similarly errant vehicles can exacerbate risk events – such as the risk of bridge collapse consequent to vehicular collision. A risk assessment was undertaken in accordance with GE-TBU-01010 (NRA BD2 Safety Barrier Risk Assessment) and GE-TBU-01019 (NRA TB 11 NRA TD 19 and Forgiving Roadsides). This assessment identified locations where it is necessary to provide vehicular restraint systems to reduce the severity and potential consequences of vehicular accident events, and consequently related events such as bridge strike events (bridge collapse) and errant vehicles interacting with sensitive environmental receptors (discharge of pollutants into sensitive groundwater receptors).

[9] The closest COMAH site Cold Chon, Oranmore is approximately 2.15km from the closest point of the proposed development boundary.

In addition to physical mitigation such as vehicle restraint systems, operational measures have been incorporated into the design which will act to mitigate the potential consequences of vehicle accident events such as a vehicle breakdown or fire. Access points have been provided that will enable efficient access for emergency services and make their response times more efficient and reduce the potential significance of consequences, i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location.

Additionally, intelligent transport systems (communication and traffic control systems including variable messaging gantries, automatic barriers at tunnel entrances, real time monitoring and control of road traffic and flows, automatic incident detection in tunnels) have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).

The proposed road development has been designed in accordance with best practice and includes measures as noted. However, there remains the possibility of vehicular accident events. The three components - source, pathway, and receptor remain. It is not possible to eliminate the source (vehicular traffic) and receptors (environmental receptor, human life). The pathway is restricted because of the restraint systems, though not eliminated. In addition, restraint systems themselves can act as hazards. They are included where the consequences of the vehicle striking the barrier are considered to be less serious than those that would result if the barrier were not in place. Such restraint systems will temper the consequences and likelihood of major accidents and/or disasters associated with vehicular accident events; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to vehicular accident events. This is the case as the loss of life or permanent injury cannot be categorically discounted.

It is therefore not possible to rule out low likelihood but potentially high consequence vehicle accident events and the vulnerability of the proposed road development to such events. Therefore, vehicular accidents are further assessed in **Section 19.2.5**.

19.2.4.3 Construction Activities

The proposed road development has been designed to ensure that it is capable of being constructed safely and without risk to health. Safe construction, and the preparation of method statements, will be the responsibility of the Contractor. Construction related hazards are capable of being managed where construction safe systems of work are implemented by the Contractor. The events identified within this section of the EIAR are equally applicable to construction and operation of the proposed road development.

In addition to the design measures and mitigation measures which are included to reduce the potential for impacting environmental receptors, a Construction Environmental Management Plan (CEMP) (see **Appendix A.7.5**) has been prepared which sets out measures to bolster the design and mitigation measures and further minimise the consequences and likelihood of impacting environmental receptors. This plan summarises the overall environmental management strategy to be adopted and implemented during the construction phase of the proposed road development.

It sets out the need to prepare an 'Incident Response Plan' during the construction phase. Such a plan would include measures to ensure that accidental spillages, sediment, erosion, and pollution do not impact on the receiving environment, consequently this plan sets out many of the mitigation and operational measures detailed in the foregoing chapters of this EIAR.

Post construction, the CEMP will be developed into an Environmental Operating Plan for the operational phase ensuring operational mitigation measures are enforced. This plan will be utilised by the road authority and will set out measures to ensure that accidental spillages, sediment, erosion, and pollution do not impact on receiving environment. Again, this reflects the operational mitigation measures detailed in this EIAR, in particular the Schedule of Environmental Commitments presented in **Chapter 20, Summary of Environmental Commitments and Residual Impacts**. The specific events which may arise during construction are screened within the following sections.

19.2.4.4 Tunnels and Bridges

Major accident and/or disaster events can be exacerbated by tunnels and their confined nature. Therefore, it was necessary to identify appropriate standards of safety and operational requirements for tunnels and incorporate them into the design of the proposed road development. In this respect requirements were derived from DN-STR-03015 (BD78/99 – Design of Road Tunnels) and EU Directive 2004/54/EC (minimum safety requirements for tunnels in the Trans-European Road Network)[10]. In accordance with DN-STR-03015 a Tunnel Design and Safety Consultation Group was established. Meetings were held with emergency service personnel to facilitate the contribution of their specific specialist knowledge and experience to determine requirements for tunnel design.

EU Directive 2004/54/EC (transposed into Irish Law by SI 213 of 2006) sets out minimum safety requirements for tunnels in the Trans-European Road Network and requires risk based analysis to steer tunnel design. The Directive sets out the requirement for managing the risks associated with fire events within tunnels. Following assessment as per the Directive, the risk level (for tunnels incorporated in the proposed road development) was determined to be low (Category C per ADR was determined, refer below). This determination steered the selection of design criteria. Design criteria selected ensure that the likelihood and consequence of events (including fire, operational, breakdown) are mitigated and managed. The following design measures, including measures for the operation of the tunnel are incorporated into the design of the proposed road development to mitigate the likelihood and consequence of events:

- the structural resistance to fire is a key aspect of any tunnel due to the high fire loads in such a confined environment. Design is required to rigorous fire curves. The tunnel structures have been designed to be capable of resisting the Rijkswaterstaat (RWS) fire curve for a minimum of 120 minutes. Provisions, such as fibre reinforced concrete or sacrificial cover, have also been included in the design to reduce the risk of spalling - a phenomenon whereby portions of

[10] Applicable to tunnels of length greater than 500m, notwithstanding regard was had to the requirements therein.

concrete fall off the tunnel lining during a fire therefore reducing the overall performance of the structure due to reduced concrete depth (thereby minimising the likelihood of collapse due to fire events)

- access to the tunnels has been provided for emergency services from each side to facilitate ease of access during any incidents
- emergency cross passages and walkways, to aid emergency egress, have been included per DN-STR-03015 (Design of Road Tunnels) at 100m spacing, this ensures that should risk events occur persons can exit the tunnel in a timely manner (thereby minimising the risk of persons becoming trapped within the affected bore)
- tunnel safety systems have been included in the design and will contribute to the management of the tunnel and will therefore assist in maintaining adequate levels of safety management. These include tunnel fire watermain, hose reels, traffic control measures (to forewarn motorists of incidents), automatic fire detection and alarm (warning emergency service providers to ensure a speedy response), automatic fire suppression, PA system, emergency lighting, safety signage, CCTV, and drainage systems for firefighting water and fuel spills (all runoff water collected to prevent discharge to sensitive environmental receptors)
- tunnel drainage systems have been designed to transfer spillages (hydrocarbons, chemicals) which may occur within the tunnel directly to a spillage containment area where it will be contained until it can be safely removed and disposed
- spillage containment areas are external to the tunnels allowing them to be managed in an open and safe environment as opposed to a confined environment
- regard was had to EU Directive 2004/54/EC regarding the carriage of dangerous goods. In this respect, regard was had to the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). Tunnel categorisation per ADR is based on the assumption that there are three major dangers in tunnels: (i) explosions, (ii) release of toxic gas or volatile toxic liquid and (iii) fires. The tunnel category, is assigned by the competent authority (Transport Infrastructure Ireland in Ireland) to a given road tunnel for the purpose of restricting the passage of transport units carrying dangerous goods. The recommended tunnel category for Lackagh Tunnel and Galway Racecourse Tunnel is 'C' in accordance with the ADR. The considerations which contributed to this are as follows:
    - Tunnel Category C requires that no article or substance which would be reasonably likely to explode, dangerously react, produce a flame or dangerous evolution of heat or produce dangerous emissions of toxic, corrosive or flammable gases or vapours are permitted to utilise the tunnel[11]
    - Tunnel Category C is recommended due to the expected low frequency of dangerous goods vehicles which would utilise the proposed road development due to the availability of alternative routes to accommodate same

[11] Reference to the ADR is required to identify gradation of consequences associated with various substances.

- Tunnel Category C is recommended as there would be a need and desire for heavy goods vehicles to use the tunnel to access retail and service industries throughout the city and county and therefore must be accommodated
- An advanced intelligent transport system will be implemented to control access to the entire network and in particular to the tunnels

Adopting Tunnel Category C as per ADR minimise the risks associated with the carriage of dangerous goods on the proposed road development and the potential hazards that may result in major accidents and/or disaster events.

As part of the design of the proposed road development the necessity to introduce mechanical ventilation in the design of the tunnels was considered. The need for such a measure was deemed unnecessary in accordance with the requirements of EU Directive 2004/54/EC and DN-STR-03015 (BD78/99 - Design of Road Tunnels). It was deemed unnecessary as the tunnels are less than 500m in length and facilitate natural ventilation.

Bridge strike events have also been considered as part of the risk assessment and the structural design of structural elements for the proposed road development has been undertaken in accordance with the Eurocodes and national design standards (TII Publications).

Structures incorporated into the proposed road development have been designed in accordance with best practice and includes mitigation and operational measures. However, there remains the possibility of structure accident and disaster events, particularly tunnel events. The three components – source, pathway, and receptor remain. It is not possible to eliminate the source (vehicular traffic) and receptors (human beings and natural environment). The pathway is restricted, though not eliminated through the implementation of fire suppression systems, vehicle restraint systems, adequate access for emergency services and holding tanks for tunnel runoff). Such systems will reduce the consequences and likelihood of major accidents and/or disasters; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to structure related events. This is the case as the loss of life or permanent injury cannot be categorically discounted.

It is therefore not possible to rule out low likelihood but potentially high consequence of a structure collapse or fire event and the vulnerability of the proposed road development to such events. Therefore, structure collapse and tunnel events are further assessed in **Table 19.1** in **Section 19.2.5**.

19.2.4.5 Services

Hazards identified relate to those associated with undertaking works on utilities (electrocution, gas explosion, burst watermain). Extensive consultation took place with utility service providers to ensure that a resilient and safe design was developed (appropriate protection measures and appropriate design criteria).

This interaction resulted in the incorporation of design measures to reduce or eliminate the consequences of potential risk events. The following measures are incorporated into the design to minimise or eliminate the consequences and likelihood of major accident and/or disaster events:

- all service diversions have been agreed with utility service providers. All service diversions must be undertaken in accordance with utility service providers requirements, all of which place health and safety to the fore
- safe construction, and the preparation of method statements, will be the responsibility of the Contractor. As noted previously, at the forefront of design development was the need to ensure that the proposed road development is capable of being constructed safely and without risk to health, can be maintained safely, and complies with all relevant health and safety legislation

Notwithstanding the fact that the utility diversions have been designed in accordance, and will be undertaken by or on behalf of the Contractor in line, with utility service provider requirements, there remains the possibility of additional diversions. Despite the extensive consultation there may still be some unknown services. The survey and information received from utility service providers covered the extent of the proposed road development, however, anomalies exist between these and interpretation is required. Further, even if a comprehensive map of all ground based infrastructure, and indeed overhead infrastructure, could be obtained, there is no guarantee that such conditions remain static, particularly so in the urban environment.

Thus, the three components - source, pathway, and receptor will remain. It is not possible to eliminate all sources (electric cabling, gas mains) and receptors (human beings, environmental receptors). The pathway is restricted but not eliminated, mitigation measures such as extensive consultation with providers and undertaking utility surveys have been undertaken but the pathway remains. Such mitigation will reduce the likelihood of major accidents and/or disaster events; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to utility service events. This is the case as the loss of life or permanent injury cannot be categorically discounted.

It is therefore not possible to rule out low likelihood but potentially high consequence utility service events (electrocution or gas explosion) and the vulnerability of the proposed road development to such events. Therefore, utility service events are further assessed in **Table 19.1** in **Section 19.2.5**.

19.2.4.6 Ground Conditions

The geotechnical design of the proposed road development has been undertaken in accordance with the national design standards (for example TII Publications), the Eurocodes, and best practice. This ensures a resilient and safe design. Ground investigations were undertaken which provided design criteria upon which to base the design of earthworks and foundations. Design criteria were utilised which reduce the consequences and likelihood of major accidents and/or disaster events associated with soils and geology by ensuring that a resilient design is prepared (safety factors etc.).

The ground investigations undertaken identified hazards such as poor ground conditions and karstic conditions. The results of these investigation were utilised in the design of the proposed road development to ensure that a resilient design was developed and to reduce the consequences and likelihood of events (bridge collapse due to inadequate foundations/bearing capacity, earthworks collapse due to

utilisation of inadequate design criteria, earthworks collapse due to inadequate information of ground conditions).

Additionally, determining geotechnical design criteria required significant interaction with the various environmental specialists. This interaction resulted in the incorporation of design measures to reduce or eliminate the consequences of potential risk events. The following measures are incorporated into the design to minimise or eliminate the consequences and likelihood of major accident and/or disaster events:

- in flood prone areas a drainage layer is included to ensure hydraulic conductivity thus preventing water build-up which may result in or exacerbate flooding
- granular fill is proposed for embankments to ensure that sediment does not enter sensitive watercourses or groundwater bodies and impact environmental receptors (groundwater or watercourse pollution). In particularly sensitive areas the use of a geotextile separator is proposed
- in environmentally sensitive areas appropriate protection systems are included to avoid damage to environmental receptors (such as protection layer over Limestone pavement, rock fall ditches, flood bunding)
- with respect to the construction of Lackagh Tunnel, a construction methodology has been proposed which places safety to the fore so as to eliminate the risk of tunnel collapse. The development of this methodology has been influenced by geotechnical investigation which determined appropriate design criteria. Refer to **Chapter 9, Soils and Geology** and **Appendix A.7.3** for further information
- blasting operations during construction will be subject to re-calibration based on site specific conditions and will only be undertaken by appropriately qualified persons (minimises risks associated with blast rock)

In addition to design measures, horizontal movement and vibration monitoring (rock mass monitoring, karst ground areas) will be implemented to ensure that movements will not result in hazards which could cause major accident and/or disaster events, during the construction or operation of the proposed road development. This is essential as hazard events often arise from natural events (heavy rainfall etc.) and the only feasible means of mitigating the impacts of such events is to ensure a resilient design is prepared, as detailed above, and that appropriate control measures (monitoring, response times) are implemented during both the construction and operation of the proposed road development.

The geotechnical design for the proposed road development has been designed in accordance with best practice and includes design measures and mitigation measures as noted. There still remains however, the possibility of geotechnical events. Despite the ground investigations and assessment complete unknown ground conditions remain as the investigations undertaken were targeted to areas of interest and the results had to be interpolated for the areas in-between. It is not possible to map all ground based hazards. Further, even if all ground based hazards could be identified at this point, there is no guarantee that such conditions will remain constant given the karstic nature of the ground.

The three components - source, pathway, and receptor will remain. It is not possible to eliminate all sources (karstic conditions, weather events) and receptors (human beings, environmental receptors). The pathway is restricted, though not eliminated through design and mitigation measures. Such measures will temper the likelihood of major accidents and/or disasters; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to ground condition events. This is the case as the loss of life or permanent injury cannot be categorically discounted (engulfment due to earthworks collapse or events triggered by ground related events).

It is therefore not possible to rule out low likelihood but potentially high consequence of ground collapse events and the vulnerability of the proposed road development to such events. Therefore, ground collapse events are further assessed in **Table 19.1** in **Section 19.2.5**.

19.2.4.7 Hydrogeology

Potential hydrogeological impacts of the proposed road development were evaluated in accordance with TII DN-DNG-03065 (Road Drainage and the Water Environment). This standard reflects the requirements of the following:

- The EU Water Framework Directive (WFD) 2000/60/EC
- The Groundwater Directive 2006/118/EC
- European Communities Environmental Objectives (Groundwater) Regulations 2010
- European Communities Environmental Objectives (Surface Water) Regulations 2009
- European Communities (Drinking Water) (No.2) Regulations 2007
- European Communities (Quality of Salmonid Waters) Regulations 1988
- Water Services Acts 2007 – 2013

The hydrogeological investigations undertaken identified groundwater levels and groundwater movement. The results of these investigation were utilised in the design of the proposed road development to ensure that a resilient design was developed and to reduce the consequences and likelihood of events (groundwater contamination of an aquifer due to inadequate information, groundwater inundation to tunnels or onto road surface due to inaccurate design criteria).

Additionally, determining design criteria with respect to hydrogeology required significant interaction with the various environmental specialists. This interaction resulted in the incorporation of design measures to reduce or eliminate the consequences of potential risk events (pollution to groundwater bodies or aquifers, groundwater flooding). The following measures are incorporated into the design to minimise or eliminate the consequences and likelihood of major accident and/or disaster events:

- A risk assessment in accordance with TII DN-DNG-03065 was undertaken (groundwater vulnerability and aquifer classification). This assessment was

supplemented by site specific hydrogeological risk assessments. This standard and the associated assessment takes into account climate change requirements (appropriate protection measures to prevent groundwater contamination as a result of the proposed road development was determined and included in the design)

- Based on the spillage risk assessment (refer to **Chapter 10, Hydrogeology**) the risk of a serious spillage occurring has an annual probability of less than 0.5% and is considered acceptable per TII DN-DNG-03065. Notwithstanding the low risk of serious spillage, additional spillage protection measures are included at each drainage outfall location, these spillage containment areas prevent the contamination of groundwater and surface water bodies by providing $25m^3$ of containment for accidental spillages of hydrocarbons and chemicals per DN-DNG-03022 (Drainage Systems for National Roads). During a spillage event, the spill will be collected by the drainage network and conveyed towards the outfall where a penstock will divert the spill to the spillage containment area where it will be contained until it can be safely removed and disposed
- Hydrogeological information has been utilised to determine design requirements, for example, hydrogeological assessment information has been utilised to determine waterproofing and groundwater inundation levels for the proposed Lackagh Tunnel and Galway Racecourse Tunnel thereby reducing the potential for the proposed road development to flood during operation and result in major accidents and/or disasters
- The proposed road development has been designed considering the hydrogeological assessment information to determine design elevations thereby reducing the potential for the proposed road development to flood during operation and result in major accidents and/or disasters. Similarly, a drainage layer has been included in the design at appropriate locations to ensure hydraulic conductivity is maintained
- The results of the hydrogeological assessment have been used to determine tunnel waterproofing requirements thereby reducing the potential for the proposed road development to flood during operation and result in major accidents and/or disasters

The hydrogeological design of the proposed road development has been designed in accordance with best practice and includes design measures and mitigation measures but as noted, there remains the possibility of hydrogeological accident and disaster events. Despite the extensive investigations and assessment, unknown ground conditions remain as the investigations undertaken were targeted to areas of interest and the results had to be interpolated for the areas in-between. Further, even if all ground based hazards could be identified, there is no guarantee that such conditions remain constant, given the karstic nature of the ground.

The three components - source, pathway, and receptor remain. It is not possible to eliminate all sources (karstic conditions or weather events) and receptors (human beings and environmental receptors) and the pathway is restricted, though not eliminated through design measures and mitigation. Such measures will reduce the likelihood of major accidents and/or disaster events; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to hydrogeology events (groundwater contamination or groundwater

inundation). This is the case as the loss of life or permanent injury cannot be categorically discounted (drowning due to groundwater inundation or harm consequent to groundwater contamination).

It is therefore not possible to rule out low likelihood but potentially high consequence hydrogeological events (flooding or groundwater contamination) and the vulnerability of the proposed road development to such events. Therefore, hydrogeological events are further assessed in **Table 19.1** in **Section 19.2.5**.

19.2.4.8 Hydrology

The drainage design for the proposed road development was undertaken in accordance with TII DN-DNG-03065 (Road Drainage and the Water Environment).

Based on the spillage risk assessment (refer to **Chapter 11, Hydrology**) the risk of a serious spillage occurring has an annual probability of less than 0.5% and is considered acceptable per TII DN-DNG-03065. Notwithstanding the low risk of serious spillage, additional spillage protection measures are included at each drainage outfall location, these spillage containment areas prevent the contamination of groundwater bodies or surface water by providing 25m^3 of containment for accidental spillages of hydrocarbons and chemicals per DN-DNG-03022 (Drainage Systems for National Roads). During a spillage event, the spill will be collected by the drainage network and conveyed towards the outfall where a penstock will divert the spill to the spillage containment area where it will be contained until it can be safely removed and disposed.

As per this standard and the European Union: Directive on the Assessment and Management of Flood Risks (2007/60/EC) a Flood Risk Assessment (FRA) was undertaken for the proposed road development. The proposed road development is essential infrastructure and is therefore considered to be 'highly vulnerable development' according to the Flood Risk Management Plan Guidelines. The FRA considered fluvial, pluvial, and groundwater flooding. Both the FRA and TII DN-DNG-03065 standard take into account climate change requirements.

The results of the FRA were utilised to determine design criteria to reduce the likelihood of major accidents and/or disaster events associated with flooding by ensuring that a resilient design was prepared (waterproofing and freeboard above maximum water level). The results of the FRA were utilised in the design of the proposed road development to ensure that a resilient design was developed and to reduce the likelihood of events (flood inundation to tunnels or onto road due to inadequate design criteria or flooding to assets adjacent to the proposed road development).

The FRA resulted in the incorporation of design measures to reduce or eliminate the consequences of potential events (flooding). Without appropriate flood relief design the proposed road development would have the potential to significantly impact on drainage in its vicinity and exacerbate flood risk. The following measures are incorporated into the design to minimise or eliminate the consequences and likelihood of major accidents and/or disaster events:

- mitigation measures to neutralise the flood impact to the Twomileditch – 'Significant Pluvial Flood Risk'. With the mitigation in place the loss of flood

storage is compensated and there is a moderate to significant positive impact on flooding and flood risk in the Twomileditch and N83 Tuam Road area

- the potential flood risk for the Lackagh Tunnel and Galway Racecourse Tunnel is rated as representing a moderate flood risk. This risk is associated with the potential for elevated groundwater table under more extreme 1000-year flood events and climate change conditions. The tunnels are to be fully sealed and groundwater ingress will be prevented
- the proposed tunnels, by virtue that waters require pumping to the foul sewer, retain a residual flood risk e.g. pump failure. This residual risk is mitigated through proposed regular inspection and maintenance procedures
- road drainage outfalls discharging to receiving surface and groundwaters without flood flow attenuation, could increase downstream and cause local flooding at the discharge points. This has been mitigated in the drainage design through suitably sized attenuation ponds and outlet flow controls
- potential blockages to culverts and bridges on streams and the lack of maintenance could present a localised residual flood risk. This residual risk is mitigated through proposed regular inspection and maintenance procedures
- residual risk of localised flooding on the proposed road carriageway due to blockages/failure within drainage network. This residual risk is mitigated through proposed regular inspection and maintenance procedures
- this residual flood risk can be managed through a program of regular inspection and maintenance of drainage facilities that includes, gullies, inspection chambers, pipes, culverts, outfalls, attenuation ponds and infiltration basins

The drainage design of the proposed road development has been completed in accordance with best practice and includes design measures and mitigation measures as noted above. However, there remains the possibility of hydrological (flooding or water pollution) events.

The three components - source, pathway, and receptor will remain. It is not possible to eliminate all sources (karstic conditions or weather events) and receptors (human beings and environmental receptors). The pathway is restricted, though not eliminated through design measures and mitigation measures. Such measures will reduce the likelihood of major accidents and/or disaster events; however, it is not possible to entirely discount the possibility of major accident and/or disaster events with respect to hydrology events (pump failure, interaction with hydrogeology). This is the case as the loss of life or permanent injury cannot be categorically discounted.

It is therefore not possible to rule out low likelihood but potentially high consequence hydrological events (flooding or water contamination) and the vulnerability of the proposed road development to such events. Therefore, hydrological events are further assessed in **Table 19.1**.

19.2.5 Risk Screening Summary

When undertaking this screening process, a number of low likelihood but potentially high consequence events were identified for a number of disciplines. These events are applicable to both the construction and operational phases of the proposed road development.

The events requiring further assessment are:

- Vehicular Events
- Structural Collapse Events
- Tunnel Fire Events
- Service Utilities Events
- Ground Conditions Related Events
- Hydrogeological Events
- Hydrological Events

The assessment of these events is detailed in **Table 19.1**.

19.2.6 Major Accidents and/or Disasters Assessment

The assessment of the risk of major accidents and/or disasters that were not screened out is presented in this section.

Table 19.1 presents hazards which remained following the screening process, defines the impact (the reasonable worst consequence if the hazard occurred), assesses the likelihood of the hazard occurring, and assesses the consequent risk. As part of this assessment embedded mitigation which reduces the hazard, the likelihood of the hazard, and significance of the potential risk consequent to the hazard is detailed. Ultimately it will be determined whether the risk could constitute a major accident and/or disaster and, if so, whether the risk has been mitigated to the greatest degree possible.

Table 19.1: Environmental Risk Record

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
Vehicular Events				
Vehicular accident event resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Vehicular accident events cannot be discounted. Such events are likely to occur during the operation of the proposed road development. This assessment examines the implications of low likelihood but potentially high consequence vehicular accident events (multi-vehicle collision resulting in a large number of fatalities). Damage to an environmental receptor may occur. Such damage can occur via discharge of hazardous (e.g. hydrocarbon oils, corrosive or toxic liquids) materials to the existing environment. In this case the risk is that of impacting groundwater or surface water, which may result in impacts on humans or ecological receptors. If a vehicular accident event occurs it may result in events external to	The proposed road development has been designed in accordance with best practice and national standards ensuring that the proposed road development is designed safely and will thus operate safely. Vehicular restraint systems have been incorporated into the design of the proposed road development to reduce the severity and potential consequences of vehicular accident events, where they may occur. Access points have been provided that will enable efficient access for emergency services and make their response times more efficient and reduce the severity and potential consequences of vehicular accident events, where they may occur i.e. incidents will not be exacerbated by delayed response or the inability to access an event location.	Emergency service organisations, local authority personnel, and regional authority personnel are responsible for responding to and coordinating the response to the fallout of major accidents and/or disasters, including vehicular accident events. In this regard a Major Emergency Plan is prepared and operated by these organisations. As part of the design process for the proposed road development representatives of these organisations were consulted and measures were incorporated into the design to enhance response to the fallout of major accidents and/or disasters, including vehicular accident events.

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
		the proposed road development, such as fire events. Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure). The drainage system has been designed to contain fuel / oil spills using spillage containment areas, penstocks and hydrocarbon interceptors. Spills will not discharge into the receiving environment in the event of a major spillage event as the pathway can be blocked with the implementation of the above measures. .	All reasonably practical measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence vehicular accident events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of vehicular accident events. The road authority will be responsible for responding to and coordinating the response to events on the network (environmental clean-up of oil spills, managing traffic flows etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
				of the schedule of environmental commitments and response to environmental incidents an Environmental Operating Plan for the operational phase is prepared and operated by the Road Authority based on the CEMP in **Appendix A.7.5**. No additional mitigation measures are required.
Structural Collapse Events				
Structural collapse (bridge collapse, tunnel collapse) event resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Structural collapse events are extremely rare but their potential consequences are significant. They cannot be discounted as collapse may occur due to events outside the control of the designer, contractor, or road authority, for example, act of terrorism, other third party interference, or other unusual circumstances. Impacts on an environmental receptor may occur. Such impacts include surface or groundwater quality (collapse into	Structures have been designed taking account of the potential for vehicle strike incidents. The severity and potential consequence of strike events has been reduced via the introduction of vehicular restraint systems. All structure foundations have been designed taking cognisance of anticipated ground conditions, appropriate foundations have been proposed taking cognisance of same and thus reducing likelihood of structural collapse events due to ground conditions.	Structural collapse due to negligent inspection/ maintenance has been discounted as the road authority in Ireland undertake inspections on all structural assets on a regular basis. The road authority will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows etc.) and maintenance

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
restored through minor clean-up and restoration efforts.		watercourses); human beings, population and health; or biodiversity Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	Access points have been provided that will enable efficient access for emergency services and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. incidents will not be exacerbated by delayed response or the inability to access an event location. Particular attention has been paid to the potential for collapse of drill and blast tunnels. Permanent tunnel stability at Lackagh Tunnel will be provided by a cast in-situ reinforced concrete lining. Fibre reinforced concrete or sacrificial cover, has been included in the design of tunnels to reduce the risk of spalling - a phenomenon whereby portions of concrete fall off the tunnel lining during a fire therefore reducing the overall performance of the structure due to reduced concrete depth (including sacrificial cover minimises the	(removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation of the schedule of environmental commitments and response to environmental incidents a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence structural events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
			likelihood of collapse due to fire events). Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).	the severity and potential consequences of structural events. No additional mitigation measures are required.
Tunnel Fire Events				
Tunnel events (explosions, fire) resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Such tunnel events are extremely rare but their potential consequences are significant. Tunnel events are rare because extensive preventative and mitigatory systems are incorporated into tunnels to reduce the severity and potential consequences of tunnel events (fire, partial or total tunnel collapse vehicular accident event, spillage or fuel or other hazardous liquids). In addition to physical mitigation such as vehicle restraint systems, operational	Structures have been designed taking account of vehicular strike incidents and the severity and potential consequence of strike events has been reduced via the introduction of vehicular restraint systems. The proposed road development has been designed in accordance with best practice and European standards ensuring that the proposed road development is designed safely and will thus operate safely. Access points have been provided that will enable efficient access for	Emergency service organisations, local authority personnel, and regional authority personnel are responsible for responding to and coordinating the response to the fallout of major accidents and/or disasters, including vehicular accident events. In this regard a Major Emergency Plan is prepared and operated by these organisations. As part of the development of the proposed

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
and restoration efforts.		measures have been incorporated into the design which will act to mitigate the potential consequences of vehicle accident events such as a vehicle fire events within the tunnel. Low likelihood but potentially high consequence tunnel events cannot be discounted as events may occur due to events outside the control of the designer, contractor, or road authority. For example, act of terrorism, other third party interference, or other unusual circumstances. Tunnel events require particular regard due to their confined nature (any event may escalate quickly). Damage to an environmental receptor may occur. Such damage can occur via discharge of materials to the existing environment (fuel, oil, gas). In this case the risk is that of impacting groundwater or surface water, which may result in impacts to human beings, or ecological receptors	emergency services and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location. Tunnels are naturally ventilated reducing the potential for smoke/gas accumulation. Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure). The drainage system has been designed to retain fuel/oil spills and not discharge this to the receiving environment (blocking pathway) and thus impact an environmental receptor.	road development representatives of these organisations were consulted and design measures were incorporated into the design to enhance response to the fallout of major accidents and/or disasters, including tunnel events. The Road Authority will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation of the schedule of environmental commitments and response to environmental incidents a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
		Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	Systems have been included in the design of the tunnels to reduce the severity and potential consequences of tunnel events (fire, vehicular accident event). Cross passages are incorporated into both tunnels enabling persons to rapidly exit the tunnel and allowing emergency service personnel and the road authority to access incidents.	Operating Plan for the operational phase and operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence tunnel events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of tunnel events. No additional mitigation measures are required.

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
Service Utility Events				
Service events (explosions from gas mains, flooding from burst watermains, fire from striking electric cabling, electrocution from striking electric cabling, fire) resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	This assessment examines the implications of low likelihood but potentially high consequence service events (electrocution, gas explosion, burst watermain). Damage to an environmental receptor may occur. Such damage can occur via discharge of materials to the existing environment (e.g. gas from the existing gas network). In this case the risk is that of impacting groundwater or surface water, which may result in impacts to humans or ecological receptors. Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	All service diversions have been agreed with utility service providers. All service diversions must be undertaken in accordance with utility service providers' requirements, all of which place health and safety to the fore. Safe construction, and the preparation of method statements, will be the responsibility of the Contractor. As noted previously, at the forefront of design development was the need to ensure that the proposed road development is capable of being constructed safely and without risk to health, can be maintained safely, and complies with all relevant health and safety legislation.	Service events risk can be managed through implementation of a safe system of work. The road operator will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation of the schedule of environmental commitments and response to environmental incidents, a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
				operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence service events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of service events. No additional mitigation measures are required

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
Ground Conditions Related Events				
Ground related events (ground collapse) resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Ground related collapse events are extremely rare but their potential consequences are significant. They cannot be discounted as collapse may occur due to events outside the control of the designer, contractor, or road authority. For example, natural phenomena, natural events - extreme rainfall. Damage to an environmental receptor may occur. Such damage can occur via collapse of an element of the proposed road development resulting in damage to the ancillary operational elements of the proposed road development, for example the drainage system which may result in discharge of materials to the existing environment (fuel, oil, gas, hazardous liquids). In this case the risk is that of impacting groundwater or surface water, which may result in impacts to humans or ecological receptors.	The proposed road development has been designed in accordance with best practice and national standards ensuring that the proposed road development is designed safely and will thus operate safely. Access points have been provided that will enable efficient access for emergency services and the road operator and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location. Embankments/cuttings have been designed taking cognisance of anticipated ground conditions, appropriate foundations have been proposed taking cognisance of same and thus reducing likelihood of structural collapse events due to ground conditions.	Structural collapse due to negligent inspection / maintenance has been discounted as the Road Authority in Ireland undertake inspections on all assets. The road operator will be responsible for responding to and coordinating the response to events on the network, including service events (environmental clean-up, fixing vehicular restraint systems etc). In this regard a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and operated by the Road Authority. All reasonable practicable measures have been included in the design of the proposed road development to reduce

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
		Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	Drill and blast tunnels are of particular interest when it comes to ground related events. Permanent tunnel stability at Lackagh Tunnel will be provided by a cast in-situ reinforced concrete lining. Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).	the severity and potential consequences of low likelihood but potentially high consequence ground related events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of ground related events. No additional mitigation measures are required.
Hydrogeological Events				
Hydrogeological events (flooding, groundwater contamination) resulting in loss of life or permanent injury or permanent or long-lasting	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Hydrogeological events are extremely rare but their potential consequences are significant. They cannot be discounted, hydrogeological events may be consequent to other events (structure collapse, vehicular accident event, hydrological event) or may be outside the control of the designer, contractor, or road	The proposed road development has been designed in accordance with best practice and national standards ensuring that the proposed road development is designed safely and will thus operate safely. The drainage system has been designed to contain fuel/oil spills using spillage containment areas, penstocks and hydrocarbon	Groundwater risk can be managed through a program of regular inspection and maintenance.The road operator will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.		authority. For example, natural phenomena, natural events - extreme rainfall, extreme groundwater levels. Damage to an environmental receptor may occur. In this case the risk is that of impacting groundwater or surface water, which may result in impacts to humans or environmental receptors. Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	interceptors. Spills will not discharge into the receiving environment in the event of a major spillage event as the pathway can be blocked with the implementation of the above measures. Access points have been provided that will enable efficient access for emergency services and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location. Systems have been included in the design of the tunnels to reduce the severity and potential consequences of tunnel events (pump systems etc.). Cross passages are incorporated into both tunnels enabling persons to rapidly exit the tunnel and allowing emergency service personnel and the road operator to access incidents. Tunnels require particular attention when it comes to groundwater interactions. Permanent	etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems). With regard to implementation of the schedule of environmental commitments and response to environmental incidents a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence hydrogeological related events. Appropriate precautionary measures have been included in the design of

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
			waterproofing of the tunnels will be provided by the application of a water proof membrane/barrier. Intelligent transport systems have been incorporated into the design which will act to mitigate the potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).	the proposed road development to reduce the severity and potential consequences of hydrogeological related events. No additional mitigation measures are required.
Hydrological Events				
Hydrological events (flooding, groundwater, surface water contamination) resulting in loss of life or permanent injury or permanent or long-lasting damage to an environmental receptor that	Yes, loss of life or permanent injury may result. Yes, permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts may result.	Hydrological events are extremely rare but their potential consequences are significant. They cannot be discounted, hydrological events may be a result from other events (structure collapse, vehicular accident event, hydrological event, hydrogeological event) or may be outside the control of the designer, contractor, or road authority. For example, natural phenomena, natural events - extreme rainfall, extreme groundwater levels.	The proposed road development has been designed in accordance with best practice and national standards ensuring that the proposed road development is designed safely and will thus operate safely. The drainage system has been designed to retain fuel/oil spills and not discharge this to the receiving environment (blocking pathway) and thus impact an environmental receptor. Access points have been provided that will enable efficient access for	Flood risk can be managed through a program of regular inspection and maintenance of drainage facilities. The road operator will be responsible for responding to and coordinating the response to events on the network (environmental clean-up - oil spills, managing traffic flows etc.) and maintenance (removing hazards which may result in risk events, fixing vehicular restraint systems).

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
cannot be restored through minor clean-up and restoration efforts.		Damage to an environmental receptor may occur. In this case the risk is that of impacting groundwater or surface water, which may result in impacts to humans or ecological receptors. Any potential air quality, noise, landscape and visual, material assets, architectural and cultural heritage impacts will not be permanent or long lasting.	emergency services and make their response times more efficient and reduce the severity and potential consequences of events, where they may occur i.e. any incidents will not be exacerbated by delayed response or the inability to access an event location. Systems have been included in the design of the tunnels to reduce the severity and potential consequences of tunnel events (pump systems etc.). Cross passages are incorporated into both tunnels enabling persons to rapidly exit the tunnel and allowing emergency service personnel and the road operator to access a flooding incident. Tunnels require particular attention when it comes to flooding. Permanent waterproofing of the tunnels will be provided by the application of a water proof membrane/barrier. Intelligent transport systems have been incorporated into the design which will act to mitigate the	With regard to implementation of the schedule of environmental commitments and response to environmental incidents a CEMP has been prepared and included in **Appendix A.7.5** and will feed into the Environmental Operating Plan for the operational phase and operated by the Road Authority. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence hydrological related events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential

Impact (Reasonable Worst Consequence if event did occur)	Could this event constitute a major accident or disaster in terms of the definitions provided?	Likelihood of hazard occurring	Assessment and Management of Consequent Risk	Details of the preparedness for and proposed response to such events
			potential consequences of major accidents and/or disasters by forewarning motorists of incidents on the network (adverse weather events, incident on network, network closure).	consequences of hydrological related events. No additional mitigation measures are required.

19.2.7 Mitigation Measures

Following the assessment of the proposed road development, under the heading of vulnerability to major accidents and/or disasters, it is concluded that no further mitigation measures beyond those already incorporated and described above and elsewhere in this EIAR are required.

19.2.8 Residual Impacts

The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely unlikely. These events have been considered throughout the design process and measures have been included in the design to reduce the severity and potential consequences of such events.

19.2.9 Summary

This section presented an assessment of the likely significant adverse effects of on the environment arising from the vulnerability of the proposed road development to risks of major accidents and/or natural disasters. The risk assessment identified and quantified risks due to the proposed road development focusing on: unplanned, but possible and plausible events occurring during the construction and operational phases. From examining all plausible risks associated with the proposed road development, the scenarios which are considered to be the highest risk in terms of a major accident and/or disaster included:

- vehicular events
- structural collapse events
- tunnel fire events
- service utilities events
- ground conditions related events
- water related events

The outcome of the assessment identified that while these events would have ‘very serious’ consequences should they occur; the risk is considered ‘unlikely.’ These events have been considered throughout the design process and measures have been included in the design to reduce the severity and potential consequences of such events.

19.3 Methodology used to assess interactions and cumulative impacts

19.3.1 Guidance

As described previously in **Section 19.1**, the requirement to address interactions of effects and cumulative impacts is set out in the EIA Directive as amended by Directive 2014/52/EU on the assessment of the effects of certain public and private projects on the environment and in the Roads Act 1993, as amended.

This chapter has been prepared in accordance with the following guidance:

- EPA (2017) Guidelines on the Information to be contained in Environmental Impact Assessment Reports, Draft, August 2017
- European Commission (2017) Environmental Impact Assessment of Projects – Guidance on the preparation of the Environmental Impact Assessment Report. (Office for Official Publications of the European Communities 2017)
- EPA (2015) Revised Guidelines on the Information to be contained in Environmental Impact Statements, Draft, 2015
- EPA (2015) Advice Notes on Current Practice in the Preparation of Environmental Impact Statements, Draft, 2015
- EPA (2003) Advice Notes on Current Practice in the Preparation of Environmental Impact Statements, 2003
- EPA (2002) Guidelines on the Information to be contained in Environmental Impact Statements, 2002
- European Commission (1999) Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, (Office for Official Publications of the European Communities 1999)

19.3.2 Assessment Methodology

At the initial stage of preparing the EIAR for the proposed road development, the potential for significant interactions of impacts and cumulative impacts were examined and any potential impacts were identified. These potential impacts were included in the scope and addressed in the baseline and impact assessment studies for each of the relevant environmental factors and were also addressed in the design of the proposed road development.

There were numerous discussions and communications including workshops and meetings between the environmental specialists and the design team throughout the design process which helped to identify and minimise the potential for significant interactions of impacts and cumulative impacts arising in the first instance.

The interaction of impacts within the design of the proposed road development and the mitigation measures relative to those interactions in respect of each of the environmental factors have been identified and addressed in detail in the respective chapters dealing with each environmental factor in this EIAR. Thus no additional

mitigation is proposed in this chapter. This chapter presents a summary of each assessment of the interaction (inter-relationship) of impacts (from the proposed road development) between the various environmental factors and summarises the mitigation measures relative to those interactions.

The matrix and expert opinion approaches, as outlined in the EU Guidelines (1999), were used in the identification of the potential for significant interactions of impacts. Refer to **Tables 19.2** for the matrix of potential interactions.

Similarly, cumulative impacts arising from the interaction between the proposed road development and other projects in respect of each of the environmental factors have been identified and addressed in detail in the respective chapters dealing with each environmental factor in this EIAR. This chapter however, presents a summary of these individual cumulative assessments with other projects and considers the cumulative effect of the entirety of the project as a whole with other projects. No additional mitigation measures are proposed in this chapter.

19.3.3 Definitions

The following definitions are generally used in the description of cumulative impacts or interaction of impacts.

Cumulative effects are defined in EC guidance (2017)[12] as: "*Changes to the environment that are caused by activities/projects in combination with other activities/projects*". EC guidance (2017) also states that "*it is important to consider effects not in isolation, but together, that is cumulatively". Cumulative effects are changes to the environment that are caused by an action in combination with other actions. They can arise from*

- *The interaction between all of the different projects in the same area*
- *The interaction between various impacts within a single project"*

Cumulative effects are also defined in EPA guidance (2017)[13] as "*The addition of many minor or significant effects, including effects of other projects, to create larger, more significant effects*".

The EU guidelines (1999)[14] use slightly different definitions as follows:

Cumulative Impacts: Impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project.

Impact Interactions: The reactions between impacts whether between the impacts of just one project or between the impacts of other projects in the area.

The term '*impact interactions'* is equivalent to the term '*inter-relationship of* effects'. The EU guidelines (1999) accept that their definitions overlap to a certain

[12] European Commission (2017) Environmental Impact Assessment of Projects – Guidance on the preparation of the Environmental Impact Assessment Report
[13] Environmental Protection Agency (2017) Guidelines on the Information to be contained in Environmental Impact Assessment Reports. Draft, August 2017
[14] European Commission (1999) Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions

extent. The EU guidelines also refer to '*Cross-Media Impacts'*, in which the impact in one environmental medium may also have an indirect impact on another medium.

19.4 Interaction of Impacts

19.4.1 Matrix of Impacts

All environmental factors are inter-related to some extent, and the relationships can range from tenuous to inextricable. The interactions between the identified environmental impacts have already been considered and assessed within the individual chapters of this EIAR. There have been numerous discussions and communications including workshops and meetings between the environmental specialists and the design team throughout the design process which helped to identify and minimise the potential for significant interaction of impacts. Measures to minimise impacts have been incorporated into the design and are also included in all of the assessments and the residual impacts have been assessed.

For example, where it has been established in **Chapter 11, Hydrology** that there will be an increase in suspended solids or pollutants during construction arising from earthworks, then **Chapter 8, Biodiversity** has assessed the effect of that on aquatic flora and fauna. Measures to minimise impacts of suspended solids or pollutants have been designed with consideration to those interactions and have been incorporated into both the hydrology and biodiversity chapters and the residual impacts on both hydrology and biodiversity have been assessed. Similarly, where **Chapter 16, Air Quality and Climate** and **Chapter 17, Noise and Vibration** have established that there will be air and noise emissions during both the construction and operational phases, **Chapter 18, Human Beings, Population and Human Health** has assessed the effect of those emissions on human health and **Chapter 8, Biodiversity** has assessed the effects of those emissions on sensitive flora and fauna. Measures to minimise the air and noise emission impacts have been designed with consideration to those interactions and have been included in the assessments and the residual impacts have been identified.

Table 19.2 presents the potential interactions between the environmental factors in a matrix format. It examines the potential for the environmental factor or issue in the left hand column to have an impact on the environmental factor listed in the top row of the matrix as a result of the proposed road development. As discussed above, these potential interactions of impacts were identified throughout the design process and measures addressing these impacts have already been included within the individual chapters of this EIAR. The paragraphs following **Table 19.2** present an assessment of the potential interactions of impacts, mitigation measures and residual impacts. This assessment is based on information contained within this EIAR and the outcome of discussions and interactions between the environmental specialists and the design team.

If there is the potential for an impact during the construction phase, this is indicated by a 'C'. An 'O' indicates the potential for an impact during the operational phase and 'CO' indicates the potential for an impact during both phases. If it is considered that there will be no potential for an impact, this is indicated by 'none'.

For example, the construction of the proposed road development will require construction traffic movements (left hand column) which could potentially generate negative impacts ("C") on a number of environmental factors (top row of table) such as air quality and climate, noise and vibration, biodiversity, human beings, population and human health, material assets (both agriculture and non-agriculture) and the risk of major accidents and/or natural disasters. These environmental factors could then in turn result in (secondary/indirect) impacts on other environmental factors. For example, excavation activities will generate material (direct impact on soil and rock resource) some of which will require transportation (secondary impact on construction traffic) and disposal (secondary impact on resource capacity offsite). Air emissions (secondary impact) arising from this construction traffic could subsequently impact on human beings, population and human health. All of these interactions and secondary/indirect impacts have been considered in each of the respective chapters of this EIAR.

Table 19.2: Potential Interaction of Impacts Matrix (C = Construction, O = Operational, 'None = no potential impact)

Key environmental Interaction Matrix	Traffic	Air Quality and Climate	Noise and Vibration	Biodiversity	Archaeological, Architectural and Cultural Heritage	Landscape and Visual	Soil and Water	Resource and Waste Management	Material Assets Non-Agriculture	Material Assets Agriculture	Human Beings, Population and Human Health	Risk of Major Accident and/or Disaster
Traffic		CO	CO	CO	None	None	CO	C	CO	CO	CO	CO
Air Quality and Climate Factors	None		None	CO	None	None	None	None	C	C	CO	None
Noise and Vibration	None	None		C	None	None	C	None	C	C	CO	None
Biodiversity	None	None	None		None	CO	None	None	None	None	C	None
Archaeological, Architectural and Cultural Heritage	None	None	None	C		CO	None	None	None	None	C	None
Landscape and Visual	CO	None	O	CO	CO		None	None	CO	CO	CO	None
Soil and Water	C	C	C	CO	None	C		C	C	C	C	None
Resource and Waste Management	C	None	None	None	None	None	None		None	C	C	None
Material Assets Non Agriculture	CO	None	None	None	None	CO	None	C		None	CO	None
Material Assets Agriculture	None	None	None	None	None	None	None	C	None		CO	None
Human Beings, Population and Human Health	CO	None	None	None	C	None	None	C	CO	None		None
Risk of major accident and/or disaster	CO	CO	CO	CO	None	None	CO	None	CO	None	CO	

19.4.2 Potential Interactions

All of the potential impacts arising from the potential interactions were identified at a very early stage in the design process and in the EIAR preparation. They were therefore addressed in the design of the proposed road development and in the environmental baseline and impact assessment studies. As a result, the potential impacts were either avoided altogether through design measures or they were addressed through specific mitigation measures. This early identification process helped to identify and minimise the potential for significant interactions of impacts arising. The potential impacts and mitigation measures are discussed further below.

19.4.2.1 Overview of Traffic Interactions

Construction Phase

The construction of the proposed road development will require construction traffic movements which could potentially generate negative impacts on a number of environmental factors such as air quality and climate, noise and vibration, biodiversity, human beings, population and human health, visual impact, material assets (both agriculture and non-agriculture) and the risk of major accidents and/or natural disasters.

The level of construction traffic generation is dependent on the types, intensity and duration of construction activities taking place. For example, if there are significant volumes of excavated material or demolition materials which require disposal offsite or if significant materials are required to be imported on site, these activities have the potential to generate significant construction traffic volumes.

Construction traffic movements have the potential to generate a visual impact as well as air quality and noise and vibration emissions which could potentially negatively impact on human beings, population and human health. The generation of construction traffic will also result in road diversions and general short term disruption for people and properties in the area which could potentially negatively impact on material assets. In addition, construction traffic has the potential to negatively impact on biodiversity arising from severance, disturbance and mortality. Finally, there is a potential interaction between construction traffic and the risk of major accidents and/or natural disasters arising from the risk of a major traffic accident occurring during the construction phase.

Operational Phase

Operational traffic and the physical presence of the proposed road development could potentially generate negative impacts on the same environmental factors identified for the construction phase above.

19.4.2.2 Interaction of Traffic with Air Quality and Climate

Construction Phase

An air quality assessment of construction traffic impacts was carried out and the results show that all of the predicted concentrations are in compliance with the air quality standards (Refer to **Table 16.20** of **Chapter 16, Air Quality and Climate**). Therefore, significant residual impacts from construction traffic on air quality and subsequently human beings, population and human health will not arise.

During the construction phase of the proposed road development, 150,000 tonnes per year of CO_2 are estimated to be generated (arising from all construction activity, not just construction traffic), assuming a 36-month construction programme. Ireland has committed to achieve a 20% reduction in non-Emission Trading Scheme (ETS) greenhouse gas emissions by 2020 (relative to 2005 levels). The emissions predicted to be produced during the construction phase of the proposed road development constitutes 0.39% of Ireland's 2020 CO_2 limit under the EU Climate Change and Renewable Energy Package. These emissions will occur for the duration of the construction phase. Measures to mitigate these potential impacts on climate are outlined in **Section 16.6** of **Chapter 16, Air Quality and Climate** and include measures such as the implementation of an energy management system and a Construction Traffic Management (CTMP) (as presented in the CEMP in **Appendix A.7.5**). The overall conclusion of the air quality and climate assessment is that with the implementation of such mitigation measures, no significant residual impacts on air quality climate will arise during the construction phase.

Operational Phase

An air quality assessment during the operational phase of the proposed road development was carried out and the results show that all of the predicted concentrations are in compliance with the air quality standards (Refer to **Table 16.20** of **Chapter 16, Air Quality and Climate**). Therefore, significant residual impacts from construction traffic on air quality and subsequently human beings, population and human health will not arise.

19.4.2.3 Interaction of Traffic with Noise and Vibration

Construction Phase

Construction traffic will generate noise emissions and there is a potential for noise impacts from construction traffic along public roads. A noise and vibration assessment of the noise emissions due to construction traffic identified that all bar three roads (Bearna to Moycullen, Cappagh Road and Bóthar Nua) will experience a potential increase in noise in the order of less than 3dB over a worst case scenario of a 12-month construction period.

The Bearna to Moycullen Road will experience an increase of 3dB and whilst this is perceptible the overall noise level along this road is of low to moderate level, calculated at 56dB $L_{Aeq,\ T}$ at 10m from the road edge and the overall impact is deemed to be moderate, short-term. Cappagh Road will experience an increase of 8dB and whilst this is perceptible the overall noise level along this road is of low to moderate level, calculated at 56dB $L_{Aeq,\ T}$ at 10m from the road edge and the overall

impact is deemed to be moderate, short-term. Bóthar Nua will experience an increase of 7dB and whilst this is perceptible the overall noise level along this road is calculated at 62dB $L_{Aeq, T}$ at 10m from the road edge and the overall impact is deemed to be major, short-term.).

These impacts will be short-term and the use of best practice noise control measures, hours of operation, scheduling of works within appropriate time periods, will ensure impacts are controlled as far as practicable during the construction phase along public roads. Therefore, significant residual impacts from construction traffic on noise and subsequently human beings, population and human health will not arise.

Vibration impacts relating to construction traffic will be limited given the low generation of vibration from vehicles along well maintained roads. Therefore, significant residual impacts from construction traffic on vibration and subsequently human beings, population and human health will not arise.

Operational Phase

Traffic during the operational phase of the proposed road development will generate new noise emissions. Noise levels will be increased at the majority of noise sensitive locations along the length of the proposed road development. Whilst noise levels of varying increases and impact magnitudes are calculated at the assessment locations, the incorporation of a low noise road surface and the use of noise barriers along the roadside boundary will reduce noise levels to within the design goal of 60dB L_{den} or to the pre-existing Do Minimum noise levels at the majority of noise sensitive locations. Residual noise levels at a small number of locations will remain above the 60dB L_{den} design goal by 1 to 2dB. The noise assessment has concluded that changes in road traffic noise levels will be negligible to major in accordance with DMRB guidance, however the overall impact at the properties taking account of typical population response to the absolute noise levels under consideration across the study area is negligible to moderate.

Overall, noise levels will be increased at properties along the route of the proposed road development once operational and a change in the noise environment will occur. The proposed road development, however, has been designed to reduce operational noise levels to within national design guidelines through the incorporation of detailed noise mitigation measures. The number of properties along its route is relatively low compared to those within the city centre which are currently exposed to significantly higher noise levels from passing road traffic. The reduction in high volumes of traffic traversing the city centre will result in a moderate to major positive noise impact to an extensive number of noise sensitive properties along the existing road network.

Therefore, significant residual impacts from operational traffic on noise and subsequently human beings, population and human health will not arise.

19.4.2.4 Interaction of Traffic with Biodiversity

Construction Phase

The generation of traffic during the construction phase has the potential to negatively impact on biodiversity resulting in temporary severance or disturbance issues. Construction traffic and other construction activities such as watercourse crossings can present as a temporary barrier and/or hazard to mobile species such as otter, bats, badger, and fish potentially resulting in temporary severance and/or mortality. Furthermore, the physical presence of construction traffic can result in temporary disturbance to these species. Mitigation measures have been incorporated into **Chapter 8, Biodiversity** to address these potential impacts. These include measures such as exclusion zones around badger setts, construction measures for working along watercourses and strict controls on temporary crossing points over watercourses and temporary crossing points for bats. As a result of the implementation of such mitigation measures, significant residual impacts on biodiversity due to construction traffic will not arise.

Operational Phase

The generation of traffic and the physical presence of the proposed road development during the operational phase has the potential to negatively impact on biodiversity resulting in severance, disturbance and mortality issues. Mobile species such as bats, barn owls and other birds could potentially collide with traffic or structures resulting in mortality. The flight paths of bats could also potentially be severed due to the physical presence of the proposed road development. Furthermore, the introduction of lighting in otherwise unlit areas could potentially negatively impact bat activity.

As discussed previously, these types of impact interactions were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts were either avoided altogether through design measures or they were addressed through specific mitigation measures in the relevant EIA chapters. For example, the choice of the design of the River Corrib Bridge included an objective to minimise potential ecological impacts on birds due to collision risks and bats. Mammal underpasses and the Castlegar Wildlife Overpass were all designed with an objective to minimise the barrier effect for bats. Landscape planting has specifically been designed to minimise barn owl and bat mortality arising from collisions with traffic. Further mitigation measures have also been incorporated into **Chapter 8, Biodiversity** to further address these potential impacts. As a result of the implementation of design measures and other mitigation measures, significant residual impacts on biodiversity due to operational traffic and the physical presence of the proposed road development will only arise in relation to the Peregrine falcon. The presence of the proposed road development has the potential to permanently displace nesting Peregrine falcon from the nest site at Lackagh Quarry Refer to **Chapter 8, Biodiversity** for further details.

19.4.2.5 Interaction of Traffic with Soil, Water Quality and Resource and Waste Management

Construction Phase

During the construction phase, there is the potential for interaction between soil, water quality, resource and waste management and construction traffic. As mentioned previously, if excavated materials or demolition materials require disposal offsite or if construction materials are required to be imported, these activities have the potential to generate construction traffic volumes. For example, excavation activities will generate material (direct impact on soil and rock resource) some of which will require transportation (secondary impact on construction traffic) and disposal (secondary impact on resource capacity offsite). Construction traffic will also produce sediment runoff through potential spillage of saturated silts and peat slurry during the haulage of materials. This has the potential to impact on water quality. The interaction of water quality with human beings and biodiversity is discussed further below.

During the design process, every effort was made to balance the import and export volumes of materials thereby minimising construction traffic generation in the first instance. In addition, the Construction and Demolition Waste Management Plan (as presented in the Construction Environmental Management Plan (CEMP) in **Appendix A.7.5**) has been prepared to ensure that waste arising during the construction and demolition phase will be managed and disposed of in a way that ensures compliance with the provisions of the Waste Management Acts 1996-2011 and associated Regulations (1996-2011) to ensure that optimum levels of reduction, re-use and recycling are achieved. Furthermore, the Construction Traffic Management (CTMP) (as presented in the CEMP in **Appendix A.7.5**) has been prepared to ensure that construction traffic will be managed and monitored safely and efficiently throughout the construction phase. As a result of the implementation of mitigation measures such as the CEMP and the design measures, significant residual impacts from material imports and exports on construction traffic will not arise.

19.4.2.6 Interaction of Traffic with Material Assets

Construction Phase

The generation of construction traffic will result in road diversions and general short term disruption for properties in the area which could potentially negatively impact on residential, commercial and agricultural areas.

There are two locations where temporary road diversions will be in place in order to construct bridge structures at Ch. 3+300 Aille Road L5384 and Ch. 13+150 School Road, Castlegar L2134. Temporary night-time closure of existing roads may be required where overbridges are to be constructed at locations such as the Rahoon Road, Letteragh Road, N59 Moycullen Road, Menlo Castle Bóithrín, Bóthar Nua, An Seanbóthar, N84 Headford Road, N83 Tuam Road, Briarhill Business Park Road and R339 Monivea Road. The north end of the Anne Gibbons road will also be permanently closed with property access to the south maintained.

As detailed in the CEMP (**Appendix A.7.5**), the Contractor will put in place a Public Communications Strategy which will include procedures to inform members of the community who will be directly affected by the construction phase on schedules for any activity of a particularly disruptive nature which is likely to impinge on their property such as blasting, demolition, road closures and diversions, pile driving and any mitigating actions that are being taken (shielding, restriction on work hours, etc.) to minimise such disruption.

Furthermore, the Construction Traffic Management (CTMP) (as presented in the CEMP in **Appendix A.7.5**) has been prepared to ensure that construction traffic will be managed and monitored safely and efficiently throughout the construction phase. Therefore, significant residual impacts will not arise.

Operational Phase

The north end of the Anne Gibbons road will also be permanently closed with property access to the south maintained.

The indirect interaction of traffic with material assets is assessed elsewhere under the heading of air quality, noise and vibration, landscape and visual and human beings, population and human health.

19.4.2.7 Interaction of Traffic with Human Beings, Population and Human Health

Construction Phase

Construction traffic will be restricted to the designated haul routes. There will however be a temporary increase in traffic on these routes during construction, affecting the journey amenity of other road users and the general amenity of local residents. There will also be a requirement for some temporary road diversions and night time closures which would mainly result in slight negative impacts on journey time. As a result, there will be a slight impact for some people due to an increase in journey times. The Construction Traffic Management Plan included in the CEMP in **Appendix A.7.5** has been prepared to ensure that construction traffic will be managed and monitored safely and efficiently throughout the construction phase and includes designated traffic routes, timings and parking arrangements to be updated by the contractor prior to the commencement of construction.

The potential for impacts on human beings, population and human health arising from air and noise emissions generating from construction traffic was also identified. Refer to **Sections 19.4.2.2** and **19.4.2.3** above. Significant residual impacts from construction traffic on air quality and noise and vibration and subsequently human beings, population and human health will not arise.

Employment will be generated during the construction phase and will provide a positive economic impact to the local economy in terms of spending on food and accommodation, although a proportion of workers are likely to reside in Galway. The employment multiplier for similar infrastructure projects has been estimated at 1.5, implying the creation of one additional full-time equivalent jobs for every two people employed full-time on the construction of the proposed road development.

Social severance of communities will arise during construction due to works such as the movement of construction traffic, although physical connectivity will be maintained with the exception brief temporary restrictions to movement.

Some agricultural properties will also experience severance. Temporary alternative access routes and permanent utility diversions will be required during construction.

Operational Phase

During operation, some commercial properties such as service stations will experience a reduction in passing trade due to the diversion of traffic from some areas in Galway City and its environs.

The proposed road development will alleviate traffic congestion within Galway City and its environs and will therefore have a positive impact on the local and the larger regional population of Galway and the western region. This will improve the quality of life of those living within Galway City due to a reduction in traffic volumes and congestion, reduced pollution and reduced social and physical severance. The redistribution of traffic will significantly improve traffic movement in Galway City and its environs overall, thereby making it easier for people to work and travel through the city. The diversion of traffic from Galway City Centre to the proposed road development and the consequent freeing up of road space for pedestrian, cyclist and public transport use will result in a positive indirect impact on journey times and journey amenity. Along the route of the proposed road development, the presence of the road itself will remain a source of social severance, although physical connectivity will be maintained.

19.4.2.8 Interaction of Traffic with Risks of Major Accident and/or Disaster

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters was assessed. A major traffic collision was identified as such an event. Although, the consequence of this is ‘very serious’, resulting in mass injury or loss of life, the likelihood is considered to be low. All possible measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence vehicular accident events. Appropriate precautionary measures have been included in the design of the proposed road development to reduce the severity and potential consequences of vehicular accident events.

19.4.2.9 Overview of Soil Interactions

Construction Phase

The construction of the proposed road development will include soil activities such as earthworks and excavations. These activities will generate air, noise and vibration emissions which could potentially create negative impacts on a number of environmental factors such as air quality and climate, noise and vibration,

biodiversity, human beings, population and human health, material assets (both agriculture and non-agriculture).

The level of emissions generation is dependent on the types, intensity and duration of construction activities taking place. For example, if there are significant volumes of excavated material or demolition materials which require disposal offsite or if significant materials are required to be imported on site, these activities have the potential to generate construction noise and dust. These interactions are discussed further below in the interactions of air emissions and noise and vibration emissions.

Earthwork movement and excavations will also create landscape and visual impacts and generate waste materials. These are discussed further below.

19.4.2.10 Interaction of Air Emissions with Human Beings

Construction Phase

The construction of the proposed road development will require earthworks, particularly during site clearance and excavation. These activities have the potential to generate significant air emissions (dust) which could potentially negatively impact on human beings under the environmental topic of both human beings, population and human health and material assets (both agriculture and non-agriculture). In general, any additional airborne concentrations of particulate matter arising from construction would be small and very local to the construction activity (minimising human exposure). Particles generated by most construction activities tend to be larger than 10µm in diameter which are too large to enter the human lungs. An assessment was carried out of the potential dust impacts at locations where the main construction activities will take place and where the construction compounds will be located (Refer to **Section 16.5** of **Chapter 16, Air Quality and Climate**). The results of the assessment indicate that there are a number of receptors located within 100m of the construction activities/construction compounds where there is potential for significant soiling effects to arise with standard dust control mitigation measures in place. These soiling effects could impact both residential, commercial and agricultural areas for example and also in ecologically sensitive areas such as Lough Corrib cSAC.

Further mitigation measures have been designed to minimise the impact of dust and other air emissions during the construction phase. (Refer to **Section 16.6.2** of **Chapter 16, Air Quality and Climate**). These measures are based on best practice as outlined in the British Research Establishment (BRE) document 'Controlling particles, vapour and noise pollution from construction sites' and the Institute of Air Quality Management (IAQM) 'Guidance on the assessment of dust from demolition and construction', 2016. Furthermore, dust screens will be implemented at locations where there is the potential for air quality impacts during the construction phase as outlined in **Section 16.5.3** of **Chapter 16, Air Quality and Climate** i.e. at locations where sensitive receptors are located within 100m of the works.

Dust deposition and PM_{10}/$PM_{2.5}$ monitoring shall be carried out to confirm the effectiveness of the mitigation measures. The residual impact on air quality during

the construction phase will not be significant following the implementation of mitigation measures outlined above.

As noted above, the results of the air quality assessment show that all of the predicted concentrations are in compliance with the air quality standards (Refer to **Table 16.20** of **Chapter 16, Air Quality and Climate**). Therefore, significant residual impacts on air quality and subsequently human beings, population and human health will not arise.

Operational Phase

Air emission from traffic on the proposed road development during the operational phase have the potential to generate negative impacts on human beings, population and human health.

The potential impact on air quality during the operational phase was assessed. Pollutant concentrations were provided at the worst-case receptors, i.e. those properties that are closest to the affected links. (Refer to **Section 16.5.4** of **Chapter 16, Air Quality and Climate**). The pollutants assessed included NO_2, PM_{10}, $PM_{2.5}$, CO and Benzene. The results of the assessment show that the predicted changes in concentration of all the pollutants are in compliance with the air quality standards. Therefore, significant residual impacts from operational traffic on air quality and subsequently human beings, population and human health will not arise.

Air quality improvements will improve at a number of locations during the operational phase due to decreases in annual average daily traffic (AADT) levels. The reduction in traffic will result in a localised improvement of air quality in these regions, which will be particularly evident where sensitive receptors are adjacent to roadways and traffic reductions are substantial. Refer to **Table 16.28** of **Chapter 16, Air Quality and Climate** for further details. Therefore, positive impacts will arise for human beings, population and human health at a number of locations due to the improvement in air quality during the operational phase.

19.4.2.11 Interaction of Air Emissions with Biodiversity

Construction Phase

As noted above construction activities such as earthworks, particularly during site clearance and excavation have the potential to generate significant air emissions (dust) which could potentially negatively impact on biodiversity. An assessment was carried out of the potential dust impacts at locations where the main construction activities will take place and where the construction compounds will be located. The results of the air assessment indicate that with standard dust control mitigation measures in place there is still potential for significant soiling effects to arise in ecologically sensitive areas such as Lough Corrib cSAC.

As noted above further mitigation measures have been designed to minimise the impact of dust and other air emissions during the construction phase. In addition to those measures noted above, a 2m dust screen will be provided at the locations in the areas of the overlap of the proposed road development and the Lough Corrib cSAC.

Dust deposition and $PM_{10}/PM_{2.5}$ monitoring shall be carried out to confirm the effectiveness of the mitigation measures. The residual impact on air quality during the construction phase will not be significant following the implementation of mitigation measures outlined above.

Operational Phase

Air emission from traffic on the proposed road development during the operational phase also have the potential to generate negative impacts on biodiversity.

An assessment was carried out on the potential for air pollution to impact on the Lough Corrib cSAC due to operational traffic under the headings of nitrogen compounds, Volatile Organic Compounds (VOC), metals/dust and ammonia at the River Corrib Bridge between Ch. 9+250 and Ch. 9+600, between Ch. 9+800 and Ch. 10+100 at Menlough, and Lackagh Tunnel between Ch. 10+450 and Ch. 11+450. The assessment shows that all predicted NO_x concentrations are in compliance with the Air Quality Standard for the protection of vegetation. The proposed road development contribution to the NO_2 dry deposition rate along the 200m transect from the proposed road edge was also calculated as detailed in **Table 16.23** of **Chapter 16, Air Quality and Climate**. The maximum increase in the NO_2 dry deposition rate is approximately 20% of the critical load for the lower boundary limit of inland and surface water habitats of 5-10kg(N)/ha/yr (TII 2011). Even with the addition of background levels, compliance with the critical load is achieved.

No critical load limits exist for VOCs for the protection of vegetation. An assessment of emissions of benzene was carried out for the proposed road development and predicted concentrations including background levels were well within the air quality standard for the protection of human health. Significant impacts arising from metals/dust and ammonia will not arise as they are all in compliance with the air quality standards. The air quality standards been developed to protect the environment as a whole. Refer to **Chapter 16, Air Quality and Climate** for further details. In summary, significant residual impacts from operational traffic air pollutants on vegetation along the route of the proposed road development are not likely.

19.4.2.12 Interaction of Noise and Vibration Emissions with Human beings

Construction Phase

Construction traffic movements and construction activities such as blasting, rock breaking and general earthworks have the potential to generate significant noise and vibration emissions which could potentially negatively impact on human beings under the environmental topic of both human beings, population and human health and material assets. A number of examples of locations where blasting and drilling may be required (which have the potential to experience impacts) are provided below.

Construction of the N59 Link Road North involves deep excavation towards the N59 Moycullen Road tie in, therefore a substantial volume of soil and rock excavation will be required which will likely require drill and blasting excavation.

The closest noise sensitive locations are approximately 50m from the excavation works. In the absence of specific noise mitigation measures, it is likely that construction noise limits during, day, evening and weekend periods will be exceeded, specifically during the intermittent use of high noise activities (rock drilling, crushing and breaking, if required). The use of specific noise mitigation measures will be applied in this area therefore including scheduling of works, choice of plant and screening.

Construction of the N59 Letteragh Junction involves an extensive area of cutting which will likely require drill and blast excavation. The closest noise sensitive locations are approximately 25m from the excavation works. Whilst excavation works will take place within the cutting area, it is likely that crushing and regrading works will take place within the proposed site compound located along the N59 link Road North which is set back from noise sensitive properties. Notwithstanding the above, given the close distances of excavation works to noise sensitive properties, the use of controlled noise mitigation measures will be required in this area to reduce construction noise levels at the nearest noise sensitive locations.

Construction of the Lackagh Tunnel will be undertaken in an east to west direction using drill and blast techniques. The tunnel portal and main works area will be within the proposed site compound at Lackagh Quarry. The closest noise sensitive properties to the tunnel are over 500m away and hence are well set back from the main excavation works in this area.

Construction of the N84 Headford Road Junction and the cutting on the eastern side of Lackagh Quarry will involve substantial earthworks for both cutting and embankment construction. There will be a large cutting into the eastern face of Lackagh Quarry within the eastern end of this section of the proposed road development which is located some 300m from the nearest noise sensitive locations. Construction of the N84 Headford Road Junction will involve extensive engineered fill works to cross the existing N84 Headford Road with an element of cutting required for slip roads. The closest noise sensitive locations are within 40 to 50m from these works and hence there is potential for construction noise levels to exceed daytime, evening and weekend construction noise criteria in the absence of noise mitigation measures.

As detailed previously, these potential impacts were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts have been addressed through specific mitigation measures in **Chapters 9, Soils and Geology** and **17, Noise and Vibration** and in the CEMP in **Appendix A.7.5**.

For example, the schedule of commitments specify that the contractor, undertaking the construction of the works, will be obliged to take specific noise abatement measures and in particular blast design control must comply with the best practice outlined in British Standard BS 5228 – 1: 2009 +A1 2014: *Code of practice for noise and vibration control on construction and open sites – Noise* and the NRA (now TII) guidelines *Good Practice Guideline for the Treatment of Noise during the planning of National Road Schemes* (National Roads Authority, 2014). Refer also to **Chapter 17, Noise and Vibration**.

Furthermore, a designated noise liaison officer will be appointed to site during construction works. Clear forms of communication will be established between the contractor and residents in noise sensitive areas in proximity so that residents or occupants of businesses are aware of the likely duration of activities likely to generate higher noise or vibration. All noise complaints will be logged and followed up in a prompt fashion by the liaison officer.

Mitigation measures have also been considered for potential vibration impacts. The TII Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities should be limited to the values set out in **Table 17.3** of **Chapter 17, Noise and Vibration**.

On review of the likely vibration levels associated with construction activities, it may be concluded that the construction of the proposed road development is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or cosmetic damage to buildings. Property condition surveys will be offered for all buildings within 50m of the proposed development boundary and those within 150m of proposed blasting works along the proposed road development. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works. Mitigation measures have also been proposed for vibration sensitive manufacturing facilities within the industrial estates at Parkmore and Ballybrit, refer to **Chapter 17, Noise and Vibration** for further details.

The results of the construction noise and vibration assessments have been taken into account in the assessment of human health (Refer to **Chapter 18, Human Beings, Population and Health**) and concludes that significant residual impacts from noise and vibration emissions (arising from construction traffic and other construction activities) on human health will not arise.

Operational Phase

The noise emission sources from the proposed road development during the operational phase will be from traffic. These emissions have the potential to negatively impact on human health. Traffic noise levels have been calculated at many noise sensitive locations along the length of the proposed road development and mitigation has been identified for a number of locations (Refer to **Table 17.13** of **Chapter 17, Noise and Vibration**). The mitigation measures required to reduce traffic noise levels are specified based on the predicted noise levels for the Design Year of 2039. The results of the modelling exercise show that noise mitigation is required for 102 properties along the route of the proposed road development for this Design Year.

Measures to reduce operational noise levels along the proposed road development include the use of a Low Noise Road Surface (LNRS) to reduce noise generated at source and the use of noise barriers to reduce noise levels along the propagation path between the source (proposed road development) and the specific receivers (houses, schools, churches etc.). These screens may be constructed as earth bunds, proprietary noise barriers or a combination of both. The use of a low noise road surface (LNRS) will provide a mean reduction in traffic noise level of -2.5dB compared to Hot Rolled Asphalt (HRA) along the length of the mainline of the proposed road development and along the main junction slip roads accessing the

N59 Moycullen Road, N84 Headford Road, N83 Tuam Road and existing N6 in addition to the N59 Link Road North and South as part of the proposed road development. **Table 17.14** of **Chapter 17, Noise and Vibration** summarises the noise barrier requirements for the proposed road development.

During the operational phase, noise levels will be increased at the majority of noise sensitive locations along the length of the proposed road development. Whilst noise levels of varying increases and impact magnitudes are calculated at the assessment locations, the incorporation of a low noise road surface and the use of noise barriers along the roadside boundary will reduce noise levels to within the design goal of 60dB L_{den} or to the pre-existing Do Minimum noise levels at the vast majority of noise sensitive locations. Residual noise levels at a small number of locations will remain above the design goal but are within 3dB of the design goal or are less than the predicted noise level in the Do-Minimum scenario. The assessment has concluded that changes in road traffic noise levels will be negligible to major in accordance with DMRB guidance, however the overall impact at the properties taking account of typical population response to the absolute noise levels under consideration across the study area is negligible to moderate.

Overall, noise levels will be increased at properties along the route of the proposed road development once operational and a change in the noise environment will occur. The proposed road development, however, has been designed to reduce operational noise levels to within national design guidelines through the incorporation of detailed noise mitigation measures. The number of such properties along its route is relatively low compared to those within the city centre which are currently exposed to significantly higher noise levels from passing road traffic. The reduction in high volumes of traffic traversing the city centre will result in a moderate to major positive noise impact to an extensive number of noise sensitive properties along the existing road network.

The results of the operational noise assessments have been taken into account in the assessment of human health (Refer to **Chapter 18, Human Beings, Population and Health**) and concludes that significant residual impacts from noise emissions (arising from operational traffic) on human health will not arise. Equally there will be no significant residual impacts on material assets arising from noise emissions.

19.4.2.13 Interaction of Vibration Emissions with Soil

Construction Phase

The soils and geology assessment also considered the potential vibration impacts arising from blasting and tunnelling on geology and in particular at the locations described above such as the Lackagh Tunnel. As noted previously, these potential impacts were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts have been addressed through specific mitigation measures in the **Chapters 9, Soils and Geology** and **17, Noise and Vibration** and in the CEMP in **Appendix A.7.5**. For example, ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities to ensure that the construction does not exceed the design limitations.

In situations where the site specific blast design has determined that blasting is not feasible in a particular location due to excessive ground vibrations, alternative extraction methods such as hydraulic breaking, hydraulic splitting, chemical splitting and electrical disintegration may be implemented and monitored. Monitoring will be implemented during blasting, during excavation of cuts, for overburden slopes steeper than 1V:2H (V= vertical slope, H = horizontal slope) and rock slopes steeper than 1V:1.5H.

A geotechnical expert will be appointed by the contractor and will be present to monitor the surrounding ground vibrations near sensitive receptors during blasting works. In the unlikely event that the blast vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

The tunnelling construction methodology at Lackagh Tunnel has specifically considered potential impacts on geology and in particular the Annex I habitats at the surface, namely Limestone pavement and Calcareous grassland. Again, a geotechnical expert will be appointed by the contractor and will be present to monitor the rock mass stability during their construction period. In the unlikely event that instability within the rock mass is observed, additional support measures will be installed to ensure that there is no impact to the surface above. The additional rock support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards and best practice guidance documents. However, based on the conservative design approach it is considered that the risk of instability will be avoided and additional support measures will not be required.

Furthermore, a geotechnical expert will be appointed by the contractor and will be present to monitor the vibrations at the surface, including the areas of Limestone pavement, during blasting works for the construction of Lackagh Tunnel and its Western Approach. The blast target vibration limit is defined as 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the ground surface which includes areas of Limestone pavement, which provides an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement. In the unlikely event that the blast target vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

Therefore, significant residual vibration impacts from blasting/tunnelling (arising from construction activities) on soils and geology will not arise.

19.4.2.14 Interaction of Noise and Vibration Emissions with Biodiversity

Construction Phase

The biodiversity assessment also considered the potential impacts of blasting at the locations identified above including potential impacts on wintering birds at Ballindooley Lough.

As noted above, these potential impacts were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts have been addressed through specific mitigation measures in the **Chapters 8, Biodiversity**, **9, Soils and Geology** and **17, Noise and Vibration** and in the CEMP in **Appendix A.7.5**.

For example, blasting associated with the eastern approach to Lackagh Quarry (Ch. 11+800 to Ch. 12+100) and the cutting at Castlegar (Ch. 12+550 to Ch. 13+650) will be carried out between the months of April to September (inclusive) to minimise the exposure of wintering birds at Ballindooley Lough to blasting-related disturbance. Refer also to **Chapter 8, Biodiversity**, **Chapter 9, Soils and Geology** and **Chapter 17, Noise and Vibration**.

The biodiversity assessment also considered the potential impacts of disturbance to the Peregrine falcon due to noise. Despite the mitigation measures proposed, a significant residual impact on Peregrine falcon due to noise during construction remains. Refer also to **Chapter 8, Biodiversity**.

Therefore, the only significant residual impacts from noise emissions (arising from construction traffic and other construction activities) on biodiversity is disturbance to the Peregrine falcon.

Operational Phase

There will be a significant residual impact on Peregrine falcon due to potential noise disturbance from road traffic during the operation of the proposed road development.

19.4.2.15 Interaction of Biodiversity with Human Beings

Construction and Operational Phase

Interactions exist with biodiversity whenever human beings interact with the natural environment. These could be realised in two ways by:

- activities giving rise to impacts on biodiversity
- the presence ecosystem services, with biodiversity at the heart, which have the capacity to regulate and support the natural environment that contributes to human well-being

In the context of the proposed road development, potential impacts arise due to the presence of biodiversity and the benefits that biodiversity provides in terms of amenity or passive enjoyment of the landscape. The design of the proposed road development took cognisance of ecosystem services and sought to protect water

quality and air quality and prevent soil erosion. It also sought to maintain local biodiversity which can be enjoyed by human beings.

The River Corrib for example is used by many people for recreational purposes, both on the water (rowing or angling) and along its banks (walking). Many species including Otter and bats, fish including salmonids, and birds utilise this corridor also. Angling is directly reliant on biodiversity. The River Corrib is an important salmonid river and consequently of importance for angling, therefore the protection of river water quality is essential for both biodiversity and amenity of the River Corrib corridor. Equally the presence of the fauna listed above and the flora along the river sides makes it an enjoyable place to walk or row, enhancing a person's recreational experience and contributing to their well-being. The proposed road development does not impact on this ecosystem service, which ultimately contributes to human well-being.

The interaction between biodiversity and human beings has been considered for example in the design of the River Corrib Bridge. Factors such as no piers in the water which would minimise impacts on aquatic biodiversity and amenity use of the river, type of structure to minimise bird collision risk and the aesthetics appearance of the bridge were all considered in the design thus protecting this ecosystem.

The principal focus of amenity activity is the River Corrib corridor, but interaction of biodiversity and human beings and well-being occurs throughout the study area. Some other natural environments, for example wetlands east of the River Corrib in the vicinity of Menlough and Ballindooley, contribute regulating and cultural ecosystem services by moderating water flow and acting as habitat for valued wildlife species. Natural environments such as peatlands and limestone have a role in filtering water quality in the study area with potential economic and health implications, although the role of biological processes is greater in the former. Vegetation such as hedgerows, treelines and woodland also have a role in noise attenuation and air quality regulation. Potential impacts for the above interactions on water quality or soil erosion would apply mainly during the construction phase. Measures have been taken however, to mitigate these through the sediment control and pollution prevention controls described in the CEMP in **Appendix A.7.5** and on biodiversity in **Section 8.6** of **Chapter 8, Biodiversity**.

19.4.2.16 Interaction of Archaeology, Architectural and Cultural Heritage with Biodiversity

Construction and Operational Phase

There is a potential for the archaeological trench testing along the route of the proposed road development to impact on biodiversity. These potential impacts will be the same as those identified in **Chapter 8, Biodiversity** as a result of the construction of the proposed road development.

These is also an interaction between architectural and cultural heritage with biodiversity with the design of the River Corrib Bridge. This crossing of the River Corrib, will introduce a dominant new feature into its landscape corridor which will have an impact on the heritage of Menlo Castle. Menlo Castle is also a maternity

roost of the Lesser Horseshow bat. The design of the River Corrib Bridge took cognisance of these constraints and mitigation measures such as additional planting are provided, however significant residual impacts will continue to arise on the lowland landscape valley of the River Corrib, and the setting of Menlo Castle.

19.4.2.17 Interaction of Archaeology, Architectural and Cultural Heritage with Human Beings

Construction and Operational Phase

The proposed road development will impact on archaeological, architectural and cultural heritage features which are of interest and importance to the local people. As noted previously, these potential impacts were identified at a very early stage in the design and environmental assessment process. As a result, the potential impacts have been addressed through specific mitigation measures in a number of chapters such as **Chapter 13, Archaeological, Architectural and Cultural Heritage, Chapter 12, Landscape and Visual** and **Chapter 18, Human Beings, Population and Human Health**. For example, the setting of Menlo Castle provides an area for amenity use. There is a potential for a change in the amenity of this area if there is a change in the setting as a result of the River Corrib Bridge. This is discussed further under the heading of the interaction of landscape and visual with human beings. Menlo Castle is an important element of this setting. Whilst the proposed archaeological mitigation measures will record the current context of Menlo Castle, they will not fully remove the residual impact of the proposed road development on the setting of Menlo Castle – post mitigation the operation of the proposed road development will have an indirect moderate negative impact on the castle.

Other interaction examples include an occupied thatched cottage at Castlegar which is also a protected structure which will be demolished to facilitate the construction of the proposed road development. Prior to demolition, the thatched cottage will be subject to a full measured, written and photographic survey. This will be carried out by a suitably qualified person or team under Ministerial Directions in consultation with the Department of Culture, Heritage and the Gaeltacht and a TII Project Archaeologist. There is also a mass path located at Parkmore which is of heritage and amenity value for local people. The design of the Parkmore Link Road was revised to maintain access along this mass path. Archaeological testing and a written and photographic record prior to construction will also be carried out. Once the recommended mitigation measures have been applied (to the mass path and thatched cottage), there will be no residual impact on the archaeological, architectural or cultural heritage resource as a result of the construction of the proposed road development

19.4.2.18 Interaction of Landscape and Visual with Material Assets and Human Beings, Population and Human Health

Construction and Operational Phase

The landscape character and existing views in the area will change during both the construction and operational phases of the proposed road development. This impact has the potential to interact with people, both in terms of landscape and visual impacts where they live, work and their use and "experience" of surrounding amenities.

Lighting impacts both from the proposed road development itself and from traffic using the proposed road development during operation have the potential to impact on people. Similarly, lighting impacts from construction compounds during winter months have the potential to impact on people, depending on where they are situated.

Mitigation measures are proposed to minimise impacts during construction and include the implementation of the CEMP; provision of hoarding; careful location of storage areas to avoid impacting on residential and commercial properties and trees; and the decommissioning and reinstatement of construction compound areas to their pre-construction condition at the end of the construction contract.

The introduction of the proposed road development will change the views and landscape character of the area in varying degrees, some areas will require mitigation planting to screen impacts, other areas will experience views of the proposed road development. These changes have the potential to impact on people, especially in residential areas.

During the operation stage, visual impacts will arise from the physical built presence of the proposed road development, including its significant structures, elevated embankments, deep cuttings, traffic usage and additional illumination both fixed and from vehicles, especially where the proposed road development is on embankment or at junctions and bridging locations. In open views, embankments have the potential for visual obstruction and significant visual intrusion. Deep cuttings can also result in significant change to the visual nature of landscape continuity. These visual impacts have the potential to significantly impact on material assets non-agriculture such as such as residential areas. As discussed previously, these potential interactions of impacts were identified at a very early stage in the design process and many of them have been addressed/minimised through design measures and also through specific mitigation measures in the relevant EIA chapters.

For example, measures for the mitigation of potential noise impact will be required at a number of locations along the proposed road development, especially where residential properties are in close proximity to the carriageway. Such noise impacts and mitigation measures are considered in detail in **Chapter 17, Noise and Vibration**. Mitigation measures will involve the provision of barriers or earth bunds or a combination of such features. While initially these features may increase the visual presence of the proposed road development, they also provide for

immediate visual screening of the proposed road development and its associated traffic. In the majority of circumstances these features can also be appropriately incorporated into the proposed landscaping measures.

The proposed road development also includes for realignments/tie-ins to existing national, regional and local roads, together with drainage works and accommodation measures, all of which have potential for localised visual impacts. Local road realignment is important as many residential properties tend to be located along such roads and local direct impacts can arise.

A full schedule and description of visual impacts on properties is set out in the Visual Impact Schedule (VIS) Tables in **Appendix A.12.1** and on **Figures 12.1.01** to **12.1.14**.

In the pre-establishment stage, 71 of the 351 locations (c.20%) will have an imperceptible impact. A further 167 locations (c.48%) will have a slight or moderate short-term impact. Eighty-four locations (c.24%) will have significant or very significant short-term visual impact. The remaining 29 locations (c.8%) will experience profound short-term negative visual impact associated with the presence and early operation stage of the proposed road development.

As landscape measures establish and mature the level of visual impact will gradually recede so that in the post-establishment stage some 156 locations (c.44%) will have an imperceptible impact. A further 140 locations (c.40%) will have a slight or moderate medium-term impact. Thirty-four locations (c.10%) will have significant or very significant medium-term visual impact. The remaining 21 locations (c.6%) will continue to experience profound medium and longer-term negative visual impact associated with the proposed road development. Refer to **Figures 12.1.01** to **12.1.14** for locations of properties.

The properties with on-going significant and very significant visual impact are either located in more remote and rural areas and are in proximity to the proposed road development, or are in suburban areas and are located directly adjacent to the proposed road development.

19.4.2.19 Interaction of Landscape and Visual and Biodiversity

Construction and Operational Phase

The construction phase will require site clearance and will result in the removal of a variety of habitats. This biodiversity (and landscape) impact, such as the removal of a woodland area, has the potential to permanently interact with the landscape character and amenity (and biodiversity) of an area. In addition, there is a potential for a change in biodiversity (such as introduction/spread of non-native invasive plant species) to negatively impact on landscape and visual aspects.

These potential interactions of impacts were identified at a very early stage in the design and environmental assessment process and have been addressed through specific mitigation measures, such as planting, in the relevant EIA chapters. For example:

- Mitigation measures to avoid the introduction or spread of non-native invasive plant species to Moycullen Bogs NHA during construction or operation have been detailed in the Non-native Invasive Species Management Plan which forms part of the CEMP in **Appendix A.7.5**

- To minimise the loss of habitat associated with the proposed road development, there are also areas within the proposed development boundary which are included for mitigation planting where general construction works will not be undertaken. These are shown on **Figures 8.23.1** to **8.23.14**

- Planting of woodland, hedgerow and grassland habitats along the proposed road development as detailed in the landscape drawings (**Figures 12.2.01** to **12.2.14**) will provide compensatory habitat for some bird species. In some instances, such as in large areas of improved agricultural grassland with no vegetated field boundaries, this will improve the diversity of bird habitat

- Sections along the proposed road development, will be planted with dense low growing scrub cover (e.g. blackthorn) to discourage Barn owls from foraging near the proposed road development. The planting will be of a density to minimise the lag time between planting and obtaining sufficient ground cover to deter foraging Barn owl

- In areas where there is a high probability that Barn owls regularly attempt to cross the proposed road development (the section of embankment between Ch. 9+600 and Ch. 10+100), lines of closely spaced (approximately 2m centres) trees, greater than 3m in height, will be planted along the top of the embankments of the proposed road development; outside of the safety barrier and clear zone. The understorey will also be densely planted. This is to present a solid vegetated barrier to deflect Barn owl from these high-risk areas and/or force birds to fly over the proposed road development above the road traffic

- Specific landscape planting mitigation measures have been proposed to preserve flight paths for bats during both construction and operational phases. The Castlegar Wildlife Overpass is a critical component of the strategy and specific landscape planting has been designed on the approach to and over the overpass. The overpass will allow bats to fly across the proposed road development between the roosts and foraging habitats on the north side and Coopers Cave and foraging areas to the south at this location

- An area of habitat enhancement for the purposes of offsetting the loss of suitable bat habitat due to the proposed road development within the known core foraging area of the Menlo Castle Lesser horseshoe bat population is included with in the proposed development boundary. Hedgerows in this area will be augmented and thickets of hazel, hawthorn, holly and oak will be provided in several of the fields to create pockets of wood and grassland habitat. Grazing will continue on the lands as it has been shown that this improves the quality of this type of habitat for Lesser horseshoe bats. Connectivity to foraging areas will also be secured through tying the proposed planting strips to hedgerows and woodland edges. Planting of new hedgerows in fields between the proposed road development and Menlo Castle will improve the foraging resources of this core foraging area. Such planting will include additional native hedgerows planted across the existing fields to increase the lengths of hedgerows close to

the proposed new roost for Lesser horseshoe bats. The fields will still be grazed and the hedgerows can be fitted with field gates as required providing gaps are kept to a minimum.

The landscape planting mitigation measures proposed will significantly reduce the level of biodiversity residual impact.

19.4.2.20 Interaction of Landscape and Visual and Archaeology, Architectural and Cultural Heritage

Construction and Operational Phase

There is a potential for a change in the setting of archaeological, architectural and cultural heritage features if there is a change in landscape character or views. For example, the proposed road development, including a c.650m long bridge at the crossing of the River Corrib, high embankments and a c.320m long viaduct at Menlough will introduce a dominant new feature into its landscape corridor. The new bridge in particular will be prominent along the River Corrib and NUIG Sporting Campus and from Menlo Castle, while the embankments and viaduct on the east of the River Corrib cross a very remote and elevated semi-natural landscape. The bridge and viaduct, and particularly traffic on the structures, will also be visible where elevated vantage points on the west side of the river allow for viewing across the River Corrib valley.

Given the existing environment, and the nature of this section of the proposed road development, integration will be slow and structures such as the bridge and viaduct will permanently influence landscape character. There will be a profound short-term and very significant medium negative impact on local landscape character. In addition, there will be a significant archaeological, architectural and cultural heritage impact on Menlo Castle and its demesne. Mitigation measures such as landscape planting in the vicinity have been proposed to soften the impacts however significant residual landscape impacts will continue to arise on the lowland landscape valley of the River Corrib, and the setting of Menlo Castle.

19.4.2.21 Interaction of Soil and Water Quality with Human Beings, Population and Human Health and Material Assets

Construction Phase

The construction works will involve considerable earthworks throughout the proposed road development area including cuttings and embankments, tunnels, bridges and viaducts and the movement earthworks materials both within the proposed road development boundary and outside of the proposed road development boundary (quarries, borrow pits etc.). These works and other construction activities have the potential to impact on water quality, water supplies, people and material assets. These potential impacts were considered at a very early stage and pollution control measures have been incorporated into the design and specified in the CEMP.

As detailed in the CEMP in **Appendix A.7.5** and in **Section 11.6** of **Chapter 11, Hydrology**, a suite of mitigation measures has been proposed and include an Incident Response Plan (IRP) and Sediment, Erosion and Control Plan (SECP). Stringent mitigation and control of potential polluting activities associated with construction activities is proposed which will significantly reduce pollution risk. Stringent controls are proposed to limit the risk of untreated sediment run-off entering the water body and to minimise the risk of construction spillages of concrete and hydrocarbons into these waters (refer also to the CEMP in **Appendix A.7.5**). Specifically, there will be no in-stream works at the River Corrib channel associated with the construction of the river bridge crossing that fully spans the River Corrib channel, so as to protect the major downstream drinking water abstraction to the Galway City Water Treatment Plant at Terryland.

Mitigation measures to address impacts on water supplies from wells have also been considered (Refer to **Chapter 10, Hydrogeology**) and will include measures such as replacement wells, connections to mains supplies or financial compensation for wells which will be lost during the construction phase. Monitoring will also be carried out at some locations and standard mitigation measures and aquifer specific mitigation measures will also be employed for protection of groundwater. These measures will ensure that significant residual impacts on water supplies will not arise

Operational Phase

Potential pollution impacts during the operational phase (such as from operational traffic) on water quality have also been considered. The operational phase presents a potential pollution risk to the Terryland water supply both from accidental spillages and from routine road run-off discharges. However, pollution control measures have been designed and put in place to significantly reduce the risk. The proposed drainage system design incorporates a range of pollution control features to limit the water quality impact to receiving waters. These include filter drains, grassed surface water channels, petrol and oil interceptors, detention ponds, wetlands and infiltration basins and spillage containment areas. The use of filter drains and grassed surface water channels are proposed in non-sensitive groundwater areas (granite bedrock areas west of N59 Moycullen Road) where possible and closed (sealed) drainage systems are proposed in the highly vulnerable Karst Aquifer region east of the N59 Moycullen Road. A treatment wetland will be provided upstream of the attenuation pond at all proposed surface water outfalls and upstream of all infiltration basins outfalling to ground, from the mainline and its associated link roads of the proposed road development. Treatment wetlands are designed to capture the first flush rainfall events.

In addition to the treatment wetlands, oil and petrol interceptors along with spillage containment areas will also be placed upstream of all surface water outfalls and groundwater infiltration basins. The oil and petrol interceptor and isolated spillage containment areas provide protection against both minor and major road spillages. An operational spillage assessment for the proposed road development was carried out for all outfalls, both surface and groundwater, and the results show low risk of impact from serious accidental spillage involving a HGV. In conclusion, residual water quality impacts on these watercourses will be slight during the operational phase. Therefore, significant negative cumulative impacts will not arise.

19.4.2.22 Interaction of Soil and Water Quality with Biodiversity

Construction Phase

As noted above, the construction of the proposed road development has the potential to impact on water quality. This in turn has the potential to impact on biodiversity. These potential impacts were considered at a very early stage and pollution control measures have been incorporated into the design and specified in the CEMP.

As noted above a suite of mitigation measures including an IRP and SECP have been proposed which will significantly reduce pollution risk. Stringent controls are proposed to limit the risk of untreated sediment run-off entering the water body and to minimise the risk of construction spillages of concrete and hydrocarbons into these waters. As noted above there will be no in-stream works at the River Corrib channel associated with the construction of the river bridge and this will minimise effects on Lough Corrib cSAC and European designated sites downstream.

A section of Lackagh Tunnel passes under an area of Qualifying Interest (QI) Annex I habitats, namely Limestone pavement and Calcareous grasslands, within the Lough Corrib cSAC. Given the presence of Annex I habitats, the design of the tunnel and its approaches includes measures such as stabilisation of Lackagh Quarry Face around the eastern tunnel portal in order to prevent rock mass instability and slope instability, careful selection of the tunnel construction methodology, retaining systems and blast design limitations.

Furthermore, during the construction of Lackagh Tunnel the supported rock face of Lackagh Quarry Face and retaining walls for the Western approach will be monitored for movement. A geotechnical expert will be appointed, by the contractor and will be present to monitor the rock mass stability during the construction period for these specific works. In the unlikely event that instability within the rock mass is observed, additional support measures will be installed to ensure that there is no impact to the surface above. The additional rock support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards and best practice guidance documents. However, based on the conservative design approach it is considered that the risk of instability will be avoided and additional support measures will not be required.

A geotechnical expert will be appointed by the contractor and will be present to monitor the vibrations at the surface, including the areas of Annex I habitats, during blasting works for the construction of Lackagh Tunnel and the Western Approach. The blast target vibration limit is defined as 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the ground surface which includes areas of Annex I habitats, namely Limestone pavement and Calcareous grasslands, which provides an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement. In the unlikely event that the blast target vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting

works will proceed with continued monitoring. Therefore, significant residual impacts will not arise.

Potential impacts on biodiversity arising from the introduction of material derived from a different lithology were also identified at an early stage in the design process. Specific mitigation measures have been included to address these impacts (Refer to **Section 9.5** of **Chapter 9, Soils and Geology**). For example, to prevent impact to the local peatland habitats, described in **Chapter 8, Biodiversity**, fill limitations at specific locations have been identified (Refer to **Table 9.18** of **Chapter 9, Soils and Geology**). Therefore, significant residual impacts will not arise.

Operational Phase

Potential pollution impacts during the operational phase (such as from operational traffic) on water quality and biodiversity have also been considered. The interaction assessment outlined above for soil and water with human beings is the same as that for biodiversity and significant negative cumulative impacts will not arise.

During the operational phase, monitoring of the rock mass stability will continue. The rock and overburden retaining systems in Lackagh Quarry and the Western Approach will continue to be monitored as part of the operational maintenance schedule. In the extremely unlikely event that instability within the rock mass is observed additional support measures as outlined above for the construction phase will be installed to ensure that there is no impact to the structural integrity of the Annex I habitats. However, based on the conservative design approach, (the installed composite support system and monitoring during construction) it is considered that the risk of instability will be avoided and additional support measures will not be required.

The measures described above were taken into account in the biodiversity assessment of this EIAR and in the NIS. The conclusion of the NIS was that the construction or operation of the Lackagh Tunnel and approaches will not affect the structural integrity of the rock mass supporting QI habitats in Lough Corrib cSAC or affect the conservation objective attributes and targets supporting the conservation condition of the QI habitats and species of Lough Corrib cSAC. Therefore, significant negative cumulative impacts will not arise.

Furthermore, during the operational phase of the proposed road development inspection and maintenance will occur to ensure that the infiltration basins continue to operate as intended for the design life of the proposed road development. If karst features and potential pathways are found to be present during inspection, then the Karst Protocol developed for the construction phase will be implemented to ensure that no preferential pathways have formed within the infiltration basin. Therefore, significant residual impacts will not arise.

19.4.2.23 Interaction of Water Quantity with Human Beings, Population, and Human Health and Material Assets

Construction and Operational Phase

Flooding can effect properties, including dwelling, commercial, industrial and agricultural or to effect journey movements. There are potential impacts on journey connectivity and amenity, residential amenity, economic activity and human health. The proposed road development as part of the design and environmental evaluation process has undergone a detailed Flood Risk Assessment in accordance with the DoEHLG Planning System and Flood Risk Management Guidelines for Planning Authorities. The assessment identified the sources of flood risk to the proposed road development from fluvial, pluvial and groundwater sources, but not from a coastal source as the proposed road development is sufficiently set back and elevated above the coastal zone. Overall the assessment has concluded that the design of the proposed road development minimises flood risk to the development itself and is rated as having a low probability of flooding.

A potential significant flood risk impact to lands including residential properties has been identified in the vicinity of the N83 Tuam Road Junction, resulting in the permanent encroachment and loss of some of the flood storage area from this flood risk area. Flood relief mitigation measures involving improved land and road drainage, provision of compensation storage and storm water pumping to the Terryland Basin have been designed, which when implemented will result in providing a residual moderate to significant positive impact by reducing the risk of serious flooding in this area.

At all other locations along the proposed road development, there will only be slight to imperceptible impacts on flood risk as very minimal encroachment of floodplains occur and design measures in the form of large culverts and stormwater attenuation ponds are included in the design. Residual flood risks exist at the drainage outfalls and their associated attenuation ponds and at the various culverts due to potential blockages. It should be noted however, the culverts have been sized with additional capacity for climate change impacts, controlled overflow systems are in place and there will be a program of regular inspections and maintenance and therefore the risk of blockages is slight.

Therefore, significant negative cumulative impacts will not arise.

19.4.2.24 Interaction of Water Quantity with Biodiversity

Construction and Operational Phase

The interaction of water quantity with biodiversity is the same as that presented above for the interaction of water quantity with human being, population and health and material assets. Significant negative cumulative impacts will not arise.

19.4.2.25 Interaction of Resource and Waste Management with Human Beings

Construction and Operational Phase

The interaction of resource and waste management with human beings, under the environmental topic of both human beings, population and human health and material assets, was considered. For example, the demolition of residential properties will generate demolition waste which will require transportation and disposal off site. Transportation requires construction traffic which can generate noise and air emissions which can impact on people. This has been addressed previously in **Sections 19.4.2.1** to **19.4.2.3** above.

During the design process, every effort was made to balance the import and export volumes of materials thereby minimising construction traffic generation in the first instance. In addition, the Construction and Demolition Waste Management Plan (as presented in the Construction Environmental Management Plan (CEMP)) has been prepared to ensure that waste arising during the construction and demolition phase will be managed and disposed of in a way that ensures compliance with the provisions of the Waste Management Acts 1996-2011 and associated Regulations (1996-2011) to ensure that optimum levels of reduction, re-use and recycling are achieved. Furthermore, the Construction Traffic Management (CTMP) (as presented in the CEMP) has been prepared to ensure that construction traffic will be managed and monitored safely and efficiently throughout the construction phase. As a result of the implementation of mitigation measures such as the CEMP and the design measures, significant residual impacts will not arise.

Lackagh Quarry will also be fully acquired to facilitate the construction of the proposed road development. This will result in a moderate impact on soils and geology due to the loss of a portion of future quarry or pit reserves. This will also result in a significant impact on a material asset impact. Financial Compensation for this impact is to be agreed by a valuer at a later stage after appropriate liaison with the property owners affected. Financial compensation does not form part of the EIA process and is therefore not considered further.

19.4.2.26 Interaction of Material Assets with Human Beings

Construction and Operational Phase

As described in **Chapter 15, Material Assets, Non Agriculture**, the proposed road development will cross through lands populated by residential and commercial properties on the outskirts of Galway City and include both agriculture lands and lands zoned for development. The proposed road development has been designed to avoid as many properties as possible, but given the distribution of development and the presence of linear type development of the city with housing along most roads radiating out of the city, its construction will unfortunately and unavoidably result in a number of property demolitions or acquisitions with some concentrations in particular areas. As well as the direct negative impact on the householders themselves, this will present a varying negative impact on remaining residents and at a community level depending on the strength of community interaction that has evolved at each location and the sustainability of community facilities such as

schools. In several locations, and particularly in Na Foraí Maola and Troscaigh and the vicinity of the N59 Moycullen Road, the N84 Headford Road and in Castlegar, there will be a significant impact on local communities due to the need to acquire or demolish a high proportion of existing properties in these areas. It is important to recognise that the people whose homes will be subject to compulsory purchase across the route of the proposed road development have genuine concerns that their lives will be adversely affected. Many have lived in the area many years, or indeed, all of their lives.

In the event of an approval of the Protected Road Scheme and Motorway Scheme and approval under Section 51 of the Roads Act 1993 (as amended), by An Bord Pleanála and subject to the availability of funding, Notice to Treat will be served firstly on owners, lessees and occupiers of the dwelling houses and commercial properties to be acquired, within six months of the scheme becoming operative, unless an application has been made for Judicial Review, in which case the Notice to Treat will be served in accordance with the provisions of Section 217 (6A) of the Planning and Development Act 2000 as inserted by the Compulsory Purchase Orders (Extension of Time Limits) Act 2010. Compensation will be agreed or determined by the property arbitrator as soon as possible after service of Notice to Treat. After compensation has been agreed or determined and satisfactory title has been produced, part payment can be made while the claimant remains for an agreed period in the property to be acquired. This will facilitate the claimant in removing uncertainty and will facilitate arrangements being made, as early as possible, to secure a replacement property.

19.4.2.27 Interaction of Risks of Major Accident and/or Disaster and Human Beings, Population and Human Health

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters was assessed and potential interactions with human beings. A number of events were identified (Refer to **Table 19.1** above) such as major traffic collision (as described previously), hydrological and hydrogeological events, structural collapse events, tunnel fire events, service utility events and ground collapse events. As above, although, the consequence of these events is ‘very serious’, potentially resulting in mass injury or loss of life, the likelihood is considered to be low. The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely remote. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence events. Refer to **Section 19.2** above for further details.

19.4.2.28 Interaction of Risks of Major Accident and/or Disaster and Air Emissions, Noise and Vibration Emissions

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters and potential interactions with air, noise and vibration emissions was also assessed. A number of events were identified (Refer to **Table 19.1** above) such as major traffic collision (as described previously), structural collapse events, tunnel fire events, service utility events and ground collapse events. As above, although, the consequence of these events is 'very serious', potentially resulting in significant air, noise and vibration emissions, the likelihood is considered to be low. The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely remote. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence events. Refer to **Section 19.2** above for further details.

19.4.2.29 Interaction of Risks of Major Accident and/or Disaster with Soil, Water and Biodiversity

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters and potential interactions with soil, water and biodiversity was also assessed. A number of events were identified (Refer to **Table 19.1** above) such as major traffic collision (as described previously), hydrological and hydrogeological, structural collapse events, tunnel fire events, service utility events and ground collapse events. As above, although, the consequence of these events is 'very serious', potentially resulting in pollution of water or contamination of soil with the consequential impacts on biodiversity or direct impacts on biodiversity as a result of ground collapse, the likelihood is considered to be low. The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely remote. All reasonably practicable measures have been included in the design of the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence events. Refer to **Section 19.2** above for further details.

19.4.2.30 Interaction of Risks of Major Accident and/or Disaster with Material Assets

Construction and Operational Phase

The vulnerability of the proposed road development to risks associated with major accidents and/or disasters and potential interactions with material assets was also assessed. A number of events were identified (Refer to **Table 19.1** above) such as major traffic collision (as described previously), hydrological and hydrogeological, structural collapse events, tunnel fire events, service utility events and ground collapse events. As above, although, the consequence of these events is 'very serious', potentially resulting in impacts to properties, the likelihood is considered to be low. The potential for low likelihood but potentially high consequence major accident and/or disaster events remains, although the possibility is extremely remote. All reasonably practicable measures have been included in the design of

the proposed road development to reduce the severity and potential consequences of low likelihood but potentially high consequence events. Refer to **Section 19.2** above for further details.

19.4.3 Summary

All of the potential impacts arising from the potential interactions were identified at a very early stage in the design process and in the EIAR preparation. They were therefore addressed in the design of the proposed road development and in the baseline and impact assessment studies. As a result, the potential impacts were either avoided altogether through design measures or they were addressed through specific mitigation measures. This early identification process helped to identify and minimise the potential for significant interactions of impacts arising. The assessment presented above of the interactions of the potential impacts did not identify the need for any additional mitigation measures.

19.5 Cumulative Impacts

19.5.1 Introduction

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects could cumulatively result in a likely significant environmental impact. Cumulative impacts arising from the interaction between the proposed road development and other projects for each of the environmental factors have been identified and addressed in detail in the respective chapters. The results of these cumulative assessments are also summarised below.

Cumulative impacts are defined as the combination of many minor impacts creating one larger, more significant impact (NRA, 2009 and EPA 2017). Cumulative impacts consider existing stresses on the natural environment as well as developments that are underway and in planning.

Following a review of the committed projects and the planning files for Galway City and County Council, the following projects and plans which are either in place, or proposed, were considered to have the potential for cumulative impacts to increase the significance of the impacts predicted for the proposed road development are listed below:

- The planning registers for Galway City and County Council
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- M6 (M17/M18) Motorway Service Area (pre-planning)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)

- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021
- Bearna Local Area Plan 2007–2017
- Gaeltacht Local Area Plan 2008–2018
- Údarás na Gaeltachta's Strategic Plan 2014–2017
- Ardaun Local Area Plan 2018–2024

19.5.2 Human Beings, Population and Human Health

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on human beings, population and human health.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed in relation to human beings, population and health as they have the potential for cumulative impacts in respect to this environmental topic:

- The planning registers for Galway City and County Council
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- M6 (M17/M18) Motorway Service Area (pre-planning)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021
- Bearna Local Area Plan 2007–2017
- Gaeltacht Local Area Plan 2008–2018
- Údarás na Gaeltachta's Strategic Plan 2014–2017
- Ardaun Local Area Plan 2018–2024

19.5.2.1 Socio-Economics

The proposed road development will improve accessibility both within and to/from Galway City and connectivity between Galway City and areas outside of the city including Connemara, the East and North West of Ireland. As a result, there are significant potential positive impacts which will benefit economic and regional development, including tourism. The proposed road development will have a positive cumulative socio-economic impact with the proposed roads projects listed above and with the Galway Harbour Project.

The proposed road development could also stimulate new physical commercial or tourism development. These developments would be subject to planning assessment given the objectives set out in the Galway City and Galway County Development Plans to consolidate development and to provide for balanced sustainable development. They will also be subject to Appropriate Assessment to avoid any adverse impacts on sensitive landscapes and natural habitats. These considerations apply also to the largely rural area surrounding the city, noting that the proposed road development will be used for a proportion of commuting journeys as well as for regional journeys. The transfer of some of these journeys to the proposed road development away from the existing N6 is a significant positive impact, but any cumulative impacts on settlement patterns will be monitored and addressed in future development and local area plans.

The proposed road development will facilitate the full implementation of the GTS and to provide for improved public transport and facilities for pedestrians and cyclists. For example, the reduced volume of traffic on the existing N6 will present an opportunity to greatly improve the continuity of cycle lanes, including at junctions, and to add more pedestrian crossings, while minimising impacts on traffic flow. Once implemented, all these measures will have a very significant impact on safety and the journey amenity of pedestrians and cyclists, and on general environmental quality if this contributes to a modal transfer from vehicles.

In summary the cumulative impacts of the projects and plans listed above in association with the proposed road development are positive.

19.5.2.2 Irish Language

Having considered the proposed road development in tandem with other relevant plans or projects identified above, it is considered that no significant negative cumulative impact upon the status of Irish as a community language will occur.

19.5.2.3 Human Health

It is not considered that there will be any negative cumulative effects on human health. The distances between the projects noted above and the proposed road development results in no cumulative noise or air quality impacts. There is potential that reduced journey times and fewer unforeseen delays could have a potential benefit on psychological health. Any projects which make roads safer and reduce the probability of road accidents and fatalities can only be seen in positive terms from a human health perspective. The cumulative health benefits of the proposed road development with the GTS are further assessed below.

Quantification of cumulative health benefits with the GTS

The cumulative health benefits of the proposed road development with the GTS were assessed by using the Western Regional Model to quantitatively measure some of the health, accessibility and social inclusion[15] impacts once the proposed road development and the GTS were fully implemented.

Physical Activity Analysis

The assessment indicates that the total number of people cycling, over a 24-hour period in Galway City, will increase by approximately 21% as a result of the implementation of the GTS and associated cycling infrastructure improvements. This increase in cyclists will result in a reduced risk of premature deaths for those who are new to cycling and currently exercise infrequently. By comparison, results from the assessment indicate that pedestrian trips (trips which use walking only to get from origin to destination) in Galway City are expected to decrease marginally (less than 1% reduction) across the full 24-hour period. The reduction in pedestrian activity in Galway City is mostly as a result of people transferring to cycling or using the improved public transport services implemented as part of the Galway Transport Strategy.

Accessibility Analysis

The changes in accessibility for key locations were determined on a zone by zone basis. This was undertaken using a visual representation of the changes in journey times between the 'Do-Nothing' and 'Do-Something' Scenarios for cycling, public transport and private car. The results of this assessment showed that in general, most zones experience a decrease in car journey times. There are however, a small number of zones, mostly in the city centre, which are expected to experience an increase in car journey times to access key sites. This is as a result of the public transport priority measures, such as private vehicle restrictions on Salmon Weir Bridge, which make accessing these areas by car more difficult. In general, most zones also experience a decrease in public transport journey times. There are however, a small number of zones which are expected to experience an increase in public transport journey times as they will not be served as directly by public

[15] It should be noted that this analysis represents an assessment of those elements of Health, Accessibility and Social inclusion which can be measured using model outputs from the WRM. As such, these outputs are not representative of all the benefits/disbenefits which result from the implementation of the GTS under these categories.

transport once the changes in bus routes proposed as part of the GTS are implemented.

Social Inclusion Analysis

Outputs from the traffic model have also been used to assess the impacts of the Galway Transport Strategy in terms of Social Inclusion. For this assessment, the outputs from the economic module (produced using the software Tuba) were used to visually identify which locations would benefit or suffer disbenefits as a result of the GTS. The benefits in this instance are measured in terms of journey time saving. These benefits/disbenefits were then compared against the deprivation index for the same locations to assess how the benefits of the proposed road development are distributed among affluent and less affluent areas. The results of this assessment showed that most zones will experience an improvement in journey times for all trips from those zones. Some city centre zones however, will experience increase in journey times by car following the implementation of the GTS measures. This is a result of public transport priority measures and public realm enhancements in the city centre which will increase travel time for some car trips into and around the city centre. With respect to public transport, a small number of zones are seen to experience marginal disbenefits as a result of bus route changes which give these zones less direct access to the public transport network. Comparison of these benefits with the deprivation index show that, in general, the benefits of the proposed road development are distributed evenly between disadvantaged and more affluent areas and no disbenefits were experienced in the most disadvantaged areas.

19.5.3 Material Assets – Non Agriculture

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on material assets – non agriculture.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed in relation to material assets non-agriculture:

- The planning registers for Galway City and County Council
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride

- Bearna Greenway
- Galway to Oughterard (part of the Galway to Clifden) Greenway
- Galway City to Oranmore (part of the Galway to Dublin) Cycleway

Although the proposed road development overlaps with other proposed projects such as the GTS measures, none of the projects or plans have been identified that will result in a significant negative cumulative impact with the addition of the proposed road development upon material assets non-agriculture.

19.5.4 Material Assets – Agriculture

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on agriculture.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed in relation to material assets agriculture:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- M6 (M17/M18) Motorway Service Area (pre-planning)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
  - Investigation of prospective sites to the east of the city for Park and Ride
  - Bearna Greenway
  - Galway to Oughterard (part of the Galway to Clifden) Greenway
  - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

The cumulative impact on regional agriculture is appraised by assessing the impact on agriculture in County Galway due to the landtake for the proposed road development in combination with other recently constructed and planned roads (M6, N83/N18, N59 Maam Cross to Oughterard and Moycullen Bypass). These recently constructed and planned roads in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends[16] the cumulative impact on agriculture in County Galway is not significant.

There are cumulative impacts from the built M6 Motorway Scheme on four individual land parcels at the eastern end of the proposed road development. While there are significant cumulative impacts individually on these four[17] land parcels

[16] From 2010 – 2016 cattle numbers and sheep numbers increased 7% and 25% respectively – source CSO Table AAA08 and DAFM website.
[17] MO 751, MO 752, MO 754, and MO 758.

within the study area, the overall cumulative impacts on agriculture is not significant.

19.5.5 Air Quality and Climate

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on air quality and climate.

Of the projects and plans listed in **Section 19.5.1** the following have been assessed in relation to air quality and climate:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

The traffic data used in the assessment for future years, considers development proposed for the Galway area as listed above and incorporates the cumulative impacts of these projects into the do-minimum traffic data used in this EIAR. No major construction works are envisaged to take place in such proximity to the proposed road development which would significantly impact on dust levels. The cumulative impacts are considered by incorporating background concentrations into predicted values and existing traffic volumes. Negative significant cumulative impacts on air quality will not arise.

The main objective of the GTS is to address the current and future transport requirements of Galway City and its environs. This includes the provision of new transport infrastructure. The proposed road development has been assessed with reference to the of the Galway Transport Strategy measures. Negative significant cumulative impacts on air quality will not arise.

19.5.6 Noise and Vibration

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on noise and vibration.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed for cumulative impacts in relation to noise and vibration:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- M6 Motorway (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Galway Transport Strategy (GTS), which includes the following:
    - Investigation of prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway

The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of other committed plans and projects listed above which have the potential to generate traffic volumes within the study area. Further details on the traffic modelling forecasts are set out in **Chapter 6, Traffic Assessment and Route Cross Section**.

The cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. During the Do-Nothing scenario, road traffic flows along the existing road network have been modelled and the cumulative traffic noise level calculated. For the modelled Do-Something scenarios, road traffic along the existing road network coupled with traffic along the proposed road development are combined to obtain a cumulative traffic noise level. The assessment takes account of any alignment alterations to the existing roads and junctions and the re-distribution of traffic along the existing road network as a result of the proposed road development.

In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Table 17.13** and **Table 17.15** of **Chapter 17, Noise and Vibration**.

In relation to cumulative construction impacts, other committed significant construction projects have been reviewed in the vicinity of Galway City and County including the N59 Maam Cross to Oughterard Road Project (consented and pre-construction), N59 Moycullen Bypass (consented and pre-construction) and M6(M17/M18) Motorway Service Area (pre-planning). All of these projects are set back at considerably distances from the proposed road development such that if under construction at the same time, no cumulative noise and vibration impacts would occur.

Whilst there is the potential to be other small local construction activities across the study area during the construction phase, for the purposes of this assessment it has been assumed that works associated with the proposed road development will be the dominant noise and vibration source at any one location.

19.5.7 Landscape and Visual

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant landscape and/or visual effect. The projects and plans listed in **Section 19.5.1** were assessed in relation to landscape and visual.

The construction and operational stages of the proposed road development give rise to significant, very significant and profound landscape and visual impacts. These impacts are generally focused within the immediate corridor of the proposed road development on the urban/rural edge of the city. To the west and north of the city much of the lands along the corridor are identified for agricultural and/or amenity uses. Further sports and amenity developments are likely within the grounds of NUIG Sporting Campus on the west bank of the River Corrib. While there are some small areas of residential zoning at Ballymoneen, Rahoon, Letteragh, Ballindooley and Castlegar, development in these areas is unlikely to give rise to significant landscape and visual impacts or cumulative impacts. An area of enterprise, industrial and related zoning is indicated to the north and east of Galway Racecourse, but much of these lands are already developed within Parkmore Business Park.

The eastern end of the proposed road development falls within the area covered by the Draft Arduan Local Area Plan (LAP) 2017. This Draft LAP proposes major development in the area, including new residential and commercial developments on c.81 hectares of an overall LAP area of c.164 hectares on the east side of the city. The existing M6/N6 corridor runs through the centre of the Draft LAP area and the proposed road development ties-in to the existing road infrastructure within the Draft LAP area. While the Draft LAP envisages significant changes to the landscape and visual setting of the area, it is likely that the measures proposed will be delivered on a phased basis over a long period of time. Nevertheless, depending on timing of delivery, scope exists for some limited or nonsignificant cumulative landscape and visual impacts to arise.

The Galway Transport Strategy (GTS) also envisages further transport-related developments, including public transport and cycleway and greenway measures. However, these measures are unlikely to further adversely impact the landscape or visual setting along the proposed road development.

The Galway Harbour Port Extension project is at planning stage. However, if permitted, it is not expected that any significant cumulative landscape or visual effects will arise because of the separation distance between the proposed road development and the port location.

Other projects, such as the M17 Galway to Tuam Road Project (operational); the N18 Oranmore to Gort Road Project (operational); the N17 Tuam Bypass (operational); the M6 Motorway (operational); M6(M17/M18) Motorway Service Area (pre-planning); the N59 Maam Cross to Oughterard Road Project (consented and pre-construction); and the N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction), are considered too distant from the

proposed road development to give rise to cumulative landscape and/or visual effects.

In summary it is considered that there is limited potential for any significant cumulative impacts with other planned or potential developments and that these will not further increase the adverse or negative impacts associated with the proposed road development.

19.5.8 Archaeological, Architectural and Cultural Heritage

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on archaeological, architectural and cultural heritage. Of the list of projects and plans listed in **Section 19.5.1** the cumulative impacts of the proposed road development on archaeology, architecture and cultural heritage with the following projects and plans have been assessed:

- N59 Maam Cross to Oughterard Road Project
- M17 Galway to Tuam Road Project
- N18 Oranmore to Gort Road Project
- N17 Tuam Bypass
- M6 Motorway
- Proposed Galway Harbour Port Extension
- Galway Transport Strategy (GTS), which includes the following:
    - Investigate prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Galway to Oughterard (part of the Galway to Clifden) Greenway
    - Galway City to Oranmore (part of the Galway to Dublin) Cycleway
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021

No proposed developments have been identified that will result in a significant negative cumulative impact with the addition of the proposed road development upon the archaeological, architectural and cultural heritage resource.

The proposed Galway to Oughterard (part of the Galway to Clifden) Greenway will see the reopening of the railway line and potentially the repair of railway heritage features. The proposed road development will impact on a portion of the original railway line route where it passes through Dangan Lower. Sections of the railway line have been removed over the years due to differing activities, meaning that the proposed road development will result in a slight negative cumulative impact on the route of the original railway line. The proposed Galway to Oughterard Greenway scheme will have a positive impact on the cultural heritage of the area, which will help to offset the potential negative cumulative impact associated with

the proposed road development. No negative residual impacts have been identified in association with the route of the former railway.

19.5.9 Soils and Geology

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on soils and geology. Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed for cumulative impacts with respect to soils and geology:

- The N59 Oughterard to Maam Cross
- M17/N18 Gort to Tuam PPP Scheme
- Galway Harbour Port Extension
- Galway Transport Strategy (GTS), which includes the following:
    - Investigate prospective sites to the east of the city for Park and Ride
    - Bearna Greenway
    - Tuam Road Bus Corridor Scheme
    - Expansion of Public Bike Hire Scheme
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021

Cumulative soils and geology impacts can occur when other projects in the locality have similar soils and geology potential impacts as the proposed road development. Cumulative impacts are assessed based on the residual impact of these impacts on the proposed projects.

The following feature/construction activity impacts are identified in some of the projects and plans, listed above, and are also present in the proposed road development:

- Peat Removal/Disposal
- Impact to Geological Heritage Sites
- Contaminated Ground
- Loss of agricultural land and solid geology
- Haulage of material

As part of the environmental evaluation of the proposed road development the residual impact from peat removal/disposal, geological heritage sites and contaminated ground is imperceptible. Due to the mitigation measures considered in the other projects, the residual impact of those projects is also considered imperceptible. Therefore, the cumulative impact of these impacts is imperceptible.

The cumulative impact for:

- peat removal/disposal is considered to be imperceptible as peat is intended to remain within the proposed development boundary for each respective project

- geological heritage sites is considered to be imperceptible as none of the projects indicate that geological heritage sites or county geological sites will be impacted. The Galway Transport Strategy specifically outlines that it will seek to protect such sites from any inappropriate measures
- contaminated ground is considered to be imperceptible as the Galway City Development Plan (2017-23) waste management policy contains policy to ensure that proposals on contaminated lands include appropriate remediation measures

Loss of agricultural land and solid geology and haulage of material, whether imported or sourced from site, are activities that are also considered on other projects. Mitigation measures for other projects include the reduction and minimisation of removal or disposal of material off-site and the reuse of such material whether in construction fill or in designated material deposition areas. Consideration has been given to the extent of material which will be imported, exported or disposed and their combined impact. The cumulative impact is considered to remain unchanged as the combination of the impact will not increase the magnitude of the impact from small adverse.

The significance of the impact of the proposed road development operational activities is imperceptible and is considered not to change in combination with the other projects.

Therefore, there are no other plans or projects that are likely to result in a significant effect on soils and geology cumulatively with the proposed road development.

19.5.10 Hydrogeology

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on hydrogeology.

Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed for cumulative impacts with respect to hydrogeology:

- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS)

The hydrogeological baseline has identified that the groundwater bodies in the study area have a number of existing stresses in the form of discharges from wastewater treatment systems, septic tanks, road runoff, quarrying and agriculture. These potential pollutant sources have the potential to impact the groundwater environment in the form of reducing water quality by increased contaminants. On the basis of the design and mitigation measures employed for the proposed road

development to accommodate and maintain the existing groundwater body (GWB) sub-catchments there will be no alteration of groundwater pathways that could modify the impacts from existing pollutant sources.

The zone of influence from the N59 Maam Cross to Oughterard Road Project and N83/N18 projects occurs within separate groundwater sub catchments to those identified for the proposed road development and as such any impacts from these projects will not impact on the groundwater systems that the proposed road development straddles.

The proposed Galway Harbour Port Extension is located within the same GWB sub-catchment as the proposed road development but is located significantly downgradient of the proposed road development in transition coastal waters.

The Galway Transport Strategy includes some realignment of local roads but these do not incorporate cuttings or structures that could impact on groundwater.

The cumulative impact of the proposed road development with existing stresses on the hydrogeological environment and those in development or in planning has been considered. On the basis of the design and mitigation measures employed for the proposed road development there will be no alteration of groundwater pathways and hence no enhanced impact from existing pollutant sources within groundwater bodies. Furthermore, those new developments being constructed or proposed are located in different GWB sub catchments or located significantly downgradient so as not to cumulate impacts.

On this basis the cumulative impacts of the above projects with the proposed road development is imperceptible.

19.5.11 Hydrology

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on hydrology. Of the list of projects and plans listed in **Section 19.5.1** the following have been assessed for cumulative impacts with respect to hydrology:

- M17 Galway to Tuam Road Project (operational)
- N18 Oranmore to Gort Road Project (operational)
- N17 Tuam Bypass (operational)
- N59 Maam Cross to Oughterard Road Project (consented and pre-construction)
- N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)
- Proposed Galway Harbour Port Extension (planning stage)
- Galway Transport Strategy (GTS)
- Galway City Development Plan 2017–2023
- Galway County Development Plan 2015–2021

The hydrological baseline has identified that the surface water features in the study area have a number of existing stresses in the form of discharges from surface water drainage systems, road runoff and agricultural activities and loss of natural flood plains. These sources have the potential to impact the existing hydrological environment in the form of reducing water quality by increased contaminants or by increasing flood risk. On the basis that the design and mitigation measures employed for the proposed road development will maintain or improve water quality in existing catchments, there are no significant hydrological residual impacts associated with the proposed road development.

The Galway County Development Plan 2015-2021 and Galway City Development Plan 2017-2023 set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and restricting surface water runoff discharge rates to meet that of greenfield runoff rates and volumes. Therefore, the residual impact associated with future proposed or planned developments on the hydrological environment is imperceptible.

The M17/M18 Tuam to Gort Motorway Project has recently completed construction. The portion of the M17 and Tuam Bypass (circa 26km) that lies north of the existing R339 Galway to Caltra Road, lies within the catchment of the River Corrib. The portion of the M17/M18 to the south of the R339 lies within the catchment of Galway Bay for the Oranmore River, Clarin River, Kilcolgan River, Gort River and Lough Coole turlough system. This M17/M18 scheme has been designed with a modern road drainage system and construction methods that reduce the potential impact on the receiving environment. Where residual local impacts arise at various road outfalls, culvert crossings and displacement of flood storage, cumulative impacts do not arise downstream in the River Corrib or to Galway Bay given the very large dilution available and the travel distances involved.

There will be no perceptible hydrological cumulative impact between the M17/M18 Tuam to Gort Motorway Scheme and the proposed road development.

The N59 Maam Cross to Oughterard Road Project and N59 Maigh Cuilinn (Moycullen) Bypass Road Project also lie within the catchment of the River Corrib upstream of the proposed road development. Both N59 road schemes have been designed with modern road drainage systems and construction methods that reduce the potential impact on the receiving environment. Where local impacts arise at various road outfalls and culvert crossings and displacement of flood storage and changes to river and stream morphology, these impacts do not translate downstream in the River Corrib (given the very large dilution available and the travel distances involved) as perceptible impacts that would combine with residual impacts from the proposed road development. There will be no perceptible hydrological cumulative impact between the N59 Maam Cross to Oughterard to Road Project and the N59 Maigh Cuilinn (Moycullen) Bypass Road Project with the proposed road development.

The proposed Galway Harbour Port Extension is located in the Galway City Coastal catchment and at the mouth of the River Corrib Estuary downstream of the proposed road development. Hydrological residual impacts have been identified in the Galway Harbour Company, Galway Harbour Extension Environmental Impact Statement and include potential changes in salinity levels, current velocities and current directions, pollution risks during construction, maintenance dredging impacts and changes in wave climate.

The proposed road development will have no noticeable effect on the flow regime, salinity, sedimentation process or water quality downstream in the River Corrib Estuary and Inner Galway Bay, both during construction and operation stages. Therefore, no cumulative hydrological impacts will occur between the proposed Galway Harbour Port Extension and the proposed road development, even if the construction phases for both projects were to coincide.

There are a number of elements of the Galway Transport Strategy (GTS) located within the same hydrological catchments as the proposed road development. The relevant elements of the GTS that could have an impact on hydrology include:

- The upgrading of pedestrian network
- The upgrading of cycle network which includes the Bearna Greenway, the Galway to Dublin Cycleway (Galway City to Oranmore)[18], the Galway to Oughterard Greenway[19] and non-greenway elements
- Expansion of Public Bike Hire Scheme (currently under construction)
- The upgrading of public transport network including increased frequency of buses and a new cross city access link (including the N17 Tuam Bus Corridor Scheme)
- The upgrading of road network which includes modifications to the existing road infrastructure and the proposed road development

The GTS is at the plan stage so each individual measure will be subject to further detail design. The detailed design shall be in compliance with the surface water management and water quality objectives set out in the various development plans. Therefore, there will be no negative cumulative impacts associated with this development.

19.5.12 Biodiversity

This section of the chapter presents the assessment carried out to examine whether the proposed road development along with any other projects or plans could cumulatively result in a likely significant effect on biodiversity.

[18] The GTS includes that portion of the Galway to Dublin Cycleway between Galway City and Oranmore.
[19] The GTS includes that portion of the Galway to Oughterard Greenway between Galway City and Moycullen.

All of the projects and plans listed in **Section 19.5.1** have been assessed for cumulative impacts with respect to biodiversity. In addition, the following projects were also considered in the assessment:

- Sáilín to Silverstrand Coastal Protection Scheme
- Salthill Coastal Protection Works (Blackrock to Galway Golf Club)

The potential for other plans or projects to act cumulatively with the proposed road development to adversely affect the integrity of any European sites, is considered in Section 12 of the NIS (termed "in combination effects" in the context of the NIS assessment). The four European sites within the ZoI of the proposed road development are Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA and Inner Galway Bay SPA. There is no potential for any other plans or projects to act in combination with the proposed road development to adversely affect the integrity of any other European sites, as they are beyond the ZoI of the proposed road development.

The assessment identified those plans and projects which have the potential to impact on Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA and Inner Galway Bay SPA and assessed whether they had the potential to adversely affect the integrity of these European sites. Any plan or proposed project that could potentially affect these European sites in combination with the proposed road development must adhere to the overarching policies and objectives of the relevant land use plan(s), as dependent on the location of the specific plan or proposed project. These are the *Galway County Development Plan 2015-2021*, the *Galway City Council Development Plan 2017-2023*, the *Clare County Development Plan 2017-2022* and the *Mayo County Development Plan 2014-2020*. The protective policies and objectives in these land use plans will ensure the protection of European sites across the identified potential impact pathways.

As the proposed road development will not affect the integrity of Lough Corrib cSAC, Galway Bay Complex cSAC, Lough Corrib SPA or Inner Galway Bay SPA, and given the protection afforded to European sites under the overarching land use plans, it was concluded that there is no potential for adverse effects on the integrity of any European sites to arise as a consequence of the proposed road development acting in combination (or cumulatively) with any other plans or projects.

The potential for cumulative impacts to arise are limited to those residual impacts associated with the proposed road development and those effects the proposed road development will have on the receiving environment that are measurable in some way, but themselves will not result in a likely significant residual effect on biodiversity.

The residual impacts associated with the proposed road development relate to the following and are discussed in the sections below:

- Habitat loss, including both the permanent loss of Annex I habitats and habitats valued as being of local importance
- The potential loss of a Peregrine falcon nest site due to long-term disturbance/displacement impacts

- Impacts on bats as a result of the construction and operation of the proposed road development

The other impacts associated with the proposed road development that are measurable in some way, but themselves will not result in a likely significant effect on biodiversity are impacts on the existing hydrological and hydrogeological regimes, impacts on air quality and impacts to species as a result of disturbance or displacement. The land use zonings and environmental protection objectives that relate to this area are contained in the *Bearna Local Area Plan 2007-2017*, *Galway County Development Plan 2015-2021* and the *Galway City Council Development Plan 2017-2023*. There are also environmental protective policies and objectives in both the *Galway City Council Development Plan 2017*-2023 and the overarching *Galway County Development Plan 2015-2021*, and in River Basin Management Plan for Ireland (2018-2021) (draft for public consultation) for the area. The *Ardaun Local Area Plan 2018–2024* is subject to the protective policies and objectives in the *Galway City Council Development Plan 2017*-2023. The *Gaeltacht Local Area Plan 2008–2018* and the *Údarás na Gaeltachta's Strategic Plan 2014–2017*, in so far as they could interact cumulatively with the proposed road development given their spatial coverage, are subject to the protective policies and objectives in the *Galway County Development Plan 2015-2021* and the *Galway City Council Development Plan 2017*-2023.

Given the zonings and objectives that are in place in these plans, it is considered that there are no other plans or projects that are likely to result in a significant effect on biodiversity, cumulatively with the proposed road development, as a consequence of impacts on surface water and groundwater air quality and disturbance or displacement impacts.

19.5.12.1 Impacts from habitat loss

As outlined in **Section 8.4.2** of **Chapter 8, Biodiversity** habitat loss to development and land use change has been an ongoing impact locally which may have already had effects on local biodiversity. Those projects listed above in **Section 19.5.1** have, or are likely to, result in habitat impacts (including those of a high biodiversity value such as Annex I habitat types) which may also have knock-on effects on fauna species. Therefore, land use change and habitat losses are likely to continue to some degree and the loss and fragmentation of habitat associated with the proposed road development will contribute to this trend locally.

Habitat losses, regardless of their own habitat value, also have the potential to have an effect on the local fauna populations that they support. The most significant impact in that regard are the likely effects of habitat loss on the local bat populations; particularly the Menlo Castle Lesser horseshoe bat population (impacts on bats are discussed separately below).

The losses of areas of Annex I habitat associated with the proposed road development are considered to be at the highest level of geographic significance for the habitats involved. In addition, the proposed road development will be contributing to an existing trend of Annex I habitat loss locally. While the cumulative effect of habitat losses, would increase the magnitude of the impact, it

does not increase the geographic scale of the impact significance associated with the proposed road development.

In relation to areas of locally important habitats that will be lost, given the habitat types involved and that at any greater geographic scale they are likely to remain in a favourable conservation condition, any cumulative losses of these habitat types are not likely to increase the impact significance.

The protective polices in the *Bearna Local Area Plan 2007-2017*, the *Galway City Council Development Plan 2017-2023* and the *Galway County Development Plan 2015-2021* to protect biodiversity will moderate any future impacts on biodiversity, including those related to Annex I habitat types. Where the losses can be compensated[20] for (see **Section 8.8** of **Chapter 8, Biodiversity**), this offsets the contribution of the proposed road development to existing losses of the habitat type in question whilst ensuring that there is no potential for other developments to result in a significant cumulative impact.

19.5.12.2 Impacts on Peregrine falcon

Peregrine falcon is an Annex I species but is not listed as a Special Conservation Interest (SCI) species for its breeding population in any SPAs within the ZoI of the proposed road development (the closest SPA with Peregrine falcon as an SCI is in Sligo). It is also on the Green BoCCI (breeding)[21] List. Birds on the Green list are considered to be those of least conservation concern in Ireland. The local Peregrine falcon population are valued as being of county importance as the local area supports more than 1% of the known nesting sites across counties Galway and Clare.

Due to the potential for long-term disturbance and displacement of the Lackagh Quarry Peregrine falcon pair from the existing nest site, the proposed road development is likely to result in a significant negative residual effect on Peregrine falcon, at the county geographic scale.

The two other Peregrine falcon nest sites that are present locally are likely to continue to support breeding Peregrine falcon. One site is an inactive quarry which is zoned for agricultural use and is therefore, not likely to see any increased disturbance from development; the second nest site is a regularly occupied site in an active quarry and the baseline levels of disturbance, to which the resident Peregrine pair are habituated, are likely to remain. Neither of these sites are likely to be affected by any of the projects listed above, given their locations relative to where those strategies/projects will be implemented. Existing pressures at the county level on suitable nest site availability are expected to continue and may act cumulatively at the county geographic scale, but there is not sufficient data available to quantify this. However, any additional pressures on the Peregrine falcon population will not increase the overall significance of the impact of the

[20] These are not compensatory measures in the context of the requirements of Article 6(4) of the Habitats Directive as they are not compensating for an impact that would adversely affect the integrity of any European site. As concluded in the NIS, the proposed road development will not result in such an impact on any European site

[21] Birds of Conservation Concern in Ireland (BoCCI) after Colhoun & Cummins, 2013

proposed road development to a national level impact given that the species is currently considered to be of a low conservation concern for its national population.

Therefore, there are no other projects that are likely to cumulatively act along with the proposed road development to increase the predicted impact significance of the proposed road development on Peregrine falcon from the likely significant negative residual effect, at the county geographic scale.

19.5.12.3 Impacts on bats

The predicted residual impacts on bats include loss of roosts, loss of foraging habitat and the barrier/severance effect posed by roads.

Some proportion of existing roost sites in the vicinity of the proposed road development may deteriorate over time and become unsuitable for bats to use (e.g. derelict structures and old trees). Therefore, the roost sites that will be affected by the proposed road development could potentially contribute to natural declines in other roost sites locally.

Loss of foraging habitat and barriers to bat movements may result from development of zoned land within the northern fringes of Galway City. Lands used by bats which are also zoned for development include light industrial zoning (C2.1) near the N84 Headford Road and Ballindooley, which may affect the proposed artificial roost via increased light spill. The recreation and amenity zoning at NUIG may also interact with the flight paths of bats moving between the Aughnacurra roosts and Menlo Castle and the use of those lands by foraging bats (e.g. where additional lighting may be proposed in the future). However, all of these impacts would be controlled by the assessment of individual planning applications which would consider the effects on protected species such as bats as part of their appraisal by the competent authority, having regard to the protective environmental policies outlines in the *Bearna Local Area Plan 2007-2017*, the *Galway City Council Development Plan 2017-2023* and the *Galway County Development Plan 2015-2021* and the Ardaun Local Area Plan 2018-2024 [22] to protect biodiversity. Therefore, there are no additional cumulative impacts predicted regarding loss of foraging habitat or from barriers to bat movement.

19.5.13 Overall Cumulative Impact Assessment

The individual cumulative assessments for each environmental factor of each of the projects and plans have been considered above. No additional mitigation measures are required for any cumulative effects of the proposed road development with other projects and plans. Each of the projects and plans listed in **Section 19.5.1** as a whole have also been considered with the proposed road development and the assessment is presented below in **Table 19.3**. No additional cumulative impacts other than those already identified in the individual assessments will arise.

[22] Although a draft plan at the time of writing, it is included as it is likely to be adopted in 2018.

Table 19.3: Overall Cumulative Impact Assessment

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
M17 Galway to Tuam Road Project (operational)	**Socio Economic:** Overall there will a positive cumulative impact in terms of connectivity between Connemara, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends[23] the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. This project is complete and therefore there will be no additional cumulative increase in air quality pollutant levels. The cumulative impacts are considered by adding background concentrations to predicted concentrations. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	

[23] From 2010 – 2016 cattle numbers and sheep numbers increased 7% and 25% respectively – source CSO Table AAA08 and DAFM website.

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: As the drainage for this project will ultimately discharge to the River Corrib and Galway Bay, there is the potential for cumulative effects on water quality in the River Corrib and in Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
N18 Oranmore to Gort Road Project (operational)	**Socio Economic:** Overall there will be a positive cumulative impact in terms of connectivity between West County Galway, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends from 2010 to 2016 the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. This project is complete and therefore there will be no additional cumulative	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	increase in air quality pollutant levels. The cumulative impacts are considered by adding background concentrations to predicted concentrations. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no negative significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant negative cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no negative significant cumulative impacts	
	Biodiversity: As the drainage for this project will ultimately discharge to the River Corrib and Galway Bay, there is the potential for cumulative effects on water quality in the River Corrib and in Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
N17 Tuam Bypass (operational)	**Socio Economic:** Overall there will be a positive cumulative impact in terms of connectivity between West County Galway, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. This project is complete and therefore there will be no additional cumulative increase in air quality pollutant levels. The cumulative impacts are considered by adding background concentrations to predicted concentrations. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Biodiversity: As the drainage for this project will ultimately discharge to the River Corrib and Galway Bay, there is the potential for cumulative effects on water quality in the River Corrib and in Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
M6 Motorway (operational)	**Socio Economic:** Overall there will be a positive cumulative impact in terms of connectivity between West County Galway, Galway City and the rest of Ireland	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. This project is complete and therefore there will be no additional cumulative increase in air quality pollutant levels. The cumulative impacts are considered by adding background concentrations to predicted concentrations. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for tthis project, and the environmental protection policies included within the *Galway County Development Plan 2015-2021*, and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
M6 (M17/M18) Motorway Service Area (pre-planning)	**Socio Economic:** Overall there will be a positive cumulative impact for users of the M6 and the proposed road development given demand for services on these roads.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Noise and Vibration: Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Soils and Geology: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
	Hydrogeology: The zone of influence for this project is within a different groundwater body sub catchment to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
N59 Maam Cross to Oughterard Road Project (consented and pre-construction)	**Socio Economic:** Overall there will a positive cumulative impact in terms of connectivity between Connemara, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase. .	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration.**	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within a different groundwater body to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: Any impacts on habitats or bats associated with this project will not affect the significance of the residual impacts associated with the proposed road development. As a project which lies within the River Corrib catchment, there is the potential for cumulative effects on water quality in the River Corrib and Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
N59 Maigh Cuilinn (Moycullen) Bypass Road Project (consented and pre-construction)	**Socio Economic:** Overall there will be a positive cumulative impact in terms of connectivity between Connemara, Galway City and the rest of Ireland.	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Agriculture: This project in combination with the proposed road development will require <1% of the agricultural area of County Galway (346,881 ha). When considered along with upward agricultural productivity trends the cumulative impact on agriculture in County Galway is not significant.	
	Air Quality and Climate: The traffic data used in the assessment for future years, considered this project and incorporates the cumulative impacts into the do-minimum traffic data. Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase.	
	Noise and Vibration: The traffic data used as part of the noise impact assessment is based on future modelled scenarios taking account of this project and the cumulative traffic noise impacts have been assessed at each of the receptor locations considered as part of this assessment. In this regard the cumulative road traffic noise impacts are incorporated into the calculated operational noise levels set out in **Chapter 17, Noise and Vibration**.	
	Landscape and Visual: Given the distance between the proposed road development and this project there will be no significant negative cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no significant cumulative impacts	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Hydrogeology: The zone of influence for this project is within a different groundwater body to the proposed road development and therefore there will be no significant cumulative impacts	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no significant cumulative impacts	
	Biodiversity: Any impacts on habitats or bats associated with this project will not affect the significance of the residual impacts associated with the proposed road development. As a project which lies within the River Corrib catchment, there is the potential for cumulative effects on water quality in the River Corrib and Galway Bay. Considering the mitigation measures considered and approved by An Bord Pleanála in granting consent for the project, the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the residual impacts associated with the proposed road development, no significant negative cumulative impacts are likely.	
Galway Harbour Port Extension (planning stage)	**Socio Economic:** Overall there will be a positive cumulative impact on the economy of Galway City	None
	Irish Language: Given the distance between the proposed road development and this project there will be no significant cumulative impact	
	Human Health: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Material Assets Non-Agriculture: There is no overlap between the proposed road development and this project and therefore there will be no significant cumulative impacts	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Given the distance between the proposed road development and this project there will be no significant cumulative impacts during the construction phase.	
	Noise and Vibration: Galway Harbour Port Extension is set back a considerably distance from the proposed road development such that if under construction at the same time, no cumulative noise and vibration impacts would occur.	
	Landscape and Visual: Given the separation between the proposed road development and the port it is not expected that there will be any significant cumulative impacts	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Archaeology, Architectural and Cultural Heritage: Given the distance between the proposed road development and this project there will be no significant cumulative impacts	
	Soils and Geology: The residual impacts on soils and geology are imperceptible and therefore there will be no negative significant cumulative impacts	
	Hydrogeology: The zone of influence for this project is within transitional and coastal waters that are significantly downgradient to the proposed road development. The residual impacts on hydrogeology are imperceptible and there will be no negative significant cumulative impacts.	
	Hydrology: The residual impacts on hydrology are imperceptible and therefore there will be no negative significant cumulative impacts on downstream estuarine and coastal waters.	
	Biodiversity: There will be no significant negative cumulative impacts as the proposed road development will not have any residual impacts on biodiversity along the coastline or in Galway Bay.	
Sáilín to Silverstrand Coastal Protection Scheme	This project only has the potential for a cumulative impact with Biodiversity. **Biodiversity:** There will be no significant negative cumulative impacts as the proposed road development will not have any residual impacts on biodiversity along the coastline or in Galway Bay.	
Salthill Coastal Protection Works (Blackrock to Galway Golf Club)	This project only has the potential for a cumulative impact with Biodiversity. **Biodiversity:** There will be no significant negative cumulative impacts as the proposed road development will not have any residual impacts on biodiversity along the coastline or in Galway Bay.	
Galway Transport Strategy (GTS),	**Socio Economic:** The proposed road development will facilitate the full implementation of the GTS and to provide for improved public transport and facilities for pedestrians and cyclists. Therefore, there will be an overall positive cumulative impact.	None
	Irish Language: The proposed road development will facilitate the full implementation of the GTS and improve connectivity for people in the Gaeltacht areas. Therefore, there will be an overall positive cumulative impact.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
which includes the following: • Investigation of prospective sites to the east of the city for Park and Ride • Bearna Greenway • (part of the Galway to Spiddal Greenway) • Galway to Oughterard (part of the Galway to Clifden) Greenway • Galway City to Oranmore (part of the Galway to Dublin) Cycleway	**Human Health:** The proposed road development will facilitate the full implementation of the GTS and to provide for improved public transport and facilities for pedestrians and cyclists and the associated health benefits in terms of physical activity, improved accessibility and social inclusion. Therefore, there will be an overall positive cumulative impact.	
	Material Assets Non-Agriculture: Whilst the GTS may result in significant impacts on material assets non agriculture, none of these material assets are also impacted by the proposed road development and therefore there will be no significant cumulative impacts	
	Material Assets Agriculture: Any potential impacts on agricultural lands as a result of the GTS will not be significant. Therefore, there will be no cumulative impacts.	
	Air Quality and Climate: The main objective of the GTS is to address the current and future transport requirements of Galway City and its environs. This includes the provision of new transport infrastructure. The proposed road development has been assessed with reference to the of the Galway Transport Strategy measures. There will be no significant cumulative impacts on air quality.	
	Noise and Vibration: The main objective of the GTS is to address the current and future transport requirements of Galway City and its environs. This includes the provision of new transport infrastructure which has not yet been fully developed. The proposed road development has been broadly assessed with reference to the Galway Transport Strategy and review of traffic re-distribution as a result of the proposed road development has been considered along existing roads. The GTS measures are unlikely to further adversely impact the noise and vibration impacts along the proposed road development.	
	Landscape and Visual: The GTS measures are unlikely to further adversely impact the landscape or visual setting along the proposed road development. There will be no significant negative cumulative impacts	
	Archaeology, Architectural and Cultural Heritage: The proposed Galway to Oughterard (part of the Galway to Clifden) Greenway will see the reopening of the railway line and potentially the repair of railway heritage features. The proposed road development will impact on a portion of the original railway line route where it passes through Dangan Lower. Sections of the railway line have been removed over the years due to differing activities, meaning that the proposed road development will result in a slight negative cumulative impact on the route of the original railway line. The proposed Galway to Oughterard Greenway scheme will have a positive impact on the cultural heritage of the area, which will help to offset the potential negative cumulative impact associated with the proposed road development. No negative residual impacts have been identified in association with the route of the former railway.	
	Soils and Geology: It is not envisaged that the GTS measures will have a significant impact on soils and geology. Therefore, there will be no negative significant cumulative impacts	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Hydrogeology: The GTS includes some realignment of local roads but these do not incorporate cuttings or structures that could impact on groundwater. Therefore, there will be no negative significant cumulative impacts	
	Hydrology: The GTS is at the plan stage so each individual measure will be subject to further detail design. The detailed design shall be in compliance with the surface water management and water quality objectives set out in the various development plans. Therefore, there will be no cumulative impacts associated with this development.	
	Biodiversity: Consideration of the GTS has also taken into account the full lengths of the greenways/cycleways of which only part are included within the GTS (e.g. Galway City to Oranmore Cycleway is part of the Galway to Dublin Cycleway). Considering the residual impacts associated with the proposed road development, the mitigation measures included within the GTS, and the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the *Galway City Council Development Plan 2017-2023*, no significant negative cumulative impacts are likely.	
Galway City Development Plan 2017–2023	**Socio Economic:** The proposed road development will help achieve objectives in the Galway City Development Plan and there will be a positive impact on quality of life for Galway City residents, accessibility for employment and amenity, economic development due to reduced congestion and improved connectivity, and residential and commercial development potential. There will be no significant negative cumulative impacts.	None
	Irish Language: The Galway City Development Plan includes objectives to promote the Irish Language. There will be no significant cumulative impacts with the proposed road development.	
	Human Health: The Galway City Development Plan includes objectives to improve physical activity, improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Other than as considered in the landscape and visual assessment, it is not envisaged that any further significant cumulative impacts will arise from the proposed road development.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Archaeology, Architectural and Cultural Heritage: There will be no cumulative impacts.	
	Soils and Geology: The Galway City Development Plan provides a series of objectives for waste management, and the sustainable management of construction and demolition (C&D) waste generated by development, while also outlining that development on contaminated lands include appropriate remediation measures. The Plan also sets out environmental protection policies. Therefore, there will be no significant cumulative impact.	
	Hydrogeology: Not applicable	
	Hydrology: The Galway City Development Plans set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore no significant cumulative impact with the proposed road development arises.	
	Biodiversity: The objectives within the City Council Development Plan, were assessed for potential cumulative impacts with the proposed road development. Considering the residual impacts associated with the proposed road development and the environmental protection policies included within the *Galway City Council Development Plan 2017-2023*, no significant negative cumulative impacts are likely.	
Galway County Development Plan 2015–2021	**Socio Economic:** The proposed road development will help achieve objectives in the Galway County Development Plan and there will be a positive impact on quality of life for Galway County residents, accessibility for employment and amenity, economic development due to reduced congestion and improved connectivity, and residential and commercial development potential. There will be no significant negative cumulative impacts.	None
	Irish Language: The Galway County Development Plan includes objectives to promote the Irish Language. There will be no significant cumulative impacts with the proposed road development.	
	Human Health: The proposed road development will help achieve objectives in the Galway County Development Plan and there will be a positive impact on quality of life for Galway County residents to improve physical activity, improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Other than as considered in the landscape and visual assessment, it is not envisaged that any further significant cumulative impacts will arise from the proposed road development	
	Archaeology, Architectural and Cultural Heritage: There will be no cumulative impacts.	
	Soils and Geology: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within this Plan, no significant negative cumulative impacts are likely.	
	Hydrogeology: Not applicable	
	Hydrology: The Galway County Development Plan set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore no significant cumulative impact with the proposed road development will arise.	
	Biodiversity: The objectives within the County Council Development Plan, including proposals to upgrade/improve the R336 road between Bearna and Scríb and the N59 road between Clifden and Maam Cross were assessed under this plan for potential cumulative impacts. Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
Bearna Local Area Plan 2007–2017	**Socio Economic:** The proposed road development will reduce the volume of through traffic from Bearna Village and improve accessibility and connectivity for residents to employment and other destinations within Galway City and the rest of Ireland. This supports the objectives of the LAP by improving traffic flow and quality of life in Bearna. There will be no significant negative cumulative impacts.	None

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Irish Language: The Bearna Local Area Plan 2007-2017 (amended 2012) includes objectives to promote the Irish Language. There will be no significant cumulative impacts with the proposed road development.	
	Human Health: The proposed road development will reduce the volume of through traffic from Bearna Village and there will be opportunities to improve physical activity, improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Other than as considered in the landscape and visual assessment, it is not envisaged that any further significant cumulative impacts will arise from the proposed road development	
	Archaeology, Architectural and Cultural Heritage: Not applicable	
	Soils and Geology: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Bearna Local Area Plan 2007–2017* and the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
	Hydrogeology: Not applicable	
	Hydrology: This set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore, no significant cumulative impact with the proposed road development will arise.	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Bearna Local Area Plan 2007–2017* and the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
Gaeltacht Local Area Plan 2008–2018	**Socio Economic:** The proposed road development will have a positive impact on residents living in the Gaeltacht arising from improved accessibility for employment and amenity and economic development. This supports the objectives of this Plan. There will be no significant negative cumulative impacts.	None
	Irish Language: The proposed road development will facilitate a strategic development principle of this LAP. Therefore, there will be an overall positive cumulative impact**.**	
	Human Health: The Galway County Development Plan includes objectives to improve physical activity, improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Other than as considered in the landscape and visual assessment, it is not envisaged that any further significant cumulative impacts will arise from the proposed road development.	
	Archaeology, Architectural and Cultural Heritage: Not applicable	
	Soils and Geology: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Gaeltacht Local Area Plan 2008–2018* and the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
	Hydrogeology: Not applicable	
	Hydrology: This set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore, no significant cumulative impact with the proposed road development will arise.	
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Gaeltacht Local Area Plan 2008–2018* and the *Galway County Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	
Údarás na Gaeltachta's Strategic Plan 2014–2017	**Socio Economic:** The proposed road development will have a positive impact on residents living in the Gaeltacht and West Galway County arising from improved accessibility for employment and amenity and economic development. This supports the objectives of this Plan. There will be no significant negative cumulative impacts.	None
	Irish Language: The proposed road development will facilitate a number of key objectives of this Strategic Plan. Therefore, there will be an overall positive cumulative impact.	
	Human Health: The proposed road development will have a positive impact on residents living in the Gaeltacht and West Galway County arising from improved accessibility and social inclusion. There will be no significant cumulative impacts with the proposed road development.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: Not applicable	
	Archaeology, Architectural and Cultural Heritage: Not applicable	
	Soils and Geology: Not applicable	
	Hydrogeology: Not applicable	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	Hydrology: Not applicable	
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within the *Galway County Development Plan 2015-2021* and the *Galway City Council Development Plan 2017-2023* no significant negative cumulative impacts are likely.	
Ardaun Local Area Plan 2018–2024	**Socio Economic:** The proposed road development will have a positive impact on residents living in Galway arising from improved accessibility for employment and amenity and economic development. This supports the objectives of this Plan. There will be no significant negative cumulative impacts.	None
	Irish Language: Not applicable.	
	Human Health: Not applicable.	
	Material Assets Non-Agriculture: Not applicable	
	Material Assets Agriculture: Not applicable	
	Air Quality and Climate: Not applicable	
	Noise and Vibration: Not applicable	
	Landscape and Visual: While the Ardaun LAP envisages significant changes to the landscape and visual setting of the area, it is likely that the measures proposed will be delivered on a phased basis over a long period of time. Nevertheless, depending on timing of delivery, scope exists for some limited or insignificant cumulative landscape and visual impacts to arise.	
	Archaeology, Architectural and Cultural Heritage: Not applicable	
	Soils and Geology: The Ardaun Local Area Plan outlines that proposed developments will be guided in general by the objectives, development standards and guidelines of the City Development. Therefore, the residual impact associated with future proposed or planned developments in relation to soils and geology is imperceptible. Therefore, there will be no significant cumulative impact.	
	Hydrogeology: Not applicable	
	Hydrology: This set out a series of objectives for appropriate management of surface water and water quality of the existing environment. This will ensure that future planning applications are developed using design criteria to ensure that no there is no	

Plan/Project	Potential Cumulative Impacts on Environmental Factors	Cumulative Impact (if any)
	unacceptable hydrological impact on receiving watercourses or surface water sewers associated with planned developments. This will typically be achieved in terms of flood risk and stream morphology by utilising sustainable drainage systems (SuDS) and complying with the Flood Risk Management Planning Guidelines (2009). Therefore, no significant cumulative impact with the proposed road development will arise.	
	Biodiversity: Considering the residual impacts associated with the proposed road development, and the environmental protection policies included within both the *Ardaun Local Area Plan 2018–2024* and the *Galway City Development Plan 2015-2021*, no significant negative cumulative impacts are likely.	

19.6 Transboundary Impacts

Transboundary impacts relate to potential impacts on other Member States, i.e. outside of the Republic of Ireland. Given the location of the proposed road development and extents of its zone of influence no transboundary impacts will arise.

19.7 References

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TII. (2017) *Road Safety Audit* GE-STY-01024.

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